Analysis of Seed Germination and Growth in Varied Lights

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ABSTRACT:

During the whole 14 days it seems as if the dark ones have grown better progress ethan the light and mid plantings. Through evidence the dark has germinated at 90% through the series of plants. The mid, only 85% of seeds has germinated. The light to summarize this germination occurrence only 50% if each category of plants has had the experience of germination.

INTRODUCTION/BACKGROUND

The Experiment was performed to show if plants in the dark are able to grow vs the plants that were grown in the light and mid-light, putting a set of three boxes for each, the dark box had absolutely no light, for the mid-light one it got covered with a jacket on top so it can get half of the light, an LED light was put over the box that was for the plants in the light so it can have more light than the others. Soybeans, Rye, and Pearl Millet were the seeds that were used to do this experiment. The reason these seeds were chosen was to test how two monocots would do against one dicot. The two monocots were the Pearl Millet and the Rye and the one dicot would be the Soybean. Two of each of the seeds were placed in a ziploc bag in the three boxes to see how well they would grow and if it were even possible for them to grow in the absolute dark. The experiment was tested to show how well the seeds would grow in the dark and too see if monocots would grow better than the dicot ones.

The research that was used, was to look at the information of the pearl millet seed to see how many days it would take to germinate and about what type of temperature could it grow in http://www.alliedseed.com/pearl-millet/. The rest of the research about the soybeans and the rye was also about their germination and information about the seeds just like the pearl millet https://plants.usda.gov/plantguide/pdf/pg_lopep.pdf. http://www.growinganything.com/growing-soybeans.html . Also on some research that was done it said that not all the plants are able to germinate in the dark. It's possible for a seed to germinate in the dark but growth and survival are different. The growth implies an increase in size or weight so things can survive and not grow. Although if you stick with a fairly large plant it won't immediately die. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-soybean http://scienceline.ucsb.edu/getkey.php?key=297

HYPOTHESIS:

The hypothesis is that the dicots and monocots in direct sunlight will grow larger than the monocots and dicots exposed to no light and half light.

METHODS AND MATERIALS:

- 36 one gallon ziplock bags
- 6 pieces of standard 8’ 5’ cut graph paper
- 60 pearl millet seeds
- 60 rye seeds
- 60 soybean seeds
- Non ionized water
- Ruler
- A marker to label bags.
- LED red and blue spectrum Grow-light
- Three new cardboard boxes from Costco
- Cloth/t-shirt
- String
- Light Timer
- 36 iron rods

Procedure:

1. Gather materials together.
2. Set up the grow-light 4 inches above the top of two boxes and set the third one in a darker spot.. Cut the top of the first box off. (purple light is required to make the plant function, blue and red LEDS =purple lights)
3. Cut the top of the second box off, and put a cheesecloth over the opening, or any fabricated material to block out some of the light
4. Leave the third box alone. The top closed will keep the plants dark.
5. In each box, cut six divots per two inches on opposite sides. These will be to keep the dowels holding seed bags secure.
6. Next, gather the gallon sized ziplock bags and pierce 4 holes. 2 on either side on the front of the bag about inch away from each other vertically.

7. After punching the holes, get an iron rod and line it up with the 4 holes, then string the rod onto the bag, creating a way for the bag to be hung within the boxes.
8. Put 15 mL of non-ionized water into the bottom of a bag.
9. Mark ten evenly spaced dots with your pencil on an 8' by 5' piece of graph paper, 4 inches up from the bottom of the paper.
10. Slide a sheet of the 8'5' measured graph paper into the bag.
11. Laying the bag flat, place seeds on the marked points from step 9. Position as precisely and gently as possible.
12. Repeat steps 1-3 for the remaining bags, seeds, and paper. Label each bag with either sun, half-sun, or dark, the seed type, and the number one or two to distinguish duplicates for measurement.
13. Put 2 of each seed type bag in each of the dark/light environments, hanging them vertically across the top of the box with the metal bars. To keep them stable, you may tape to ends to the box.
14. Close the top of the dark box and tape.
15. Using the timer, set up the light for the half-light and full light boxes to turn on at 7 am, and turn off at 4:30. Lights are on for 9 ½ hours.
16. Water with 15 ml water every other day. On weekends, put water into the corresponding other day for either day one or day two, and give 5 ml of water to the other test bags
17. Gather data from each bag of the growth over the span of 14 days

Info for planting based on actual info on how to plant in the dark //source//: https://www.nextnature.net/2012/02/growing-plants-in-the-dark/

RESULTS AND DATA:

The plants that were exposed to no light grew longer than the plants exposed to any light at all.

The monocots and dicot growth average for the plants exposed to no light was 48.26, while the half light average was 32.56. The average growth of monocots and dicots exposed to full light was 40.99. The plants that were not exposed to light grew 15.7 millimeters more on average, and the difference of growth between no light and half light plants was 7.27 millimeters. In conclusion, the plants that were exposed to no light whatsoever, were the ones who grew significantly larger than the other plants. However, it should be noted that there was a missing millet experiment, which was assigned to the half light procedures; but it was unfortunately misplaced and was not tested. Therefore,

the Half light data could very well be equal with the full light data, or the half lights could have a larger data average than what was surveyed in the experiment.

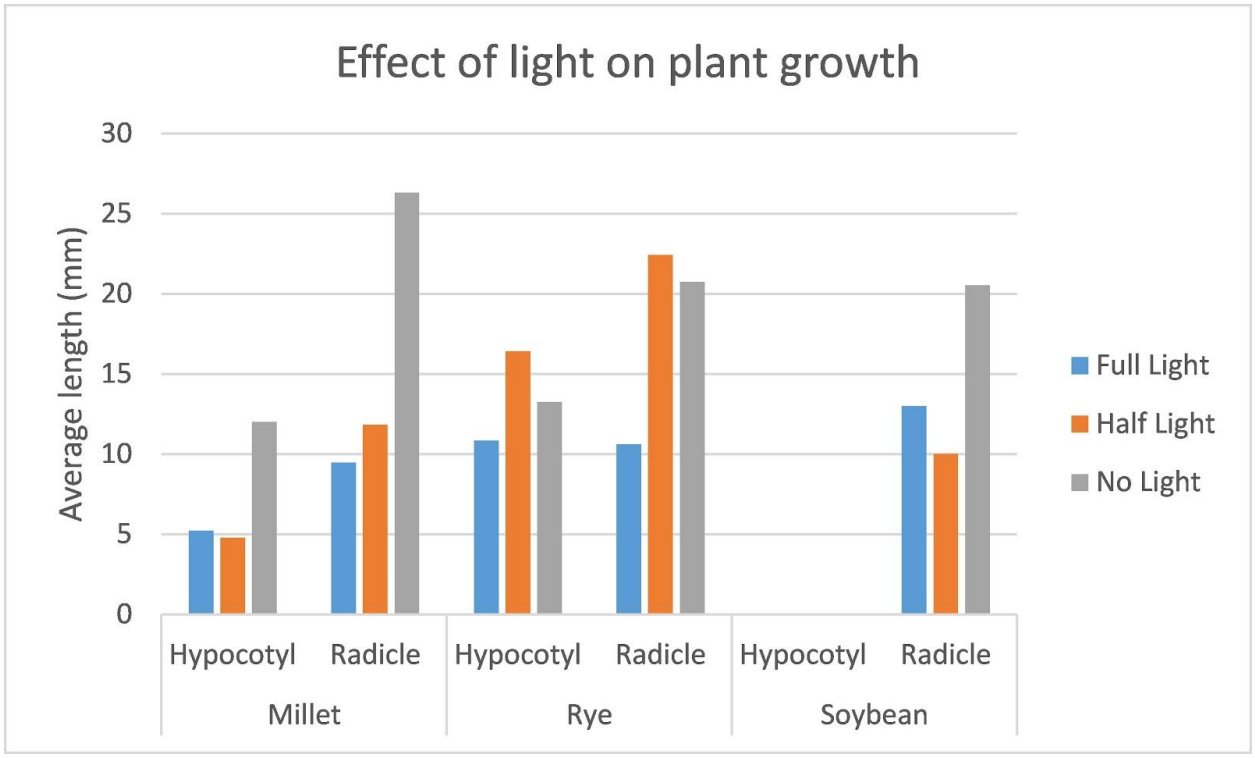
The reason the plants exposed to no light at all grew more than plants exposed to light was possibly due to rapid cell elongation(https://www.reference.com/science/plants-grow-faster-dark-a5cef99cfd57883e). This process allows for the plants to stretch upward towards the light, but not actually giving them nutrients or minerals for growth because without the process of photosynthesis, plants can not grow. So instead of actual development, the plants simply stretched towards the sunlight.

