INVESTIGATION

10

Soil Salinization: *An* Experimental Design

Lab

PURPOSE

- Develop an experimental design to investigate how salinization affects germination of various species of crop seeds
- Determine at what salt concentrations seeds no longer germinate

BACKGROUND

Most of the fertile and easily farmed land in the world is either now under cultivation or is developed for other purposes. This leaves less desirable arid land that will need irrigation to be farmed to feed the Earth's growing population. Soils in dry regions are generally rich in nutrients because there is little water to leach them below the root zone. These regions can be made to grow crops only with irrigation. Much of this water is pumped from underground aquifers containing dissolved mineral salts. As the water is sprayed onto the crops, some of it evaporates because of the low humidity. Low concentrations of salt on the land are not a problem. But over time the salts collect on or near the soil surface, where they eventually interfere with the germination and growth of the crops by removing water from plant cells. The salts decrease the osmotic potential of the soil so plants cannot take up water.

Soil **salinization** is a problem wherever irrigation is used in arid areas. These include the central valley of California and other areas of the American west, the Middle East, central Siberia, and China. In some areas, the summer irrigation effects are attenuated by the winter snows, which wash the salts back down below the root level. In some parts of the world, such as Saskatchewan, Canada, the water table contains high concentrations of salt and is near the surface. In the summer, the heat causes the water to evaporate out, leaving high levels of salt in the soil. In the United States, soil salinity costs billions of dollars and has become a cost of doing business. In the developing world, it is a matter of life and death.

Many salt ions are involved in soil salinization, such as sodium, calcium, magnesium, potassium, carbonate, chloride, and sulfate. The most common, by far, are sodium and chloride. For convenience, your team will study the effects of NaCl, ordinary table salt. An assumption will be made that the effect of NaCl will be characteristic of all the salts on the germinating seeds. Recall that

fresh water has a salinity of 0.5% or less. The concentration of salt in the ocean, near U.S. coasts, is about 3.5% by mass. For comparison, a saturated solution of NaCl at room temperature is about 36% salt by mass.

Problem

You and your partners will act as a team of consultants hired by a group of farmers who are concerned about how increasing salt concentrations in their soil will affect their crops. Design a controlled experiment to measure how increasing salt concentrations interfere with the germination of four different types of crop seed.

Materials

- NaCl
- 4 species of crop seeds
- petri dishes
- sealable plastic bags
- spreadsheet or other graphing software
- potting soil
- paper cups

Procedure

Step 1 Salt concentrations to test should include at least eight concentrations from 0% to 4%. Since some plants are very sensitive to salt, include concentrations of 0.01%, 0.1%, 0.5% and 1%.

Step 2 To allow for differences among the seeds, use at least 10 seeds in each test. You can also use potting soil in paper cups or petri dishes.

Step 3 It is recommended that you use petri dishes as test vessels, placing them in sealable plastic bags to cut down on water evaporation, which increases salinity over time.

CONCLUSIONS

Your team's final report to the farmers should contain:

1. Cover sheet with brief overview of your experimental design.
2. Procedures and equipment used.
3. Data tables.
4. Graphic presentation of experiment (it is recommended that you use a spreadsheet program such as Excel for the graphing).
5. Analysis of the graphs.

6a. Conclusions, based on your data, about what crops to grow under which conditions.

b. Recommendations of crops, other than those tested, that might be more tolerant of high salinities. (This will involve additional research.)

7. The **Threshold Level of Toxicity** and **LD-50** for each seed type, indicated on your graphs.

8a. A plan to remediate the soils if the salt concentration reaches toxic levels.

b. Recommendations for alternative irrigation methods tailored to the specific crops.