Glow and Grow: How Do Light Colors Affect Plant Growth?

By, Mirthika Asok and Adelynn Lim

2024-2025 Science Fair

Table of Contents

Acknowledgements

During our journey of creating our project and discovering new things, there are some people we couldn't have done it without. Firstly, we would like to thank our parents, family and Westmount community for pushing us through this project and supporting us the whole way through. Without them, this project couldn't have happened. We also acknowledge the professional electrician who helped us with our questions. Thanks a lot.

Timeline

We had to finish a big project on time. In order to keep track, we made a list of things that we needed to do, such as the presentation and trifold. We also made a schedule that we had to stick to. Here is our timeline:

- *Decide question by Week 4 of August*
- *Start logbook by Week 1 of September*
- *Start creating survey by Week 2 of September*
- *Start research by Week 2 of September*
- *Start sharing survey by Week 2-3 of September*
- *Have our question, hypothesis, and procedure decided by Week 2 of September*
- *Start presentation by Week 4 of September*
- *Have a rough skeleton of the presentation by Week 2 of November*
- *Finish ½ of research by week 1 of December*
- *Start experiment by week 1 of December*
- *Start slideshow presentation by week 3 of December*
- *Finish research by week 4 of december*
- *Give finishing touches and finalize project by the end of January*
- *Prepare for presentation during week one of February*
- *Present at WCS School Science Fair on Friday, February 7, 2025*

Ideas

Ideas

October 2, 2024

Deciding the topic was challenging because of all the amazing science ideas there are. We were originally thinking of making the topic about why apples turn brown and how to stop it but then we thought of a more complex and interesting topic. This idea was about the molding and ripening of fruits.

October 8, 2024

As we did more research, we found an idea that could be helpful in the world: separating water and oil sands completely. But then we decided that something more interesting would be how different colored lights affect the growth of plants.

Background Research

November 5, 2024

PAR: Light wavelengths plants can use.
PPF: Total light emitted.
PPFD: Light intensity at specific area.
WAVELENGTH: Measure of light's color.
Kelvin: Color temperature of light.
PPE: Efficiency of light conversion for plants.

November 10, 2024

What is the difference between grow lights and regular lights?
Grow lights work by converting electrical energy into photons which are light particles which stimulate photosynthesis and encourage plant growth. On the other hand, regular LED lights lack many of the wavelengths needed for plant growth. Grow lights use the lights in PAR (photosynthetic active radiation) which is the light of wavelengths which is 400 nanometers to 700 nanometers. While grow lights offer controlled climate conditions and extended periods of light, natural sunlight always remains more powerful.

What are light wavelengths?
Light waves are moving energy that appear as waves. They are NOT visible. Light waves are made of microscopic particles called photons. Light appears as waves. The wavelengths are the distances between the wave ripples (The distance between each peak of the waves). The lengths are usually measured in nanometres which are in billionths of a metre. Each wave has two parts, the electric and magnetic part. That's why light is called electromagnetic radiation. Wavelengths travel at different speeds and each color has their own wavelength. For example: blue light wavelengths are 470 nm apart and red are 665 nm apart. Light wavelengths are created from electric and magnetic fields.

<u>What are the different types of grow lights?</u>

There are 4 different types of grow lights:

Fluorescent grow lights: These grow lights come in a variety of forms, including tube lights and compact fluorescent lights (CFL). Although they produce a full spectrum of lights for plants, fluorescent lights are less energy efficient than LED bulbs but can have a harmful heat output.

Incandescent grow lights: Although some growers use incandescent bulbs, this type of grow light has a high amount of heat output that can burn plants. Incandescent lights are cheaper than other grow light options, but they use more energy and burn out quicker.

LED grow lights: LED (light-emitting diodes) lights have a longer lifespan than most other types of grow lights. They are energy-efficient and have a low heat output. LED lights typically come in two styles: LED grow light bulbs and larger LED grow light fixtures.

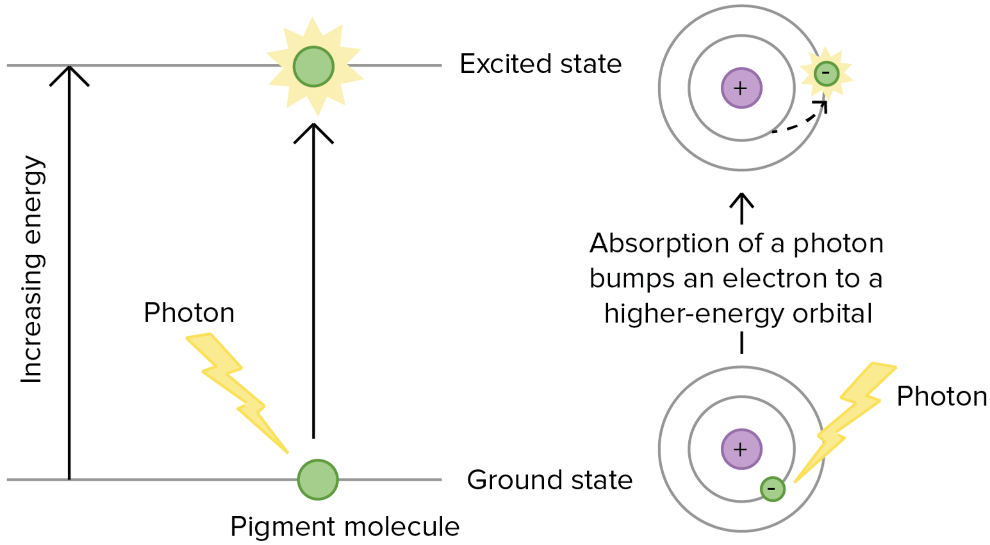
HID grow lights: HID (high-intensity discharge) grow lights replicate natural light better than other types of grow lights. These high-output lights are expensive and most often used in commercial grow rooms. There are two main types of HID grow lights: high-pressure sodium (HPS) lights, which emit a red color, and ceramic metal halide (CMH) lights, which produce a blue color perfect for seed starting.

