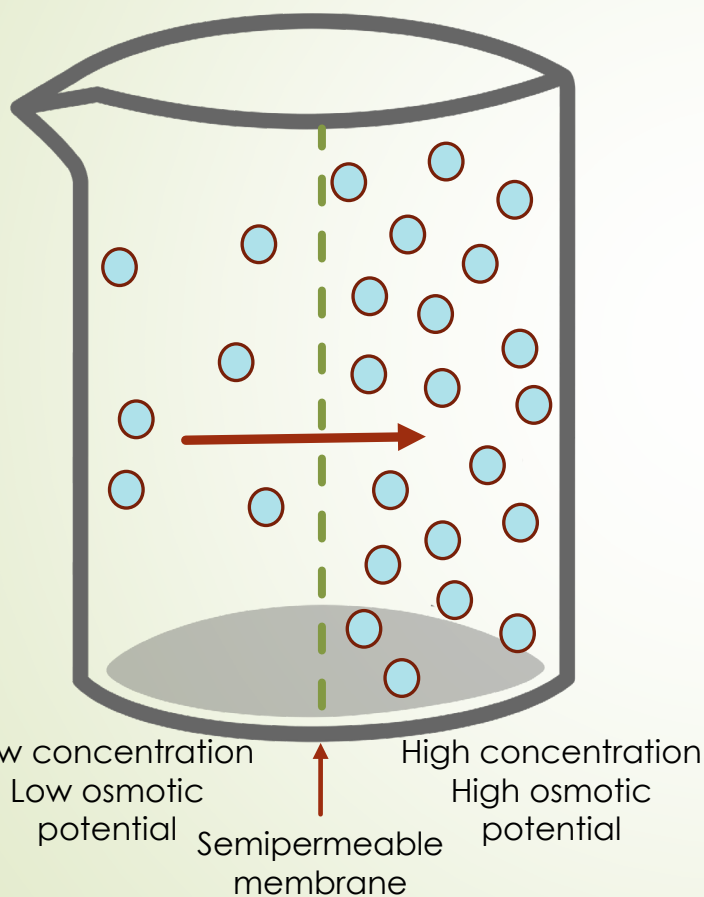


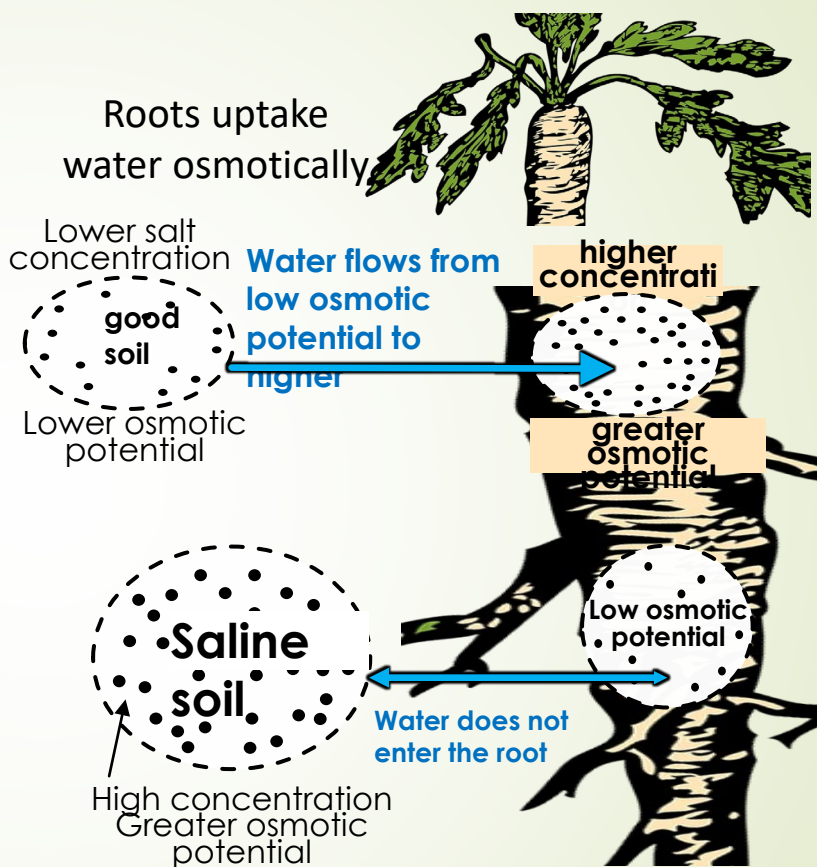
Plant Growth and Osmotic Potential

Water is a critical element for plant growth. All water used by land plants is absorbed from the soil by roots through osmosis. Osmosis is the movement of a solvent (e.g. water) across a semipermeable membrane from low solute (e.g. salt) concentration towards higher solute concentration. Excess levels of salts in soils makes soil water solute concentrations higher than in the plant root cells. This can limit plant water uptake, making it harder for plants to grow. (see Appendix A for more information)

Osmosis



Roots uptake water osmotically



For this experiment, we're going to test the effect that high salt soil concentrations have on plant growth and root development

About This Experiment



Ages
12+



Time
1 hour set up
few minutes a day for 3+
weeks



Difficulty
easy/moderate

Materials Needed

Materials: 7 clear plastic cups (Solo cups), 7 non-clear plastic cups, potting soil (small bag), wheatgrass or cat grass seed (250 seeds, can be found online or local pet store), salt, baking soda, measuring spoons, drill & small bit



