Household Chemicals and the Environment

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Topic

Environmental impact of household chemicals

Time

3 days preparation, 2 weeks of intermittent observation to completion

Safety

Please click on the safety icon to view the safety precautions.
Adult supervision is necessary. Household chemicals can cause burns. Wear gloves, safety goggles, and a lab apron. Wash hands carefully after working. Avoid inhaling strong concentrations directly. *Never mix ammonia and chlorine bleach: The fumes of this combination are poisonous. Dispose of any leftover solutions by washing them down the drain one at a time. Use plenty of water.*

Materials

ninety 100-mL disposable petri dishes, bottoms only
newspaper
2 lb clean silica sand
4 lb potting soil
6 L distilled water
plant food (mix according to manufacturer's directions)
tablespoon
100-mL graduated cylinder
seeds: 600 each of lettuce, wheat, and radish
three common liquid household products of your choice—for example, bleach, rubbing alcohol, and ammonia
90 polyethylene bags (sandwich size)
90 rubber bands
nine 500-mL beakers
masking tape
balance
waterproof marking pen
metric ruler

Procedure

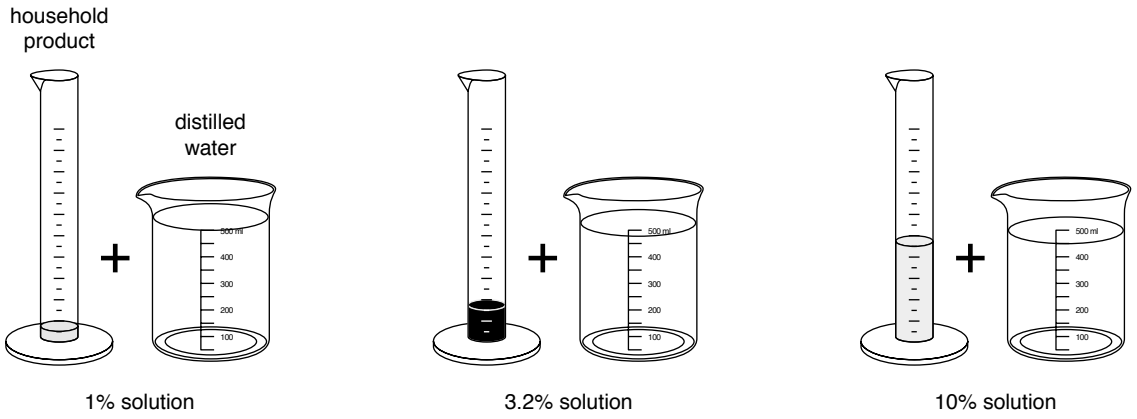
Pre-preparation: 3 Days Before You Begin

Cover a large table or part of the floor with newspaper. Pour the soil out bit by bit onto the paper, working it through your fingers to break up any clumps, ensuring uniform texture. Leave the soil spread out over the paper for 3 days to dry completely.

Part A: Preparing the Contaminant Solutions

1. Prepare three dilutions of each product you have selected (see illustration):
   a. In the 100-mL cylinder, measure 5 mL household product. Pour into 495 mL distilled water in a 500-mL beaker for a 1% solution. Rinse out the cylinder.

b. Measure 16 mL household product, and pour into 484 mL distilled water in a beaker for a 3.2% solution. Rinse out the cylinder.
c. Measure 50 mL household product, and pour into 450 mL distilled water in a beaker for a 10% solution. Rinse out the cylinder.



2. Label the beakers and set aside. You should have three dilutions of each product, for a total of three solutions.

Part B: Preparing the Test Units

1. Spread out on a table all the petri dishes you will need. You will prepare three dishes for each seed-product-% solution combination you are testing. Therefore, to test three different percentage solutions of three products on three kinds of seeds, you will need 81 dishes (3 2 3 2 3 2 3). In addition, you will need three dishes as controls for each kind of seed—nine dishes for testing three kinds of seeds. So, altogether you will need 90 dishes (bottoms only).
2. Fill the bottom of a petri dish half full with the air-dried potting soil. Empty the soil into a balance tray, and determine its mass. Return it to the petri dish. Weigh out the same amount of soil, and place it in each dish.
3. Mix plant food according to the manufacturer's directions. Add 10 drops of plant food to each dish, and allow it to soak for 10 min.
4. Plant 30 dishes of each type of seed. Put 20 seeds in each dish. Be sure to keep the three groups separate so that you know which dishes contain which type of seed.
5. Sprinkle 2 tbs of silica sand over each dish.

Part C: Setting Up the Series

1. Measure out 15 mL of a contaminate solution and add it to a dish. Enclose the dish in a polyethylene bag, and close the bag with a rubber band.
2. With the masking tape and marker, label the dish by seed type, household product, and percentage of solution: for example, "1% bleach—radish."
3. Repeat steps 1 and 2, placing each of the nine solutions you have mixed into three dishes of *each* type of the three seeds. So, for example, you will put 15 mL of the 1% bleach solution into three radish dishes, three lettuce dishes, and three wheat dishes, labeling as you go. Then, you will put 15 mL of the 3.2% bleach solution into three radish dishes, three lettuce dishes, and three wheat dishes, then the 10% bleach solution into three of each, and so on, until you have completed the entire series of solutions, using up 81 seed dishes.