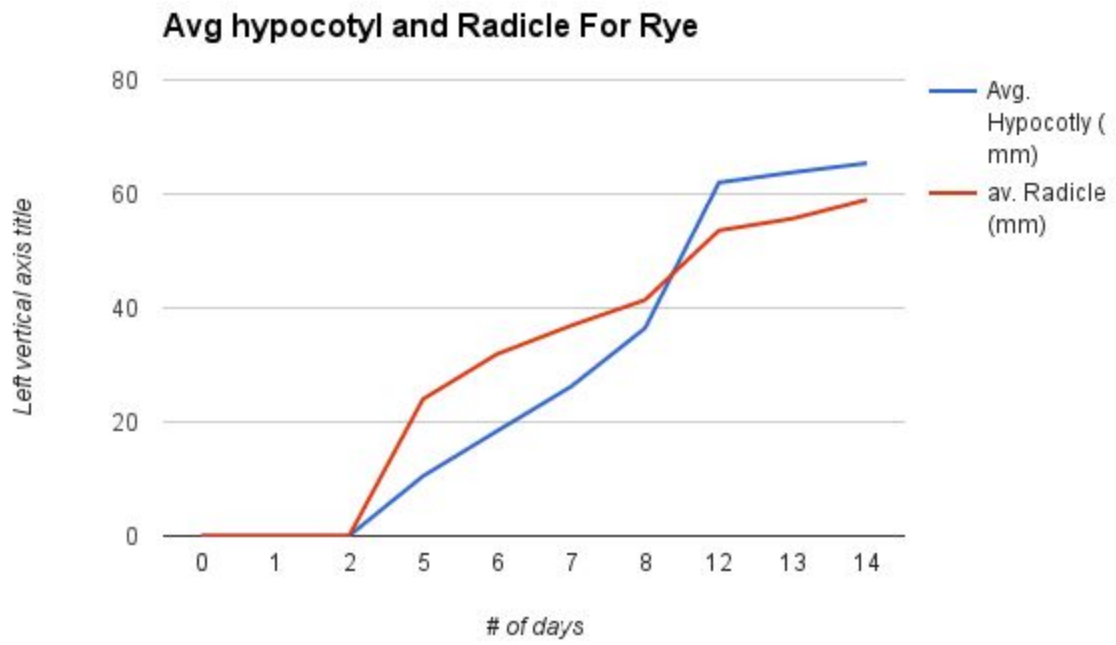
There were some unforeseen complications within the project that may have caused inconsistencies within the data. About halfway through the experiment, the box that contained the seed not exposed to light was kicked. Some of the seeds within the box fell off the notches within and the seeds fell within the bags. After reorganization, some seed growth may have been stunted, or the seed numbering may have been confused after the incident. Another problem within the experiment was the issue of measuring. For the rye and millet seeds, it was difficult to see where the root ended, because they were the same color as the grid paper we use, and borderline transparent. There was also minor difficulties in measuring the soybeans, due to the hypocotyl and radicle being one constant shoot. It was challenging to differentiate between the 2, which may have upset the data minorly.

Also another issue with the project was that the millet developed a bizarre red stain around seeds 4, 5, and 6 on the day 1 seeds. This was seen as a development of mold, which caused those plants to not grow as much as the other plants, because it proved to be toxic to the seeds.The unaffected seeds grew around the stain, and fortunately, they continued to grow normally.