<u>What is the light spectrum?</u>

The light spectrum is all the lights and wavelengths. It shows all the colors and wavelengths. The visible spectrum are all the colors that the human eye can see. We can't see all the colors because the wavelengths are either too big or small for people to perceive. Humans can see wavelengths from about 400 to 700 nm. The sunlight appears to be white but it is actually made of many wavelengths. This is why when you put the sunlight through a glass prism, you can see all the separate colors as they bend at different angles while passing through the prism. This creates a rainbow. As you can see on the chart, dark red has the longest wavelengths while violet has the shortest wavelengths. Since each color has different wavelengths, they also have different amounts of energy. This energy is held in the *photons. Short wavelengths tend to have higher energy and longer wavelengths have less energy.*

<u>How does photosynthesis really work inside of plants?</u>

When pigments absorb light, the light excites the pigments causing them to move to a different orbital that has higher energy. Imagine all the different planets in their different orbitals, these planets are the electrons and the sun is the nucleus. Pretend each orbital has different power, the outmost farthest from the sun having the most and the closest to the sun has the least power. That's how you can imagine the nucleus and the electrons. When an electron (planet) gets hit by a photon which is the energy in light it gets excited. It now has more energy and has to move to an orbital that has higher power (an orbital farther away from the nucleus (sun). When a pigment is hit with power it goes from its ground state to its excited state. The ground state is low on energy and is stable but the excited state has a lot of energy and is excited. Just like when you eat sugar, you start at your normal preferred state but then leap to an unstable excited out of control state. For the electrons to move orbitals, the energy that hits the planet must have the same energy that is in between the orbitals. The electrons always want to stay in a stable state and to do so it must either release the energy which is why sometimes flowers emit light. But it can also transfer the energy to a near molecule which will keep passing it onto the next like a relay race until it reaches the core reaction centre. This place is a special chlorophyll that can allow the excited electron to be released. The excited electron is then ejected into a chain of proteins called the electron transport chain (ETC) and as the electron is being passed down it slowly moves to its ground state by harnessing its energy to create ATP and NADPH. These two energy molecules are used in the Calvin cycle which is where carbon dioxide and those two energy molecules mix to create glucose. Meanwhile, water is playing its role in photosynthesis by replacing electrons that were removed from the atom. During this process the water splits into protons, electrons and oxygen which is released for us to breathe. If the photon that hits the electron is too strong for the electron to jump orbitals, ionization occurs, this is when the electrons get ejected from the atom.


Excited state
Increasing energy
Photon
Ground state
Pigment molecule
+
-
Absorption of a photon bumps an electron to a higher-energy orbital
Photon

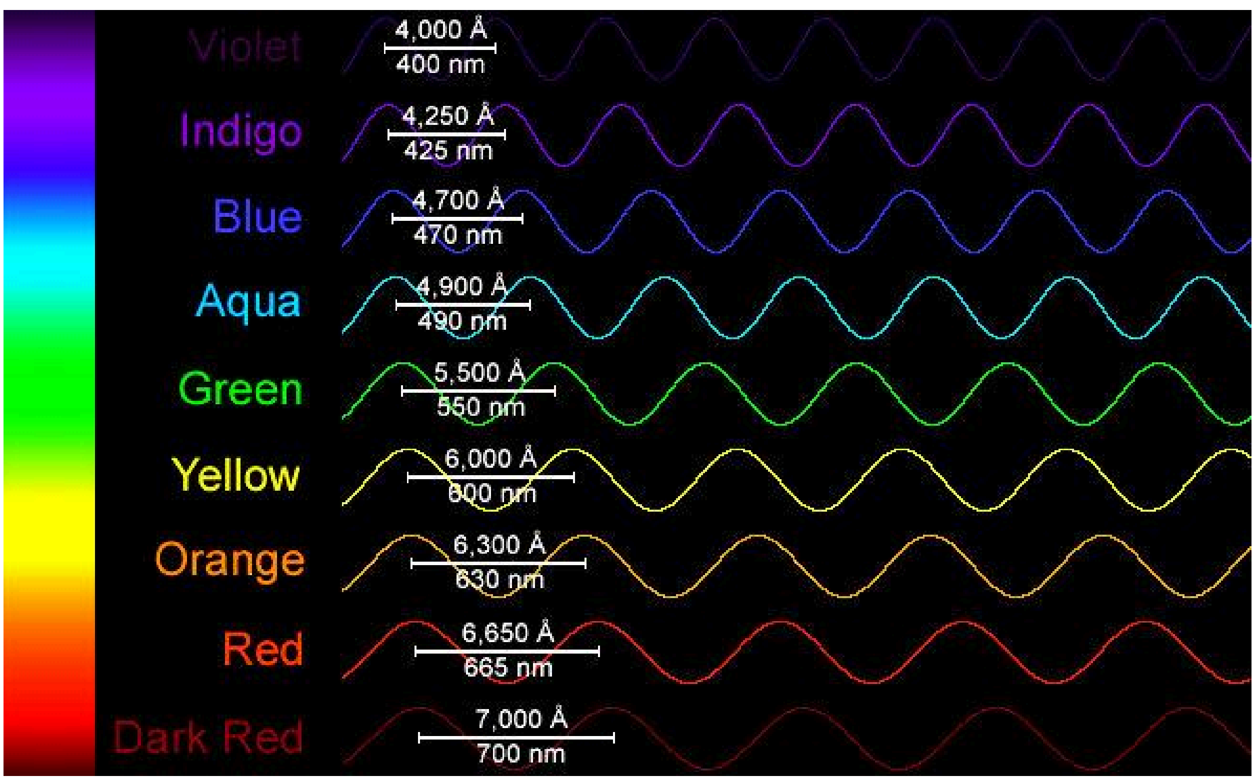
Research

<u>What are wavelengths and how do they affect plant growth?</u>

Wavelengths are the distance between the crests of waves. Plants absorb wavelengths differently depending on the length. This is because plants contain pigments that only absorb certain wavelengths and reflect others. The wavelengths absorbed are part of the absorption spectrum. The reflected wavelengths are what we see, so the green we see is the reflected wavelength.

