Phototropism: Do Plants Prefer the Blues?

Introduction

This activity will deal mainly with phototropism, illustrating how plants use various colors of light for different tasks. Unlike the gravitropism activity in which light was excluded, experiments in the classroom on Earth are done in the ever-present 1 g force. This fact can provide fascinating questions and design challenges for students.

Question: A Phototropic Riddle

If you were a plant
Or a plant were you,
Which hue would you choose
To tie your shoe?
Is it red, green or blue?

Sample Hypothesis:

My leaves are green,
Could it be green?
Or is it the red?
I'll guess blue,
And test if it's true.

Design

- Give germinating seedlings a choice of red, green or blue light, each coming from a different direction, and see if they bend toward one color more than toward the others.

Time Frame

Construction of the phototropism chamber will take approximately half of one 50 minute class period. The observational activities will take place over a period of 60 to 72 hours, with the actual time of observation and recording data requiring about 15 minutes at each interval.

Learning Objectives

In participating in the activity students will:

- learn to construct their own experimental equipment from low-cost materials;
- learn to set up a simple experiment, make a prediction and observe results; and
- understand that blue wavelengths of visible light affect the bending of plants more than red or green, demonstrating the partitioning of various energy levels of light to different growth functions.

Materials

- 35 mm black film can with lid
- one floral foam disc, 28 mm diameter and 2 to 4 mm thick
  (Floral foam is available from most florist supply stores cut to deminsions noted)
- three germination strips (See preparation of germination strips)
- three Fast Plant seeds
- water bottle
- forceps to handle seed
- hand-held hole punch
- 2 cm wide clear adhesive tape
- 2 cm wide black vinyl electrical tape
- three 1.5 cm squares, 1 each of red, green and blue transparent plastic mylar (Roscolux® films red #26, green #89 and blue #69, work well) or colored acetate from art stores or theatre departments

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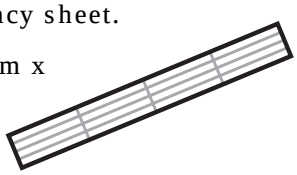
Preparation of Germination Strip

- *Making grid strips:*
  - Photocopy millimeter square graph paper onto an overhead transparency sheet.
  - Cut the sheet along the lines to make strips with the dimensions 0.5 cm x 4 cm.
  - Grid strips can be reused after rinsing, soaking for 20 minutes in a 20% bleach solution, then rinsing again and drying on paper toweling.



- *Making wick strips:*

  - Fold a square sheet of kitchen paper toweling to form an eight layered rectangle.
  - With scissors, trim end and folds to make a rectangle with the dimensions 4.5 cm x 10 to 12 cm.
  - Cut wick strips from the rectangle by cutting 1 cm strips.

- *Making germination strips:*
  - Hold a wick strip with a grid strip aligned on top of it. Moisten the wick strip.
  - As the wick strip becomes moist through capillary action, the grid strip will adhere to it through the adhesive forces of the water. Together the wick and grid strip make a germination strip.

  - The wet germination strip will adhere to the inner wall of the film can gravitropism chamber.

Procedure

1. With a hand-held hole punch, make three windows about 1.5 cm from the rim of the black film can at approximately 120 degree intervals.
2. Use a 10 cm strip of clear adhesive tape to cover each window with a red, green and blue square.
3. As with the gravitropism chamber, place a floral foam disc in the chamber and wet it with water.
4. Set up three germination strips. The germination strips should be aligned vertically, each spaced between two windows (Figure 1). Be sure that the germination strips are below the chamber rim and that there is sufficient, but not excess, water in the floral foam disc.

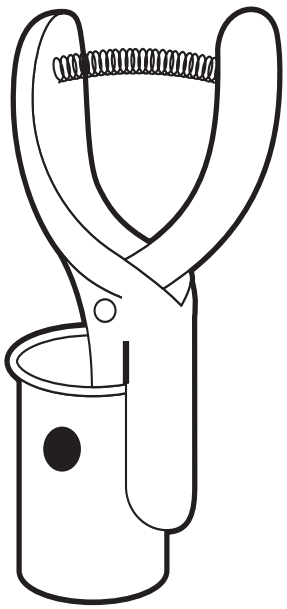
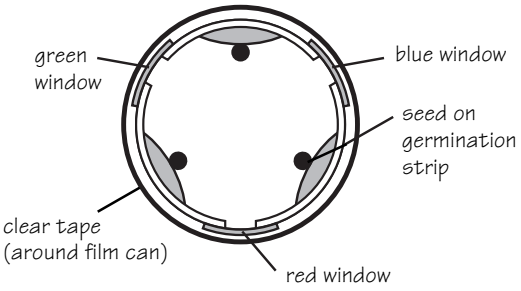


Figure 1: Film can phototropism chamber, view from above.



5. Place a seed, oriented with micropyle down, 2 cm down on each strip.

6. Snap the lid tightly onto the film can and place the phototropism chamber under a light bank where light will enter all three windows.

7. Make a top view drawing of your chamber, predicting how the plants will appear after 48 to 72 hours of germination.

8. **After 48 to 72 hours**, open the lid and indicate whether or not your prediction is to be accepted or rejected. As evidence, draw what you observe and compare it with your prediction.

Concluding Activities and Questions

In this activity students will have observed the effects of light in orienting the growth of seedlings in the presence of gravity. Have students consider the following:

- Within the mix of colors making the white fluorescence of your plant lights, which color tells the plant which way is up? Is this the same for humans? Are you sure?

- What has been the influence of gravity on the phototropic response? How would the seedlings respond to light if this experiment were carried out in microgravity?

- What will happen to the seedlings if you darken the windows? What will happen if you darken only the blue window?

- Recently plant physiologists have isolated minute amounts of a yellow molecule called *flavochrome* or *cryptochrome* that absorbs blue light and is active in the signal transduction pathway that transmits energy from the blue light to the bending response.