When using table salt (sodium chloride) and baking soda (Sodium bicarbonate) to create saline and alkali soils, you can observe the germination and growth of grass leaves at increasing levels of salt and pH. Then you can treat the salt/alkali affected soils with "leaching" and observe plant growth.

Let's Do This!

Step 1: Drill 3 small holes in 7 clear plastic cups. Have an adult help with this step for safety.



Step 2: Fill 1 clear cup (with holes) with soil 1" from top of cup and place cup inside non-clear cup (without holes).

Pour $\frac{1}{2}$ cup of water into the soil cup and allow to absorb. Pour another $\frac{1}{2}$ cup of water into the soil cup.

Place 30 grass seeds on top of the wetted soil and cover with $\frac{1}{8}$ " of new soil and gently wet. Make sure seeds are covered with soil. (label cup "Control")



Step 3: Fill 3 clear cups (with holes) with soil 1" from top. Add 1 teaspoon of salt to the soil of 1 cup. (label cup "salt 1"). Add 1 tablespoon of salt to the 2nd cup (label cup "salt 2"). Add 3 tablespoons of salt to the 3rd cup (label cup "salt 3").

Place each cup in a non-clear cup (no holes) and add $\frac{1}{2}$ cup of water to each and let absorb. Add another $\frac{1}{2}$ cup of water.

Place 30 grass seeds in each cup and cover with $\frac{1}{8}$ " of new soil and moisten new soil. Make sure seeds are covered with soil (Image 2).

