304. PLANT GROWTH AND THE SPECTRAL QUALITY OF LIGHT

In addition to the amount of light a green plant receives, the spectral quality of the light it receives is very important. The photosynthetic and accessory pigments found in green plants use particular wavelengths of light. Much of the shorter wavelength, high-energy light most damaging to living organisms is fortunately blocked from the earth's surface by the ozone layer. Wavelengths longer than the far red region of the spectrum are too low in energy to drive the chemical reactions necessary for photosynthesis. Thus, the light used for photosynthesis is that of the visible spectrum. Plants can use much of the visible spectrum because they produce a variety of light-harvesting and photosynthetic pigments which absorb at different wavelengths (POH Figure 8.9).

Within the visible spectrum, different quantities of each color reach the earth's surface. Clouds, dust particles, and atmospheric moisture all scatter light wavelengths differentially as light passes through the atmosphere. Even the time of day affects which wavelengths reach the earth's surface. In the morning and evening, light travels further through the atmosphere than it does at midday, filtering out more of the shorter wavelengths so that red light is present in greater proportion at these times.

A plant's habitat can also influence the quality of light it receives. The spectrum reaching understory plants in a forest differs from that striking the canopy plants. Even leaves on an individual plant may receive different wavelengths and intensities of light depending on their position on the plant.

Text References

POH 163-168, Light and Pigments

Study Questions

Why are so many photosynthetic pigments necessary? Describe the relationship between wavelength of light and energy content.

Purpose

To examine the effects of the wavelength of available light on seedling germination and growth.

Materials: filter setup with red, blue, green and yellow filters; filter samples for the spectrophotometer; spectrophotometer; seeds (seeds of radish, a dicot, and rye grass, a monocot, germinate in only a few days and grow quickly), full spectrum lights, potting soil, planting tray (greenhouse)

Predict how the spectral quality of light will affect plant growth. Decide which plants you will use and how you will set up your experiment. Give some thought to how you will measure plant growth. Some possible measurements include biomass (wet or dry weight), height, or number of leaves.

The small filter samples will allow you to determine the wavelengths of light that reach the plants.

Record your observations as your experiment progresses and discuss your results.

Additional References

Salisbury, F. and C. Ross. 1992. Plant Physiology. Wadsworth Publishing Co., Belmont, CA

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Name .   Lab day and time ___________________________

PRELAB PREPARATION:

1. Procedural outline. Be sure to indicate the type of plants and color of filters you will use and how you will measure plant growth.

2. Explain the differences among reflection, transmission and absorption of light.

3. Predict the wavelengths of light that will be transmitted through each of the Plexiglass filters.

4. Predict how each color of light will affect plant growth. Provide evidence in support of your predictions.

RESULTS:

5. Absorbance spectra of filters.

Color	Ultra-violet				Blue	Blue-Green			Green	Yellow		Orange		Red	
Wave-length	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700

6. Plot the absorbance of each filter against wavelength.

7. Design your own table to record plant growth observations.

8. Did the filters transmit the wavelengths that you expected them to? Explain any discrepancies.

9. Which filters allowed the best plant growth? Why did you obtain this result? Does your answer depend on the method you used for measuring plant growth?

10. Do the results support your predictions? Discuss any discrepancies and give possible explanations as to why they occurred.

11. What unusual growth patterns did you observe for plants grown under the various filters.

12. What wavelengths of light are available to a plant growing under a green filter? How do these wavelengths match with the wavelengths the plant's photosynthetic pigments can absorb?

13. Suggest possible sources of error in this experiment.