<u>How do plants absorb wavelengths?</u>

Plants absorb wavelengths by absorbing lights using molecules that take in light called pigments. Most of these pigments are chloroplasts. The photons inside the wavelengths absorb into the electrons.



This diagram represents the different wavelengths and how many nanometers they each are.

How do each of the different plant light colors affect growth?

All different light colors affect the plants differently in their own way. But some colors can not be absorbed because the amount of energy being absorbed needs to match the amount of energy between each orbital which is explained in the photosynthesis question.

Red (665 nm)	*Red light wavelengths encourage budding and flowering. This is because red wavelengths can be absorbed quickly by the chloroplasts.*
Blue (470 nm)	*Help plants produce healthy stems, increased density, and established roots. This is because the wavelengths in the blue light make chlorophyll production meaning that more light can be absorbed from more chlorophyll causing a healthy plant. Blue also speeds up photosynthesis as its absorption rate is very fast.*
Dark Red (700 nm)	*The plant's leaves grow longer and wider and their stems elongate. This is because dark red makes the plants think that they are in the shade so it extentends to try and find the sun.*
Orange (630 nm)	*Orange light slightly helps in the process of photosynthesis. Chlorophyll b absorbs a bit of orange.*
Yellow (600 nm)	*Yellow light isn't very effective for plant growth because it is poorly absorbed by chlorophyll which leads to lower photosynthesis efficiency. The plants that are exposed to yellow will grow slowly or develop weak leaves. Since yellow light is mostly reflected rather than absorbed, it provides less energy*

	for photosynthesis. The plants will also become weak or elongated as they search for better light sources.
Green (550 nm)	*Green light is the slowest for photosynthesis as the pigment called chlorophyll reflects green light. Green light can still be absorbed but it is absorbed really slowly because the photon energy in it mostly does not match the energy gap between the orbitals.*
Violet (400 nm)	*This color has the shortest wavelengths. It is not as efficient as blue and red even though they make violet. This is because blue and red have two different kinds of wavelengths that are very effective for plants. Violet on the other hand only has one kind of wavelength that is not very effective on plants.*

What are some facts about Peperomia Amigo plants?

Peperomia Amigo plants have small lance shaped, green leaves. The growth of this plant is compact and shrub-like. It never becomes very large, especially with consistent pruning. Like other peperomias, peperomia amigo plants are non toxic, making it safe to keep around furry animals.

What are some facts about squash plants?

Squash needs to be grown in a place which has 6 or more hours of sunlight and has rich drained soil. The germination period takes around 7-14 days. The full growth of a squash plant takes about 60-110 days to get a full vegetable. These vegetables need proper pollination in order to grow a fruit. To hand pollinate, remove the petals from a male blossom to reveal its stamen at its center. If you look closely, you will see pollen clinging to *it. Touch it with your finger or a paintbrush and carry it to the female blossom. After that, you have to touch the female flowers at their center.*

<u>What are some facts about radish plants?</u>
Radish plants are one of the fastest growing plants. Some of their varieties even mature in 10-30 days. They grow best in cool weather and can also tolerate frost. Inconsistent watering of radish plants can cause radishes to be spicy, woody, or cracked. And lastly, if radishes flower or bolt too soon, they could stop the root from growing which makes the plant rough and bitter.

<u>Why can only certain wavelengths be absorbed by plants?</u>
Plants can only absorb certain wavelengths because of the electrons in the pigments. When a photon hits the electrons, the amount of energy hitting the electron has to match the energy gap in between the orbitals. As we explained before, orbitals are like the planets going around the orbits in the solar system. So if the energy gap between the orbitals is very high, the photon has to match that and also be very high in energy.

<u>Sun, Full Spectrum, and Red+Blue lights- Which one is more efficient?</u>
Sunlight is the most efficient overall because it provides a perfect full spectrum of wavelengths (including red, blue, and even UV and infrared), making it the best natural light source for plants. It supports all stages of plant growth, from seedling to flowering. However, sunlight availability depends on location, weather, and season.

Full-Spectrum Grow Lights are the second best option, but it is controlled. They mimic sunlight by providing a balanced mix of all wavelengths (including yellow and green, which plants use less efficiently). Great for indoor gardening when natural sunlight is insufficient.

Red+Blue LED Grow Lights are the least efficient option in these three but still are a good choice for plants. Red (600–700 nm) and blue (400–500 nm) light are the most critical for photosynthesis. Blue light promotes leaf and stem growth, while red light stimulates flowering and fruiting.

The verdict between these three options is sunlight. Sunlight is the most efficient for plant growth, but full-spectrum lights are the best artificial alternative, providing all necessary wavelengths for balanced development. While red+blue LEDs are energy-efficient, full-spectrum lighting better supports overall plant health and long-term growth.

Scientific Question and Purpose

Introduction

October 11, 2024

We have always been curious what effect do grow lights have on plants. Both of us see them at almost all of our friends' houses and always have wondered why they have them. We know that it helps plants grow better, but we really wanted to explore more about how much of an effect it has and how it actually works.

Scientific Question

October 11, 2024

This question can be simplified into: How can different colored lights affect plant growth, and what is the most effective light color for plant growth.

Purpose

October 16, 2024

The purpose of this experiment is to understand how plants react to different types of light so we can find out which type of light(s) are most effective. We find this very interesting because it could help people find a way to grow plants faster or in a more efficient way.

Hypothesis and Variables

Hypothesis

November 3, 2025
We hypothesize that full spectrum lights will be more effective than the other two (sunlight and red+blue lights) during the growth of our indoor plants.

There are quite a few reasons for this resolution. Full-spectrum grow lights are better than other types of grow lights because they closely mimic natural sunlight, providing a balanced range of wavelengths essential for all stages of plant growth. Unlike red+blue lights, which focus only on specific wavelengths, full-spectrum lights include green, far-red, and sometimes ultraviolet (UV) light, which enhance overall plant health, and improve growth quality. They are versatile, suitable for all plant types, and can be used year-round, making them the most effective choice for indoor growing environments. We thought that they would be better than sunlight because they can be controlled unlike sunlight which is not always available.