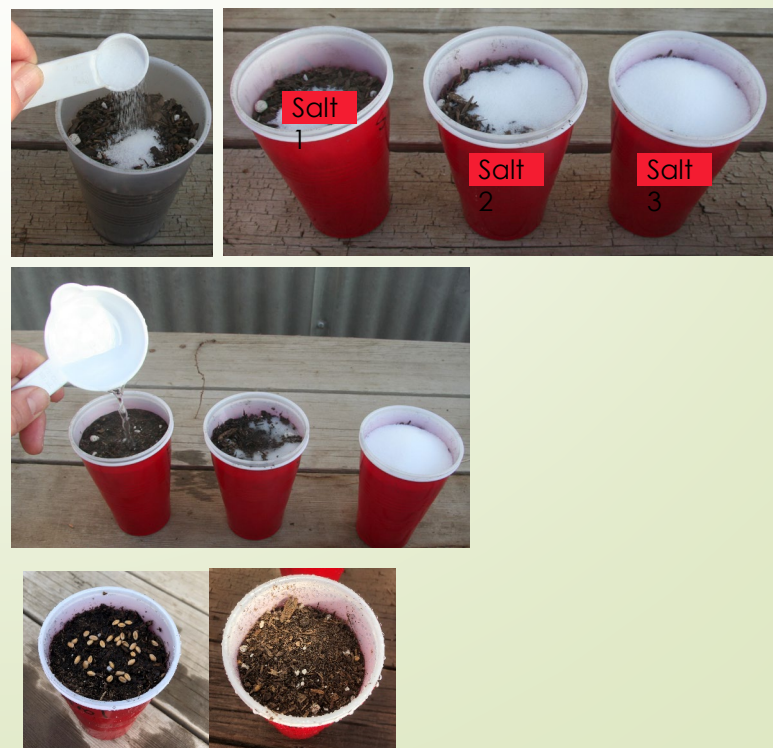


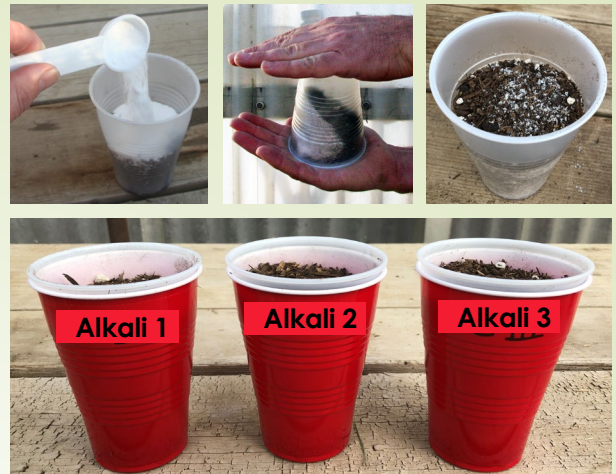
Image 2

Step 4: Fill 3 clear cups (with holes) $\frac{1}{4}$ full with soil. Add 1 tablespoon of baking soda to 1st cup and add more soil to fill cup 1" from the top. Hold your hand over the cup so soil does not spill and shake the cup to mix the baking soda with the soil (*label cup "alkali 1"*).

Add 2 tablespoons of baking soda to the 2nd cup and fill with soil 1" from top. Again, with hand over cup, shake to mix baking soda and soil (*label cup "alkali 2"*).

Add $\frac{1}{2}$ cup of baking soda to the 3rd cup, fill with soil 1" from top and shake to mix (*label cup "alkali 3"*).

Place each cup in a non-clear cup (no holes). Add $\frac{1}{2}$ cup of water to each and let absorb, then add another $\frac{1}{2}$ cup of water. Place 30 grass seeds in each cup and cover with $\frac{1}{8}$ " of new soil and moisten new soil. Make sure seeds are covered with soil.



Step 5: Let grass germinate and grow for 1 week.

Let's Look At The Results!

After 1 week count the number of plants in each cup and measure the tallest blades of grass in each cup. Record the numbers for each on the data sheet (page 6). Remove the clear cups and observe root growth.



Roots or no roots?

Observe any salt "crust" formation as the cups dry out

desert soil

After 1 week, remove “salt 2” and “alkali 2” clear cups from red cups and place in the sink or outside (where water can drain) and slowly pour 6 cups of water through each, making sure to not over-fill (pour ½ cup at a time and let drain).

Observe which cups drains fastest? (alkali soils have poor drainage) Make sure seeds are still covered with soil (add some on top if necessary) and let them grow for 1 more week.



After 1 week (2 weeks total) observe if “leached” cups now have plants that are growing? Did leaching help the same for saline vs. alkali soils?

After 2 weeks, measure the height of plants in each cup and record the results. Again, observe the roots and record observations on the data sheet.

Summarize your data and observations.

Why did plants grow or not grow in each cup?

What effect did leaching have on plant growth and why?

Did leaching work on both salt and baking soda equally and why?

