# Effect of Light Wavelength on Phototropic Response

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**Data Spreadsheet:**

https://uwprod-my.sharepoint.com/:x:/r/personal/ghollander_wisc_edu/Documents/TROPISM%20LAB.xlsx?d=w12e1b7b27df2453ea2183aeca503ce5a&csf=1&web=1&e=MxjWWm

**Introduction:**

Plants in their environment respond to different stimuli to support their essential functions. The mechanisms by which plants adapt to environmental changes are called tropisms, and in particular, phototropism is a plant's response to light. Light is required for the essential functions of a plant, particularly in photosynthesis. Understanding how plants react to light and the favorable light conditions for photosynthesis can be applied to effective growth of plants. This information can contribute to plants in greenhouses or other uses that require productive plant growth.

As the sun exposes a plant to all wavelengths of light, various wavelengths are either absorbed, which are used to drive photosynthesis, or reflected from the leaves of a plant. Blue and red light are absorbed by the chlorophyll, but more specifically, blue light induces the phototropic mechanism within plants that drives a positive phototropism.1

This study aimed to analyze how different wavelengths of light impact the tropic response of the hypocotyl of *Brassica juncea*. It was hypothesized that blue light would have the greatest phototropic effect on the hypocotyl because this wavelength of light triggers the

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[1] Fankhauser, C., & Christie, J. M. (2015). Plant Phototropic Growth. Retrieved October 17, 2023,.

mechanisms of phototropism. We also predicted that the violet light would have the second most significant response as its wavelength is closest to that of blue light, and the green light would induce the smallest response as this wavelength of light is typically reflected in plants.

Fankhauser, C., & Christie, J. M. (32015). Plant Phototropic Growth. Retrieved October 17, 2023,.

**Methods:**

To analyze the hypocotyl's response to different wavelengths of light a 19-hour experiment was conducted. This study applied varying wavelengths of light ranging from 400nm to 700nm onto 48 individual hypocotyl plants. To quantify the tropic response of each plant, the change in the angle of the hypocotyl stems is evaluated.

The 48 hypocotyl plants were divided into 16 different canisters with three plants in each. The three hypocotyl plants were stuck onto filter paper. Each segment of filter paper was immersed in water and the hypocotyl plant was oriented onto the paper by the leaves so that the stem was pointing toward the center of the canister. By this orientation, the light-induced tropism can be observed by the movement of the stem, either toward or away from the light source. The light exerted on the plants were Blue light (380 to 500 nm), Green light (500 and 600 nm), Purple light (380 nanometers) and White light (400 – 700 mm). These colors are applied to the canisters by the use of a thin-colored transparent wrapping material, cellophane. Each color of light had 4 separate canisters for a total of 12 hypocotyl plants exposed to each color wavelength of light. The canisters exposed to white light are the control group of the experiment. With comparison to the white light plants, we can identify any differences within the colored light plants' growth and development.

Photos were then taken of each plant in the canister to record their starting positions. To organize the photographs and to accurately keep track of the plants, slits were cut into the filter paper according to which plant we were recording (1, 2, or 3). Once each canister was filled and images were taken, we covered the top with saran wrap secured with a rubber band to keep the moisture contained in the canister. After the saran wrap was fixed to the top, the cellophane wrappings were placed over the appropriate canisters. Each canister was labeled with masking tape according to the color and number of canisters (ex. Purple 3). The canisters were placed onto the light source with the canister opening pointed down and the light shining up into the canister. After approximately 19 hours (4 pm to 11 am), the canisters were disassembled and photos were taken of each plant. Recording our results through images, the program Image J calculated the angle measurements before and after treatment. If the angle changed between before and after treatment the plant experienced a tropic response. The greater the angle change the greater the tropic response. The average amount of angle change between each color of light directly relates to how the hypocotyl plant responded to that wavelength of light.