4. Measure out 15 mL distilled water into three dishes of each seed type. Label these nine dishes as controls by seed type, for example, "control—radish."
5. Place the dishes so they are equidistant from a good indirect source of sunlight, where you can observe them for the next 2 weeks. Make sure that any artificial lights in the room are turned off by sundown.

Record the actual amounts as the *photoperiod* here: _____ hr light, _____ hr darkness. Room temperature should be about 70°F. Grouping the dishes by product and % solution will make it easier to record your observations.

Part D: Observations

1. Make three copies each of data tables 1 to 4. You will use one of each table per household product tested.
2. After 5 days, count the number of seeds emerged in each plate. Record your findings on the three copies of data table 1 for each product tested and for the controls.
3. After 14 days, measure and average the height of the three tallest seedlings in each dish (add the three heights and divide by 3 to obtain the average). Record your findings on the three copies of data table 2 for each product tested and for the controls.
4. Average the number of seeds that emerged for each seed type in each solution. Record your results on the three copies of data table 3.
5. Find the percentage of emergence for each seed for each dilution of each product and control. Use the following formula:

$$\frac{\text{No. seeds emerged}}{\text{No. seeds planted}} \quad 2 \quad 100$$

Record your results on the three copies of data table 3.

6. Average the shoot height for each type of seed for each dilution of each product, and control. Record your results on the three copies of data table 3.
7. Now average the number of seeds emerging for *all* types of seeds for each dilution, and record this overall average on data table 4. Find the percentage of emergence for *all* seed types in each dilution of each product, and record these on data table 4. Do the same for average shoot height.
8. Find the percentage of reduction from control of percentage of emergence for each dilution. To do this, subtract the percentage of emergence of a given dilution from the percentage of emergence for the controls (both are on data table 4), divide by percentage emergence for control, and then multiply by 100 to put your answer in terms of a percentage. Calculate the percentage of reduction from control of average shoot height for each dilution, following the same procedure.
9. Which concentration of contaminate had the most impact on percentage of emergence and seedling height?
10. Which product was the most toxic overall?
11. Which seed was the most sensitive to contaminates?
12. What happens to percentage of emergence and seedling height as the contaminate concentration increases?
13. What are some ways that household chemicals might be introduced into the soil environment?

DATA TABLE 1									
Number seeds emerged per plate, day 5 Household product: _____									
% Solution	Seed _____			Seed _____			Seed _____		
1									
3.2									
10									
Control									

DATA TABLE 2									
Average shoot height of 3 tallest seedlings per plate, day 14 (mm) Household product: _____									
% Solution	Seed _____			Seed _____			Seed _____		
1									
3.2									
10									
Control									

DATA TABLE 3									
Household product: _____									
	Average number emerging seeds			% Emergence (average no. emerged/ no. planted) × 100			Average shoot height		
% Solution	Seed _____	Seed _____	Seed _____	Seed _____	Seed _____	Seed _____	Seed _____	Seed _____	Seed _____
1									
3.2									
10									
Control									

DATA TABLE 4					
Data by product dilution for all seed types Household product: _____					
Dilution	Average number seeds emerged (per plate)	Emergence		Average shoot height	
% Solution		%	% Reduction from control	mm	% Reduction from control
1					
3.2					
10					
Control			0		0

What's Going On

Specific results will vary depending on the type of seeds used, the products used, and the environment of the experiment. One surprising effect that you may find, particularly if you look at your dishes in the first few days, is that the seeds exposed to the 1% solutions may emerge sooner than the controls. This may be due to the chemical's loosening of the seed coat, allowing the shoot to break through more rapidly. The 1% solutions may also prevent mold, which sometimes appears on the control seedlings. Despite these effects, the controls generally present the greatest number of seeds emerged in 5 days and the highest average shoot height in 14 days. The 10% concentration of all three products will have the greatest relative impact on percentage of emergence and seedling height for all seed types. This will vary according to products chosen.

The most toxic product is the one that had the greatest impact across all three concentrations tested. If you tested radish, lettuce, and wheat, you probably found that lettuce is most sensitive. As the concentration of the contaminant solutions increased, the percentage of emergence and average shoot height decreased. There are many ways that household products might be introduced into the soil environment: for example, dumping by manufacturers, runoff from home wastes, or actual use of the products outdoors.

Connections

Knowledge about the environmental impact of household chemicals is necessary for us to decide how best to use and dispose of these substances. This experiment is designed to assess the impact of three common household products on soil by studying their effect on the emergence and shoot height of different plant seedlings. The procedure demands careful measurement and yields good data for statistical analysis.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES