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Many Wyoming landowners are no stranger to the challenges of saline (sometimes called "alkali") soils.

Saline soils are high in **water soluble salts,** which can severely limit plant growth. In extreme cases, the salts accumulate on the soil surface leaving fine white crystals. Saline soils are most often found in arid or semi-arid climates such as ours, where potential **evapotranspiration** is greater than precipitation. Saline irrigation water can compound the problems associated with saline soils.

Chemistry Lesson

People often confuse the term "salinity" with common table salt, or sodium chloride (NaCl). But salinity is actually a measure of **water soluble salts**. These are simply positively and negatively charged ions dissolved in water. While this can include table salt, it also includes many other ions. For example, epsom salt (magnesium sulfate) is made from a magnesium ion (Mg^{2+}) and sulfate ion (SO_4^{2-}) bound together. When dissolved in water, magnesium and sulfate ions are free and can interact with other ions and molecules. Ammonium nitrate ($NH_4^+ + NO_3^-$) and potassium sulfate ($2K^+ + SO_4^{2-}$) are common fertilizers and also salts. The ions that most commonly accumulate in soils are calcium, magnesium, potassium, sulfate, chloride, sodium, and carbonates. With the exception of the last two, all of these ions are essential plant nutrients.

Salinity is typically measured by electrical conductivity (EC). This can be measured by a laboratory or using a handheld meter. Units for measuring salinity can vary, though deciSiemens per meter (dS/m) is the preferred unit. EC can tell you the total water soluble salts, but it does not provide specific information on **which** salts. A telltale sign of saline soils are the white crystals that form on the surface of the soil, especially in low-lying areas. A more thorough lab analysis can help identify which salts are present. Contact your local UW Extension office for help collecting a sample for a lab or interpreting results.

Effects on Plants

Plants absorb water and dissolved nutrients through their roots. When the soil water solution that contains these dissolved nutrients becomes saline (in other words, has too many dissolved ions), the plant has to use more energy to get the water needed to thrive. This condition is known as **physiological drought,** and the symptoms include stunted growth, wilting, yellowing in older leaves, and "burned" leaf margins. While there may be plenty of water in the soil, the plants simply cannot use it. This condition is also common in houseplants.

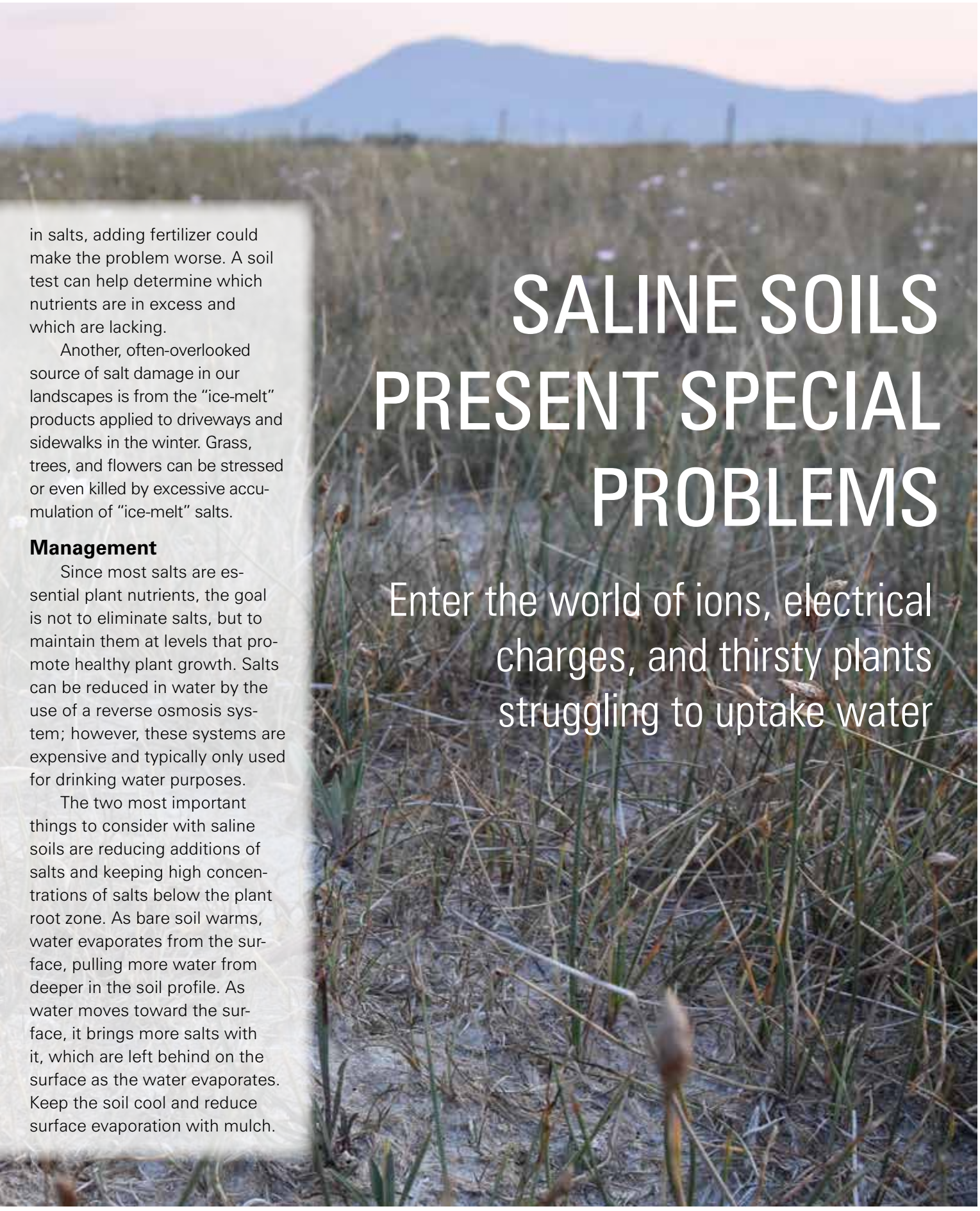
Some plant species are more tolerant to saline conditions than others. For example, beets and squash are among the most salt tolerant vegetables, while beans, peas, carrots, and onions are very sensitive. Seedlings are more sensitive than mature plants. Russian olives and junipers are more tolerant than fruit trees and aspens.