Variables

November 16, 2024
Manipulated Variable: The color of the plant lights. These are the full spectrum light, sunlight (natural) and red+blue light.

Responding Variable: The measurements of the growth that the plants are going through are the responding variable as we are comparing the resulting change that we will be observing and measuring.

Controlled Variables: In this study, there are many controlled variables involved. First, there is the temperature that the plants are kept in and that can affect how the plant grows. Soil *can also play an important role in the plant growth as they affect the movement of water and airflow for plants. The type of plant makes a difference as all plants have different growth systems. Location also plays a big role as some places have more light than others. Everything is the same for each plant except the type of light that it's exposed to.*

Experimental Design

Materials

<u>November 22, 2024</u>
In order to set up our experiment, we needed a couple items and time to help this experiment to be successful!

This is a list of things that we used:

- ***LED- Red and Blue combined lights-*** *The reason that we chose LED lights is because they are more cost effective than other lights and also more common than the other forms of grow lights. Red and blue lights combined are the most frequently purchased grow lights. Hence, we wanted to test how much of an effect they produce on our plants. We bought these lights brand new from amazon.ca.*
- ***LED- Full Spectrum lights-*** *As we mentioned in our research, full spectrum grow lights are lights that project the complete spectrum of lights which are in the 380-740 nm of wavelengths range. The reason that we used these lights is to see how plants grow when all different wavelengths act together. These lights were also purchased brand new from amazon.ca.*
- ***Tin Foil Sheet-*** *These pieces of foil were used to be wrapped around the box where the plants are growing because it can reflect light. This is so all parts of the plants receive the light needed for growth.*
- ***Plants (Peperomia Amigo)-*** *This creeping plant is a fast grower and is the sapling that we have used for this project. These plants were bought from greengate garden center.*
- ***Seeds (Radish and Squash)-*** *These plants were grown from scratch and used for our project as well. Additionally, they were bought in greengate garden center.*

Procedure

<u>November 22, 2024</u>

For this project to be successful during the observations, we will need to set up a couple of things.

1. *Wrap box with tinfoil*
2. *Attach lights to box*
3. *Place plants*

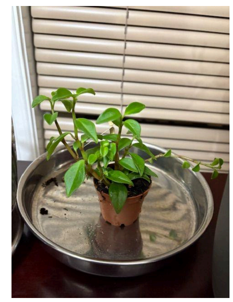
Below are some diagrams that we drew showing how everything will look:

Observations

Day 1- December 7, 2024

Details

Squash and Radish seeds just planted today. They still need to germinate before entering the lights. On the other hand, the peperomia amigo saplings have been kept in the cardboard boxes wrapped in tinfoil under the lights.



Sunlight

Peperomia Amigo- 10cm

Squash- *Just started. Still in the germination process.*

Radish- *Just started. Still in the germination process.*

Red and Blue LED grow light

Peperomia Amigo- 8cm

Squash- *Just started. Still in the germination process.*

Radish- *Just started. Still in the germination process.*

Full Spectrum LED grow light

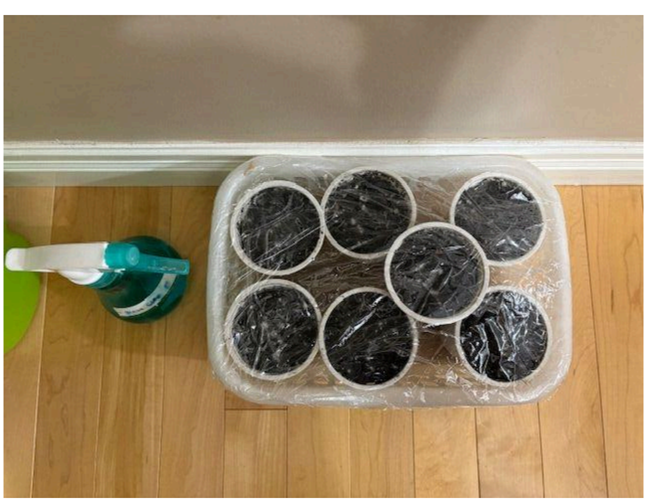
Peperomia Amigo- 9cm

Squash- *Just started. Still in the germination process.*

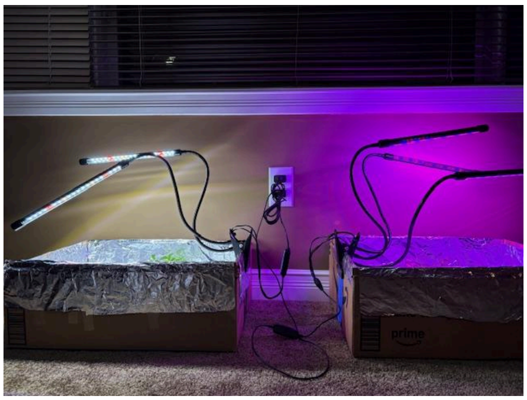
Radish- *Just started. Still in the germination process.*

Photo's

Plants still awaiting germination:



Set up of plant lights:



Day 3- December 9, 2024

Details:

The plants are growing very well. The size of the peperomia amigo plants are yet still the same. Although, they have become bushier and crowded. The radish plants have sprouted and are kept under the lights. Hence, the squash plants have not sprouted but we kept them under the lights as well. In one of the radish plants, we found some fungus upon the root but we learned that it won't do any harm to the plants.

Sunlight

Peperomia Amigo- 10cm (same as last time)

Squash- Just finished germination. Still no sprout above roots yet.

Radish- Just finished germination. Still no sprout above roots yet.

Red and Blue LED grow light

Peperomia Amigo- 8cm (same as last time)

Squash- *Just finished germination. Still no sprout above roots yet.*
Radish- *Just finished germination. Small sprout above roots which is around 1 cm long.*

Full Spectrum LED grow light
Peperomia Amigo- *9cm (same as last time)*
Squash- *Just finished germination. Still no sprout above roots yet.*
Radish- *Just finished germination. Small sprout above roots which is around 1.5cm long.*

There is a little bit of fungus surrounding the root of this plant but we have been led to know that it won't affect the plant very much.