**Results:**

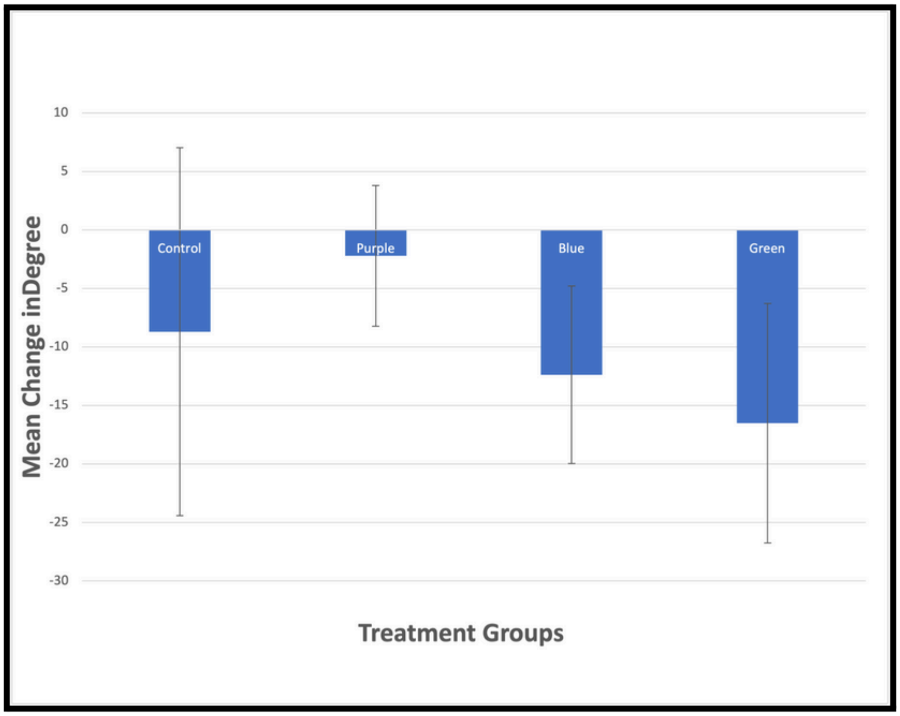


**Figure 1.** The graph above displays the four different experiment groups we had in testing the angle growth of *Brassica juncea.* Included is the mean change in angle degree along with the standard error bars for each group. The ANOVA test was run to obtain further data.

Unlike typical data, we did not see a strong correlation between the lights we chose and the change in angle of the *Brassica juncea.* The greatest rates of change, in order, were green, blue, white, and purple. The white light/control group showed the greatest range of standard error, while purple had the smallest with blue not far behind. In our experiment we had multiple plants fall off the walls of the canisters which could explain the differences in standard error with each group increasing, respectively.

**Discussion**

According to our data and graph, hypocotyls of *Brassica juncea* illuminated by green light had the most significant angle difference, which means that hypocotyls with green light treatment had the greatest phototropism (since phototropism expanded the stem of hypocotyl and resulted in a more remarkable change of angle. Hypocotyls with blue light treatment had medium angle change and thus had a medium phototropic effect. Hypocotyls with purple light treatment had the lowest angle change( even lower than the control group of normal light), resulting in the least phototropism. However, based on our calculated data, we concluded that the difference in light wavelength **did not significantly affect** the phototropic effect (positive phototropism) of hypocotyls and **did not support** our hypothesis. By running an ANOVA test of changes in the angle of three light treatments and the control group together, we got a p-value of 0.753988. Since 0.753988 is greater than 0.05( significant value), we **retained the null hypothesis** that there is **no significant effect** of the color of light on the change of angle, resulting in n**o significant effect** between the color of light and positive phototropism. Our conclusion **differed** from our hypothesis: hypocotyls absorb more light on blue light treatment with more phototropism and the least phototropic effect on a green light as more light has been reflected.

Our weaknesses in the experiment were possible explanations of the deviation of the conclusion from the hypothesis and larger p value.

1. While the experiment was well-replicated within each treatment group, the overall sample size of 48 plants may be relatively small. A decrease in sample size caused data to be more sensitive to outliers and decreased accuracy, increasing the standard error of data.
2. There was variability among individual plants as different *Brassica juncea* hypocotyls' growth rates differed, making data less accurate.
3. Mediums used to seal the canisters were different. The saran wrap used to seal the control group canisters was significantly thinner than the cellophane wrapping with saran wrap used in the other two groups. Different colors of cellophane wrapping also processed different thicknesses and textures, resulting in different absorption of light from different treatment groups.

Apart from weakness, there are strengths in our experiment.
1. We tried to reduce observer error. We specifically asked each one to measure results repeatedly.
2. We tried to reduce recorder error by using image J to measure the change of angle rather than manipulating by hand, as machines generate more accurate data.
3. Aside from light color, each canister had a similar environment as we placed each plant on the top half of the filter paper, completely taping or wrapping a rubber band over the theatrical gels to keep air out, and positioning each canister such that it was in the middle of the container to obtain the same amount of light. This ensures the robustness and reliability of the results.
4. We set control groups to ensure that all changes of dependent variables came for a change of independent variables(no other factors, less error).

In future experiments, more samples could be used for each group if there are no time and material limitations of the investigation, as an increase in sample size could produce more accurate data with less standard error. Moreover, we could use lamps that emit different colors directly rather than sealing canisters with cellophane, which could eliminate the difference in light absorbance due to different thicknesses and textures of wrapping material.Also, different types of plants could be used to generalize conclusions to test the phototropism of various types of plants and not limited only to *Brassica juncea.* Furthermore, more light colors with different light intensities could be added and investigated. Additionally, we could also investigate the effect of light intensity, auxin, and chemical concentration on tropism.