

Effect of Light Colors on Bean Plant Growth

Grade:

Grades 6-8

Delaware State Science Standard:

Science Standard 6 - Life Processes

Strand: Structure/Function Relationship

Strand: Matter and Energy Transformations

Background Information:

When you look out on a sunny day, the light appears colorless. In fact, that light contains all of the colors of the visible light spectrum, from red to violet (Figure 1). Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. When all the waves are seen together, they make white light. Light is essential in a plant's life. Without light a plant cannot grow, reproduce, or photosynthesize. Plants utilize the different colors found in visible light to control different aspects of their growth. Different wavelengths of light can trigger or inhibit growth and flowering in plants. Which colors do you think will be the most beneficial to plant's growth?

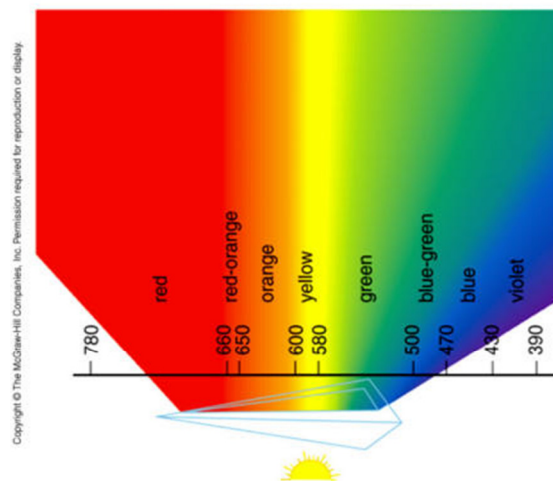


Fig. 1 Wavelengths of visible light in nanometers (nm).

Research question:

How do different wavelengths, or colors, of light affect the growth of common bean plants?

Preparation:

For this project, you can purchase large cellophane gift bags at the craft store and wrap them around the boxes with the opening twist-tied off in the back. This will allow plenty of room to reach in for watering or to insert a ruler to measure growth without exposing the plant to light. We found that dried beans from the grocery store work well if seeds are not available. You may want to plant 2 bean seeds per cup if using dried beans, to ensure that at least one grows. After they sprout, snip one of them off so that there will be one per cup.

This project will take several weeks to measure plant growth. The beans should sprout within a few days. During this experiment, explain figure 1 - that the line graph indicates the wavelengths of light. Explain what is meant by "wavelength" and that a nanometer is 0.000000001 meter in length. Show the students how white light is separated into colors using a prism, and that colors of objects are due to the reflection of specific wavelengths, while other wavelengths are absorbed.

Fun Facts:

- *Some animals can see wavelengths of light that humans can't detect. Many insects, for example can see ultraviolet light.*
- *Radio waves are a form of light.*
- *Light travels through space at a speed of about 186,000 miles per second. It takes about 1.2 seconds for light to get from the Earth to the Moon and about 8 minutes for light to reach us from the sun.*

Materials and Equipment:

- 4 colors of cellophane – red, blue, green and yellow
- 5 medium sized plastic cups
- 5 boxes big enough to cover a plastic cup and a germinating plant (a large shoebox without the lid will work)
- 5 bean plant seeds
- Potting soil
- Water
- Scissors
- Tape
- Ruler
- Measuring cup
- Log book
- Well lit area to keep the boxes
- Camera (optional)

Methods:



1. Fill each of the plastic cups $\frac{3}{4}$ full with potting soil.
2. Plant one bean seed in each of the plastic cups. The seeds should be planted $\frac{1}{2}$ inch deep in the soil. Add $\frac{1}{4}$ cup water to each cup.



3. Cut one end off the shoebox. If using another type of box, cut the end and one side off. You should have a box with a bottom and 3 sides.
4. Label each box.
5. Place the plastic cup holding a bean plant seed in each box.
6. Tape two layers of the desired color of cellophane on four of the boxes over the opening and over the top. Make sure you are able to get at least one of the corners of cellophane up for watering later.
7. You should now have five boxes, four of them covered with red, blue, yellow and green cellophane and one without cellophane. The box with no cellophane will get no colored light and will be used as the control.
8. Place the boxes (and the plastic cups) in an area that gets plenty of sunlight during the day.
9. Water each plant with up to $\frac{1}{4}$ cup water each day unless there is standing water in the cup. Because the cups have no drainage, fungus can grow and kill the plant if it receives more water than it can use, so water by pouring small amounts of water into the cup and allowing it to sink into the soil, and stop when a miniature puddle forms at the soil surface.
10. Continue watering plants for four weeks.

Analysis:

1. Keep a record of the plants' growth every day or every other day.
2. Take measurements of the length of the plants, note the color when the plants begin to germinate, describe the thickness of the stem, record the numbers of leaves present, measure the size of the leaves, etc. Keep all the information in your log book. Prepare bar graphs to compare the lengths of plants grown under each condition, the number of leaves, sizes of leaves, etc.
3. Be very careful not to break the growing tip off of the plant while measuring, be very gentle.
4. You can also take pictures as photos will better illustrate the growth quality of the plants. Make sure to insert the pictures to your log book to compare the general appearance of the plants over time.

Questions:

1. Which light color was the most beneficial to plant growth: white (unfiltered light), blue, green, yellow or red?

It is expected that white light will be the most beneficial.

2. Which color was the most detrimental to plant growth? What is the wavelength of the light for this color (see fig. 1)?

It is expected that green would be the most detrimental. The wavelength is about 550 nm

3. The color of an object is the portion of the visible light that is reflected, while other wavelengths of light are absorbed by the object. A red ball for example is red because it is reflecting red light and absorbing all other wavelengths of visible light. (a) What wavelength of light is reflected by the leaves of the bean plant? Plants use pigments to absorb light needed for growth, and they reflect wavelengths of light that are not needed. (b) Knowing this, can you explain why some of the plants in your experiment grew more slowly than others?

(a) green light- about 550 nm wavelengths.

(b) Pigments in the plant do not absorb green light, they absorb other wavelengths that are needed for growth. The green cellophane is absorbing wavelengths of light that are needed for plant growth, so the plant under green cellophane grows more slowly.

4. Chlorophylls are the major group of pigments common to all photosynthetic plants. (a) From what you have learned here, what wavelength of color do you think is reflected by chlorophyll? Carrots, sweet potatoes and cantaloupes contain another pigment, called carotene. (b) What wavelength of color do you think is reflected by carotene?

a) Most plants are green, so chlorophyll reflects green light (550 nm wavelengths).

b) Carrots, sweet potatoes and cantaloupes are orange, so carotene reflects orange light (about 640 nm wavelengths)

Extra Reading:

- Effect of environmental factors on plant growth:
<http://ag.arizona.edu/pubs/garden/mg/botany/environmental.html>
<http://extension.oregonstate.edu/mg/botany/light.html>
- Photosynthesis and pigments:
<http://www.emc.maricopa.edu/faculty/farabee/BIOBK/BioBookPS.html#Chlorophyll>
<http://www.tutorvista.com/content/biology/biology-iv/photosynthesis/photosynthetic-pigments.php>
- Videos of the photosynthesis process
<http://www.youtube.com/watch?v=mpPwmvtDjWw>
<http://www.youtube.com/watch?v=2xNwZCk2CHY&feature=related>
<http://www.youtube.com/watch?v=Wi60tQa8jfE&feature=related> (rap)