Day 5- December 11, 2024

Details:
There has been a large amount of growth in the past 2 days. The radish plants have grown leaves now and it is preparing to open up soon. Still no sign of squash plants but peperomia amigo plants are mostly still the same as well.

Sunlight
Peperomia Amigo- *10cm (same as last time)*
Squash- *Just finished germination. Still no sprout above roots yet.*
Radish- *Just finished germination. 2 large stems peaking out and have almost opened up leaves.*

Red and Blue LED grow light
Peperomia Amigo- *8cm (same as last time)*
Squash- *Just finished germination. Still no sprout above roots yet.*
Radish- *Just finished germination. Started growing leaves and is about 15mm long.*

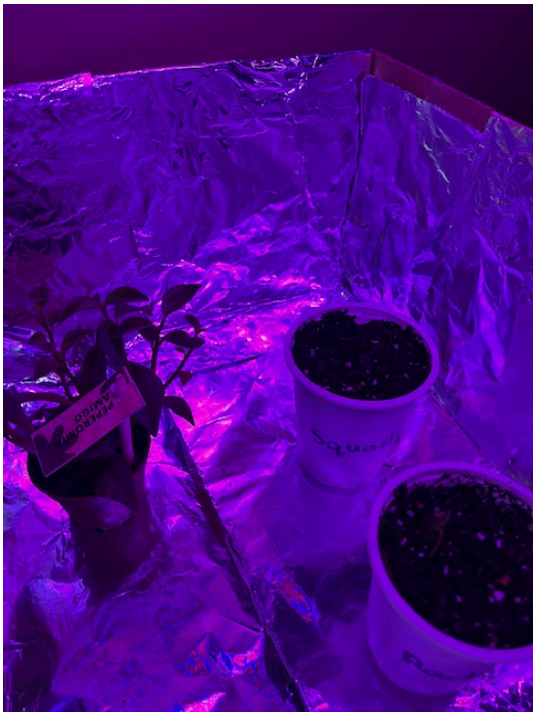
Full Spectrum LED grow light
Peperomia Amigo- *9cm (same as last time)*

Squash- *Just finished germination. Still no sprout above roots yet.*
Radish- *Just finished germination. Started growing leaves and is about 18mm long.*

Photo's

Full spectrum LED plant lights:

Red and Blue LED Plant lights:



Sunlight plants:

<u>*Day 7- December 13, 2024*</u>

Details:

Radish plants have gone through a lot of progress during the past 2 days. Some are now even taller than the peperomia amigo plants!

Sunlight

Peperomia Amigo- *10cm (same as last time)*

Squash- *Just finished germination. Still no sprout above roots yet.*

Radish- *Just finished germination. 3 large stems with leaves which are doing very well. Stem 1: 9.5cm, Stem 2: 9.8cm, Stem 3: 6.5cm*

Red and Blue LED grow light

Peperomia Amigo- *8cm (same as last time)*

Squash- *Just finished germination. Still no sprout above roots yet.*

Radish- *Just finished germination. 1 large stem which is 4.5cm long.*

Full Spectrum LED grow light

Peperomia Amigo- *9cm (same as last time)*

Squash- *Just finished germination. Still no sprout above roots yet.*

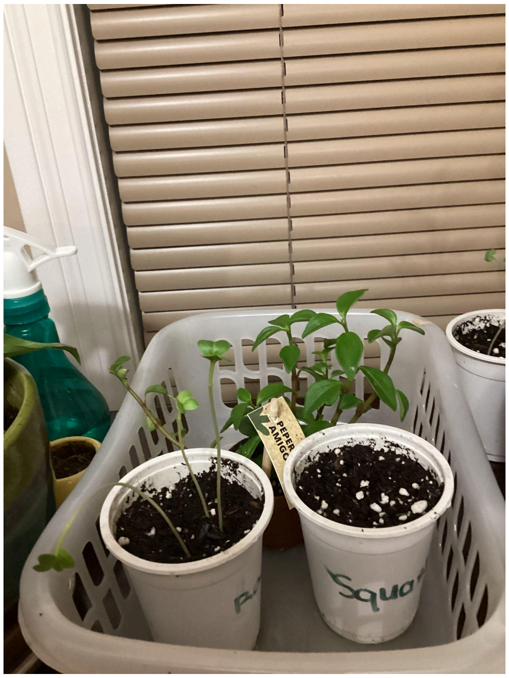
Radish- *Just finished germination. One large stem which is 5cm long.*

Photo's

Full Spectrum LED Grow lights:

Red and Blue LED Grow lights:

Sunlight Plants:



<u>Day 14- December 20, 2024</u>

<u>Details:</u>

It has been a while since I updated the growth of the plants. This whole week they have been growing exceptionally well, especially the squash. Added a support rod to the radish plants so the stems don't snap or become weak. Sunlight plants are still growing the best in all three which is pretty consistent. Second comes the full spectrum plants, and last is the red+blue LED lights. Watering the plants has been regular. Also, in the radish and squash, there were two to three stems shooting out of the soil and I plucked out the one that is not as efficient as the other one out so there is only one sapling in each cup. This is because when they both gather the nutrients in the soil, the growth is very medial. But, when there is only one, it can take up all of the nutrients in the soil making the single plant thrive very well in the small space. Peperomia amigo plants also might need repotting as roots are overflowing at the bottom and the pot is too small.