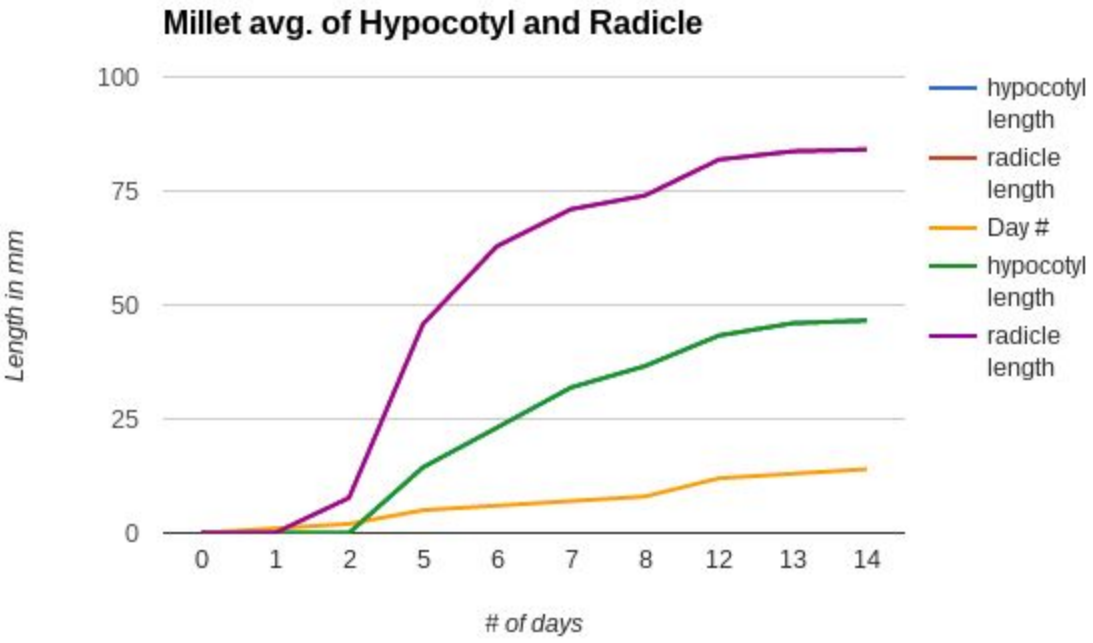
In order to measure the plants' weights in grams, we took multiple steps in order to ensure an accurate measurement. First, we put the plants on a scale, weighing them with their respective groupings. For example, the soybeans that were in the second bag that were exposed to full light were measured together and so on. After marking down their weights, the plants were placed in an incubator to be dried out. After drying out, the plants' measurements were taken again and with that we can see how much of the plant's weight was simply water weight. However, the side experiment went a tad off course. The millet and Rye proved to be too small to weigh accurately without their water weight. However, it showed that the Soybean average growth was similar with the water weight and without.