Start date: _____

Researcher's name: _____

	# of seedlings		Height of grass (inches)		Root observations (are roots to bottom of the cup)	
	Week 1	Week 2	Week 1	Week 2	Week 1	Week 2
Control						
Salt 1						
Salt 2* (leach after 1 week)						
Salt 3						
Alkali 1						
Alkali 2* (leach after 1 week)						
Alkali 3						

Observations: _____

Summary: _____

Appendix A: Resource Material

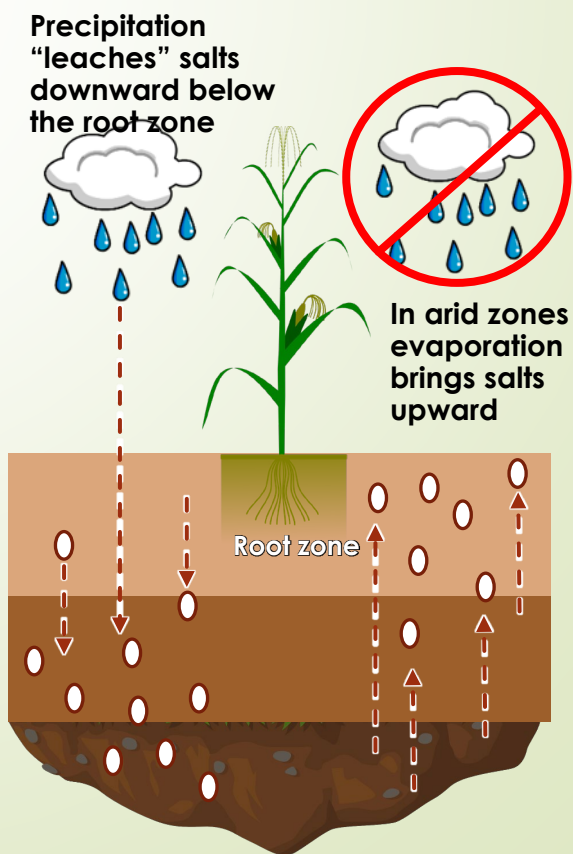
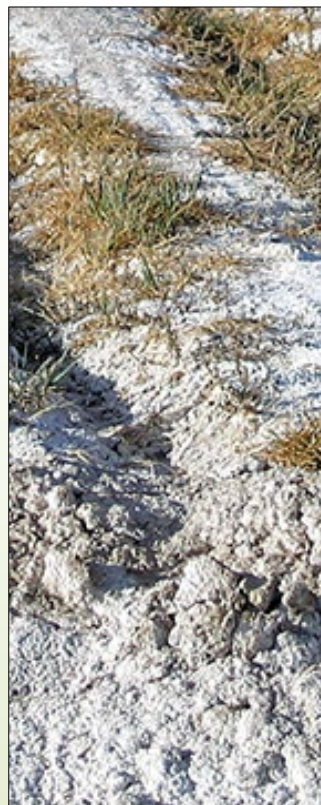
Saline and Alkali Soils

Saline and alkali soils have excessive levels of soluble salts, consisting mainly of sodium, calcium, magnesium, chloride, and sulfate and secondarily of potassium, bicarbonate, carbonate, nitrate, and boron. Soluble salts in the soil water (soil solution) can be high enough to negatively affect plant growth.

Saline and alkali soils are common in arid and semi-arid parts of the world. Low precipitation and low soil permeability in arid ecosystems contribute to the buildup of salts in the soil that would be leached by water down to deeper soil layers below the plant root zone.

Excess levels of salts in the soil root zone limit the ability of plant roots to absorb soil water. Water flows osmotically from low salt concentration to higher salt concentration. Roots uptake water osmotically by having a higher salt concentration than the surrounding soil water pool. Saline and alkali soils reverse the osmotic potential of plant roots and soil water.

One agricultural solution to improve salt affected soils is to “leach” the salts down deep into the soil using a lot of water. By leaching the salts below the root zone, plants can grow normally; but not all salts are equally mobile in water. Table salt is more soluble in water than baking soda because of the difference in polarity, bond types, and compound size.



This project was brought to you by the Great Basin Rangelands Research Unit. For more information on rangelands search USDA ARS Reno Nevada or visit nevada.rangelands.org