Sunlight

Peperomia Amigo- 10cm (same as last time)

Squash- 7.5cm

Radish- 13cm

Red and Blue LED grow light

Peperomia Amigo- 8cm (same as last time)

Squash- 4cm

Radish- 8cm

Full Spectrum LED grow light

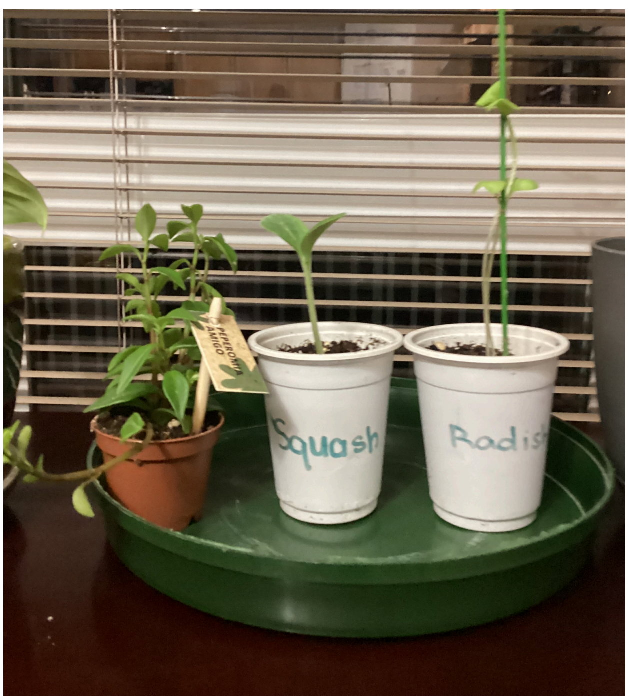
Peperomia Amigo- 9cm (same as last time)

Squash- 5cm

Radish- 9cm

Images:

Sunlight plants:



Red+Blue LED light plants:

Full Spectrum LED lights plants:

Day 21- December 27, 2024

Details:
This week, the plants have had a little bit more growth. The peperomia amigo plants have become bushier and the squash and radish plants have taken on their usual growth. This is the last day of the experiment as it was planned to only have a duration of 3 weeks. There are also baby leaves coming from both the radish and squash plants.

Sunlight

Peperomia Amigo- *10cm (same as last time but this time, they have become bushier)*

Squash- *12cm*

Radish- *15cm*

Red and Blue LED grow light

Peperomia Amigo- *8cm (same as last time but this time, they have become bushier)*

Squash- *5cm*

Radish- *8cm*

Full Spectrum LED grow light

Peperomia Amigo- *9cm (same as last time but this time, they have become bushier)*

Squash- *6cm*

Radish- *9cm*

Images:

Sunlight Plants:

Full Spectrum Plants:

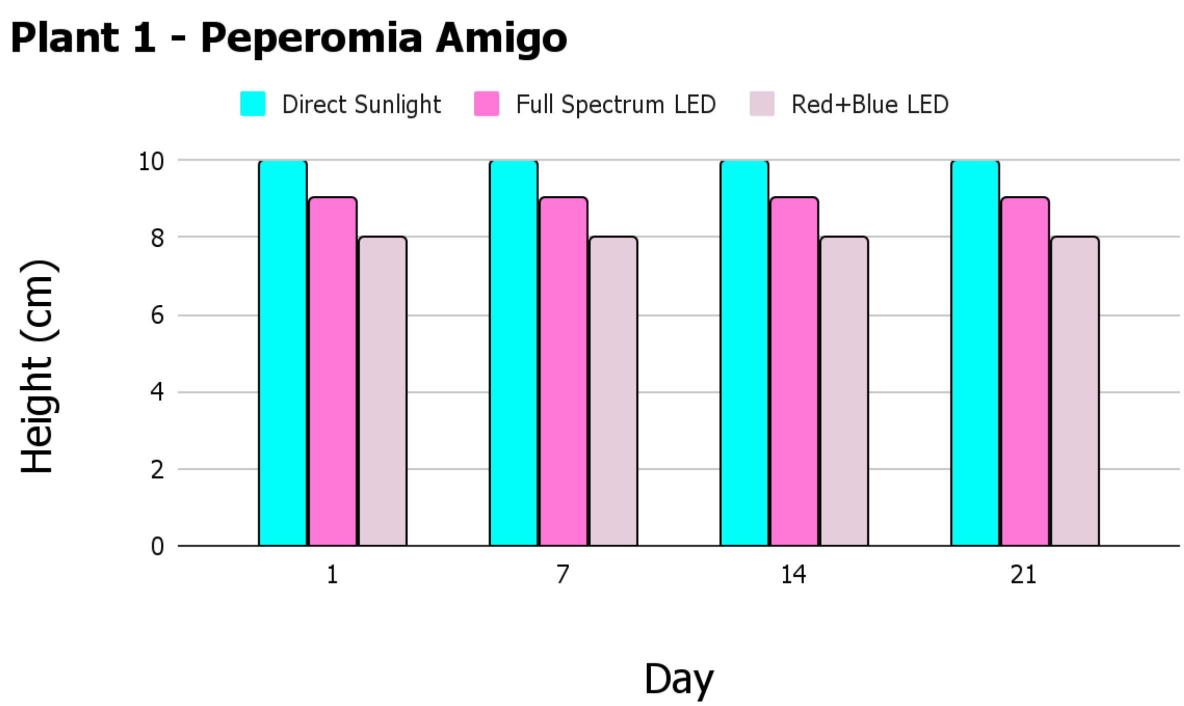
Red+Blue Lights:

