DOES DYE DIE...?
Foreign Chemicals In Our Environment

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Grade Level:
6-9

Discipline:
Biology, Environmental Science, Ecology

Goal:
To simulate the fate of foreign chemicals in our soil, food and water supply.

Objectives:
1. Students will extract dyes from water based markers and yellow food coloring.
2. Students will conduct photolysis, soil and plant metabolism tests with the dyes.
3. Students will use chromatography to test for residual dyes in soil and plant samples.
4. Students will form a working understanding of the methods used by scientists when testing for the presence and effects of foreign chemicals in our soil, water and or food supply.
5. Students will work as members of a scientific team.

Background:
When foreign chemicals are introduced into our environment, purposely through the use of pesticides or accidentally due to equipment failure, there are many mechanisms which the environment uses to get rid of or degrade them. It is critical that their presence be closely monitored.

One test used to monitor the degradation of foreign chemicals is an aqueous photolysis test. In this study, a sample of the foreign substance is mixed with water and placed in direct sunlight. If the substance breaks down or disappears it is said to have photolyzed.

A closely related test is the soil photolysis test. In this instance the water and chemical sample is applied to the soil and a slurry is formed and allowed to dry for a set period of time. (A slurry is a soupy mixture of soil and water). The sample

is then exposed to sunlight. The soil can then be tested for the presence of foreign chemicals.

A plant metabolism test is often conducted to monitor any effects which our crops/food supply might have on foreign chemicals. This test is administered by watering plants with a stock sample of the chemical and water for a prescribed period of time. At the end of the watering period, the plant is observed and a leaf or leaves is ground up to check for the presence of foreign chemicals.

Finally, a leaching experiment may be conducted in order to demonstrate any possible contamination of our ground water supply. In this test a soil sample in the form of a column is removed and the chemical/water solution is poured on the top and allowed to filter through. Based on the amount of chemical which leaches through the soil a hypothesis about the relative safety of the ground water may be made.

In this activity, non-toxic marker dye and yellow food coloring will act as the "foreign" chemicals which will be tested. For the purposes of this lesson the presence of residual dye will be demonstrated through the use of paper chromatography.

Materials:

Filter paper (1 per test), 12.5 cm diameter
Bean Plants (1 per group)
Sanford Water Color Markers(Mr. Sketch red or black)
Small vials - 1 oz. (2 per group)
Stock Jars (1 L) (1 per group)
Aluminum pie pans - 8 in. (2 per group)
Aluminum Foil (1 large piece)
Graduated cylinder
Balance
Light source
Water source
Soil (approx. 150g each group)
Funnel (Recycled water bottles may be used).
Beaker (200 ml)
Yellow Food Coloring
Plastic Coffee Stirrers (Hollow end allows them to act as pipettes).
Mortar & Pestle (Beaker and spoon may be used).

Procedure: (Preparation) (Start bean plants 2-3 weeks in advance.)

Dye Extraction

1. Extract dyes from markers. This is done by placing each marker into a beaker with 100 ml of water with the point in the water and stirring it for 1 minute.

2. After stirring let the marker sit in the water for 15 more minutes or until the point of the marker appears bleached out.

3. Remove the marker from the water.

4. Pour the water into a liter jar and add 900 ml of water. You should now have a liter of your stock solution.

5. Repeat this process for all markers.

Aqueous Photolysis

1. To begin aqueous photolysis, pour 20 ml of stock solution in both small vials.

2. Label vials and wrap one completely in foil. The wrapped vial (dark) will serve as a control.

3. Place both vials in direct sunlight.

4. Check vials daily for color change.

Soil Photolysis

1. To begin your soil photolysis, mass 50 g of soil and place in a beaker.

2. Add 20 ml stock solution to the soil and form a slurry. (Note: More water may be added if necessary).

3. Pour slurry into labeled pie plate coating bottom of pan.

4. Cover pie pan with foil.

5. Repeat steps 1, 2 and 3 for a second pie pan. (Do not cover).

6. Place both pie pans in direct sunlight.

7. Let pans sit for one week.

Plant Metabolism

1. Water bean plants with stock solution daily until water has just begun to leak from holes in bottom of pot.

2. Each group should maintain a control plant which is watered with plain water each day and is labeled and placed beside their treated plant in the sun.

3. Plants should be maintained for at least one week.

Leach Experiment Demonstration

1. Cut a small plastic bottle in half.

2. Make a few small holes in bottle cap
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3. Invert capped bottle section (funnel).

4. Create slurry with 100 g of soil and water.

5. Pour soil slurry into funnel.(Place a beaker under the funnel to catch the flow. Place a piece of white paper under the beaker to facilitate color contrast.)

6. A small amount of water should leak through.

7. Pour 10 ml of stock solution on the top of the slurry and observe the results.

8. Add 20 ml doses of stock solution and observe.

9. Repeat 5-10 times or until color leaches through.

Demonstrate Paper Chromatography

1. Take a piece of filter paper and draw a circle in the center. The circle should measure approximately 4.5 cm in diameter.

2. Using a pencil poke a hole through the center of the circle.

3. Using a pencil label the area along the circle to be tested.

4. Roll up a second piece of filter paper and insert it through the hole in the first filter.

5. Streak the labeled filter paper with your stock solution. The streak may be made with a coffee stirrer and should measure approx. 1 cm.

6. Stand the twisted filter up in a beaker of water, it will act as a wick and your chromatography should develop. This is your standard and should be repeated for each sample.

Analysis (After all samples have sat for at least one week)

Aqueous Photolysis

1. Analyze the photolysis samples using the same chromatography procedure described above. Analyze both the light and dark control samples on the same filter paper.

2. Compare results.

Soil Photolysis

1. Transfer soil sample from pie plate to beaker.

2. Add 40 ml of water and form slurry.

3. Repeat for other pie pan and label.

4. Perform chromatography on the solution and compare with standard.

Plant Metabolism

1. Remove large leaf and grind with mortar and pestle.

2. Add 2 ml of water and label.

3. Repeat for control.

4. Perform chromatography using stock solution, control plant and treated plant.

5. Compare results.

Discussion:

1. Based on the results of the chromatography would you say that the "foreign" chemical was degraded or weakened in the light or soil?

2. Was the "foreign" chemical transported through the plant?

3. Did a significant amount of the "foreign" chemical leach into the water table?

4. How has this experiment changed your understanding of chemical spills ...?

5. What safeguards would you propose in regard to chemical use and or transport in the future?

Extensions:

Hold a town meeting where students research and role play various parts,i.e.- Local Farmer, Industrialist, Parent, Environmental Activist, Congressman etc.

Additional Readings:

Investigating Groundwater: The Fruitvale Story, Lawrence Hall of Science, University of California at Berkeley. Addison-Wesley Publishing Co. 1991.