Mentors work: Jordan Hay

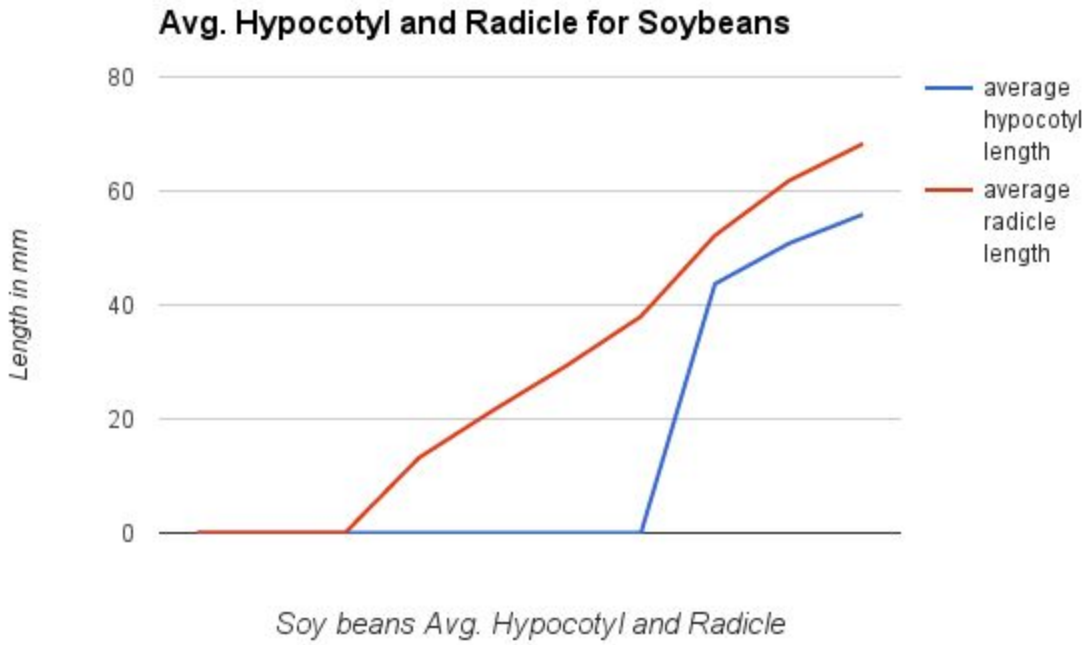

Effect of light on plant growth
Average length (mm)
30
25
20
15
10
5
0
Hypocotyl
Radicle
Hypocotyl
Radicle
Hypocotyl
Radicle
Millet
Rye
Soybean
Full Light
Half Light
No Light



This graph shows the average light, dark, and mid growth for the Rye plants. This is the average measurement for the Hypocotyl and Radicle.



This graph shows the average light, dark, and mid growth for the Pearl Millet plants. This is the average measurement for the Hypocotyl and Radicle measurements.



This graph shows the average measurements of light, dark, and mid for the Soybeans plant.

INSPIRATION FOR FUTURE RESEARCH:

The results from this experiment bring up a variety of questions that could be used in further experiments. For one, the Rye and Millet seeds grew differently in the same degree of light, even though they were both monocots. To go into the research of how these two plants metabolize different degrees of light would be a good follow-up research experiment. C4 plants like Pearl Millet use carbon fixation from carbon dioxide to create sugars and other biomolecules. They're adapted to function in hot and dry climates because of this fixation

Conversely, C3 plants like Rye use water in their fixation of carbon dioxide to make their sugars and biomolecules. This requires more moderate climates and a different concentration of carbon dioxide than those of C4 plants. In our experiment we had the same moistness of each plant and the same light degrees, but no measurement

of trace minerals, temperature or carbon dioxide were conducted. To control or change these factors might reveal more about how monocots grow.

As well as this, Soybeans in our experiment grew taller than any of the other seeds as our hypothesis predicted. However, the seeds rolled within the bags and were hard to keep track of. Though we tried our best to keep measurements as precise and consistent as possible, we relied on mostly memorization of the general size and shape of the soybeans. To conduct another experiment where the Soybeans could be more securely placed would be another good follow up.

More related to our study's results would be an investigation into why the soybeans grew taller than the other plants. We assumed that because they were dicots they would grow taller, but a more thorough look into factors that make dicots grow taller, such as a growth comparison with other smaller seed dicots would be another good follow up study.

One study we ended up following up on was an investigation into the weights of dicots and monocots grown in dark and light. This was to see if the increased height of the plants grown in dark meant that they had a heavier weight without water than those which had metabolized Carbon dioxide. The hypothesis was that the plants grown in dark would have a lighter weight once they were dried out than those grown in light due to the fact that those in light had created some amount of matter through their metabolization. Our follow up was tough to conclude, however. The percentage of water lost in full-light soybeans on average was 89.5%, the highest among the soybean averages, 86% water in half-light soybeans, and 87.5% water no light soybeans but the trait didn't carry over to the other seedlings. Rye seedlings averaged 93% water in full light, 95.75% water in half lights, and 95% water in no light, corresponding with our prediction. Millet in no light averaged 94% water weight, Millet seeds in half-light were an outlier, with 80% liquid (and because they grew mold in the earlier experiment), and Millet in no light average 94% water

The lighter weights of some of the smaller seeds once they were dried out was unmeasurable on our scale going to hundredths of grams. This may have skewed the results of our weighing slightly, as we had to round up to 0.01 to receive any data. To weigh the dried out seedlings in a similar experiment again and use a more precise scale would be a great follow up to our attempt.

Lastly, a study into why the no-light plants grew longer would be a worthy follow up to our investigation. Cells elongate when they no longer have energy from photosynthesis to continue, and this may be the reason why our no-light plants, and specifically, no-light soybeans, grew significantly taller than the other tested plants. One could look at the cells of plants in different light environments under a microscope at the end of an experiment like ours.