Managed Data

December 29, 2024

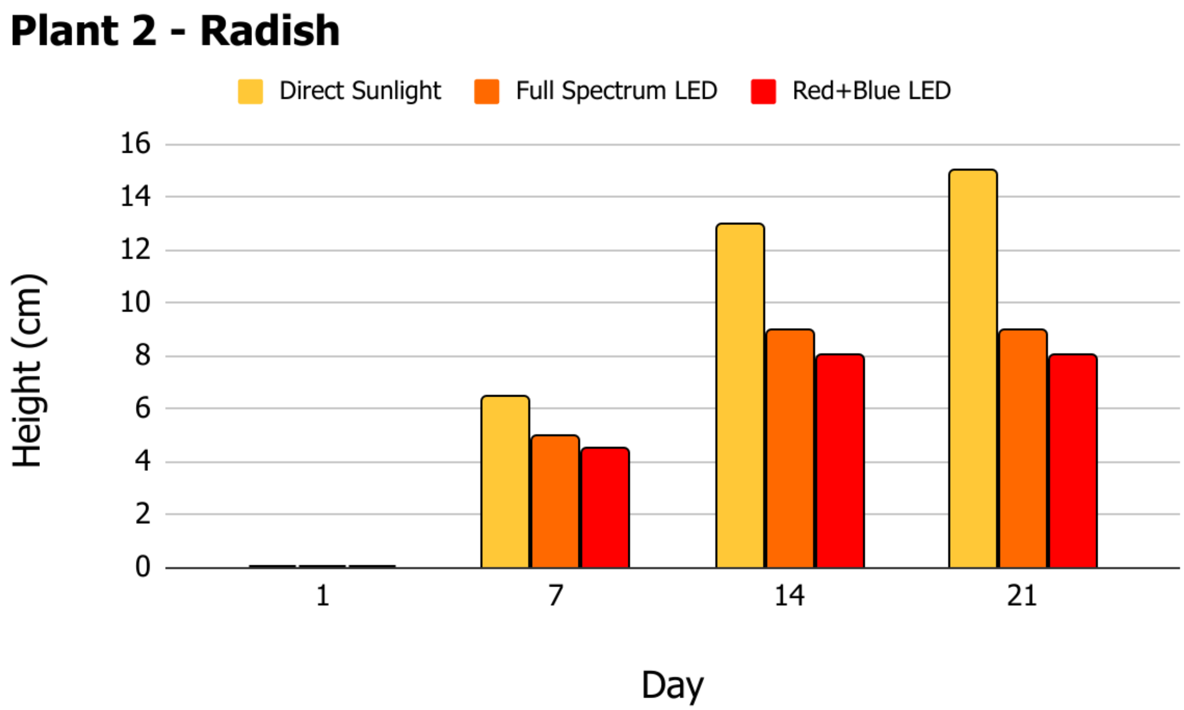
Now that we have finished collecting all the data, we have set it up into three graphs. Each graph represents each plant and how they have grown during the three week period of time using the three different light sources. The app that we used to generate these graphs is google sheets. We compared day 1, 7, 14, and 21 for this.

Below is the graph for the peperomia amigo plants:



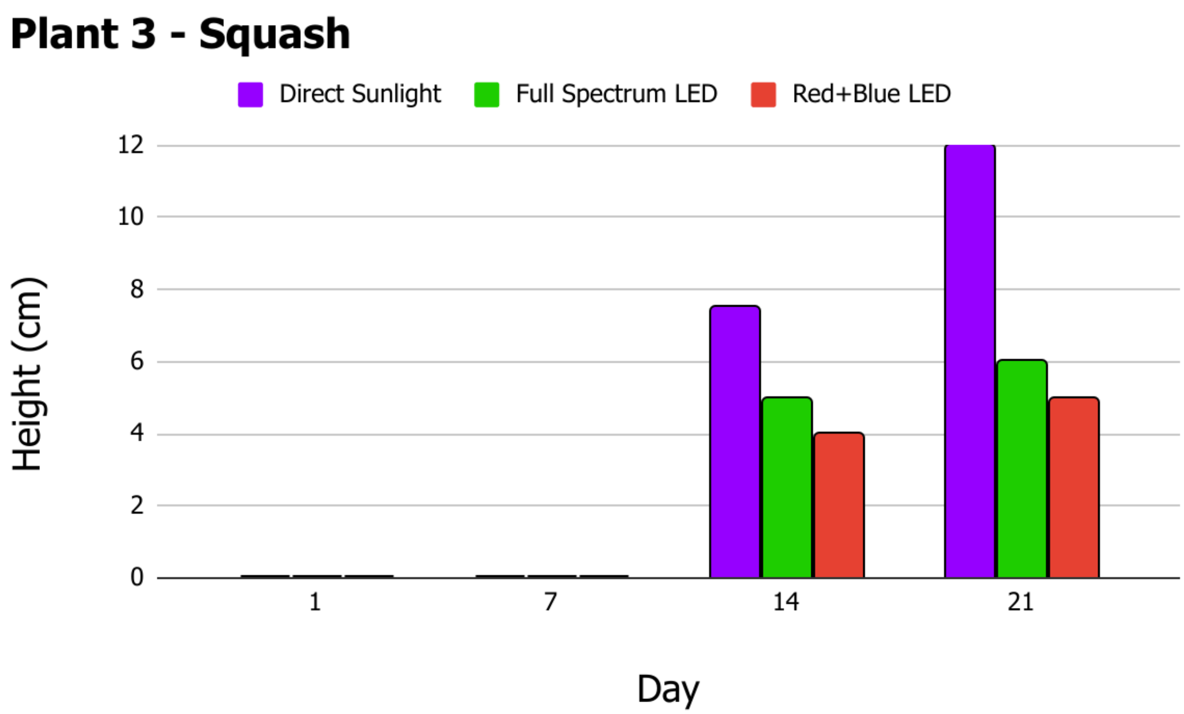
As this plant was pre-bought from the store, it didn't really show any growth over time. This was most likely due to the fact that roots were shooting out of the base of the small pot which meant that it needed repotting. If we did transfer the plant to a bigger pot, it may have shown a few signs of growth. Watering has also been very regular for this plant as the employee at green gate garden center said that we should water it 2-3 times a week and we followed it.

Next is the graph of the Radish plants:



The growth of these radish plants was much easier to see the difference between the three lights. The sunlight plant was clearly the most successful as you can see in the graph. All these radish plants were started by seed. The seeds were also store bought from green gate garden center and germinated at our house until we put them under the lights. In second place comes the full spectrum plants and by not too much, the red+blue LED light plants comes last.

Lastly, is the graph of Squash plants:



This plant had a slow start but during the time period of the 7-14 day, we were able to notice lots of changes. After it finished germination this squash plant started to grow extremely fast. As you can see in this chart, the sunlight plants are first, then comes the full spectrum plants, and very closely, comes the red+blue light plants. The sunlight was super fast compared to the other lights and grew double the height of the full spectrum plant and seven more centimetres than the red plus blue led plants.

Results and Conclusions

Does the color of light really affect the way plants grow?
The color of lights does affect the way and efficiency plants grow. As you can see above, each graph has direct sunlight as the fastest growing plant. The peperomia amiga actually did not grow at all as it was store bought and already partly grown. By the end of the experiment, the radish plants grown by direct sunlight were 15 centimeters tall while the full spectrum was only 9 centimeters and the red plus blue light plant was trailing behind with the height of 8 centimeters. The squash plants had extremely good growth and were 12 centimeters tall in just three weeks of direct sunlight. The full spectrum wasn't great and only made the plants grow half the height of the sunlight grown plants (6 centimeters). Red plus Blue led light grown plants were again the shortest with the height of 5 centimeters. This experiment showed us that sunlight had the most efficient growing effect on the plants. Full spectrum came second with an adequate growth efficiency (not nearly as fast as sunlight). Finally, in last came red plus blue light. These colors definitely affected the way that the plants grew but they were not efficient. They had the least growth effect.

Why is this?
Sunlight has very high intensity and although it is not always shining on the plants like the grow lights, it's high energy is still able to maintain healthy and fast growing plants. Despite the fact that full spectrum grow lights are supposed to mimic the sun, they are not nearly as effective and intense and they are not an exact replica. They also lack some of the wavelengths that the sun consists of. Red plus blue light was the slowest because it has the least variety of wavelengths. Plants have many different pigments and some of them only absorb certain wavelengths allowing sunlight and full spectrum to have many chances of getting absorbed. Red and blue wavelengths are mainly absorbed by only chlorophyll and don't have many chances with the other pigments.

Conclusion

The color of light does affect the way plants grow. As you can see on the graphs, sunlight was way faster than the other colors. We can see that the plants were able to easily absorb the direct sunlight but took more time to absorb the red plus blue wavelengths. Although full spectrum light closely mimics the sun, the sunlight's high intensity and energy was still able to grow the plants a lot more efficiently.

Applications, Improvements, Further Questions, New Problems, and Future Directions

February 5th, 2025

Applications

Agriculture:

- ***Crop improvement:*** *Developing new crop varieties with higher yields, better nutritional value, and resilience to environmental stresses like drought or flooding.*
- ***Precision agriculture:*** *Using data on plant growth to optimize fertilizer and water usage, improving efficiency and sustainability.*

Environmental science:

- ***Revegetation projects:*** *Selecting suitable plant species for restoring degraded ecosystems.*
- ***Biomonitoring:*** *Using plants as indicators of environmental pollution.*

Food science:

- ***Nutritional enhancement:*** *Studying plant metabolism to improve the nutritional content of food crops.*
- ***Food safety:*** *Researching methods to reduce contaminants in food crops.*

Future Directions

In the future, scientists can take our research further to create a full spectrum grow light (fastest type of grow light) that can sense light and automatically turn on when it senses no light. This special grow light could be automated to work about 13 hours a day as plants need about this much time to grow the most healthy and efficient. When the sun is not shining, the full spectrum light will turn on and when the sun is out, the LED lights will *turn off allowing the plants to get light for 13 hours straight. This light will allow plants to get the maximum amount of light.*

Improvements

We had planned for this experiment to run for three weeks which we thought would be a decent amount of time. In reality though, a longer period of time would have shown better and more detailed results. This experiment probably should have been run for about 4-6 weeks. This would have maximized the amount the plants grew.

Further Questions

Could temperature possibly be another factor to the way plants grow?

Because of our short experiment, could full spectrum light and sunlight possibly have different long term effects on plants?

Notes and workings out

The peperomia amigo plants are not growing. We followed instructions from the staff at the store (Watering the plant frequently) and the plants were not showing any signs of growth. Possibly because they have already sprouted and grown to the max.

Bibliography

HGSHydro. (n.d.). *Full spectrum vs. red/blue grow lights: What's the difference?* Retrieved January 14, 2025, from https://hgshydro.com/blog-details/full-spectrum-vs-red-blue-grow-light

Epic Gardening. (2021, August 5). *Grow lights 101: Best plant growth spectrum color? White vs red/blue LEDs* [Video]. YouTube. Retrieved January 14, 2025, from https://www.youtube.com/watch?v=kUpEQ4kU148

Let's Talk Science. (n.d.). *Plant pigments*. Let's Talk Science. Retrieved February 6, 2025, from https://letstalkscience.ca/educational-resources/backgrounders/plant-pigments

Grow lights for plants: How to use grow lights for plants - 2025. MasterClass. (n.d.).

https://www.masterclass.com/articles/grow-lights-for-plants

NASA. (n.d.). Visible light - NASA science. NASA. https://science.nasa.gov/ems/09_visiblelight/

Lightworks, | California. (2024, April 22). How does the Far Red Light Spectrum affect plants?. California LightWorks. https://californialightworks.com/blog/how-does-the-far-red-light-spectrum-affect-plants/#:~:text=Because%20far%2Dred%20makes%20your,wider%20and%20their%20 stems%20 elongate.

Peperomia amigo Marcello. (n.d.). JOMO Studio. https://jomostudio.com/products/peperomia-amigo-marcello#:~:text=Peperomia%20Amigo%20Marcello%20has%20small,keep%20around%20your%20furry%20friends.

Currie, J. (2025, January 8). The 10 best grow lights, tested and reviewed. The Spruce. Retrieved February 6, 2025, from https://www.thespruce.com/best-grow-lights-4158720

Nature Education. (n.d.). Photosynthetic cells. Nature Education. Retrieved February 6, 2025, from https://www.nature.com/scitable/topicpage/photosynthetic-cells-14025371/

National Geographic Society. (n.d.). Photosynthesis. National Geographic Society. Retrieved February 6, 2025, from https://education.nationalgeographic.org/resource/photosynthesis/

Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). Molecular biology of the cell (4th ed.). Garland Science. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK26819/

National Aeronautics and Space Administration. (n.d.). Visible light. NASA Science. Retrieved February 6, 2025, from https://science.nasa.gov/ems/09_visiblelight/

National Aeronautics and Space Administration. (n.d.). Wavelengths. NASA Science. Retrieved February 6, 2025, from https://science.nasa.gov/mission/hubble/science/science-behind-the-discoveries/wavelengths/

Encyclopædia Britannica. (n.d.). Colour: The visible spectrum. In Encyclopædia Britannica. Retrieved February 6, 2025, from https://www.britannica.com/science/color/The-visible-spectrum