Sources of Salts

Without any help from us, salts can accumulate in the soil from weathering rocks in regions with very low precipitation or poor drainage; however, many common farming and gardening activities make the problem worse.

Irrigation water (even city water) contains dissolved ions (salts) that can accumulate in soil faster than they are used by plants. Fertilizer, manure, and compost all contain some level of salts. Remember, most salts are also essential plant nutrients but will cause plant stress when present at high concentrations.

Manure and manure-based composts typically are higher in salts (nutrients) than yard waste compost. Use caution when adding raw or composted manure to the garden or landscape if your soils or irrigation water are already high in salts. Synthetic fertilizers are concentrated sources of nutrients and therefore salts. If your garden soil or irrigation water is already high



in salts, adding fertilizer could make the problem worse. A soil test can help determine which nutrients are in excess and which are lacking.

Another, often-overlooked source of salt damage in our landscapes is from the "ice-melt" products applied to driveways and sidewalks in the winter. Grass, trees, and flowers can be stressed or even killed by excessive accumulation of "ice-melt" salts.

Management

Since most salts are essential plant nutrients, the goal is not to eliminate salts, but to maintain them at levels that promote healthy plant growth. Salts can be reduced in water by the use of a reverse osmosis system; however, these systems are expensive and typically only used for drinking water purposes.

The two most important things to consider with saline soils are reducing additions of salts and keeping high concentrations of salts below the plant root zone. As bare soil warms, water evaporates from the surface, pulling more water from deeper in the soil profile. As water moves toward the surface, it brings more salts with it, which are left behind on the surface as the water evaporates. Keep the soil cool and reduce surface evaporation with mulch.

SALINE SOILS PRESENT SPECIAL PROBLEMS

Enter the world of ions, electrical charges, and thirsty plants struggling to uptake water

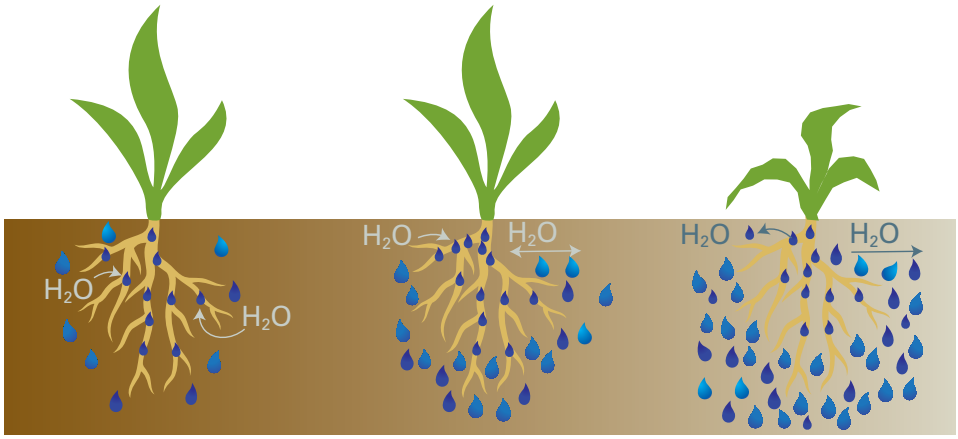
Grass clippings work well for this, as do wood chips, straw, and leaves. Mulch will also reduce weeds in your garden, add nutrients to the soil, and keep your plants happier!

If you have access to water that is low in salts and the soil is well drained, you can leach some of the salt deeper into the soil and below the plant rooting zone. Keep in mind that 6 inches of low-salt water will leach about half of the soluble salts as long as the water can move down through the soil and carry the salts below the rooting zone of the plants.

While saline soils and water can be challenging, they are not impossible to manage. Here are a few tips:

1. Establish raised beds and fill with clean soil low in salts.
2. Grow salt-tolerant varieties of vegetables, turf, and landscape plants.
3. Use transplants when possible; they are more tolerant of saline conditions than seedlings.
4. Keep the garden well-watered to make up for the fact plants are working a lot harder to get the water they do need.

When planning gardens or landscapes, we often talk about soil fertility, what varieties to plant, or how much water to use. Don't overlook potential negative effects from soil or water salinity. Soluble salts can be a problem in many areas of Wyoming, and addressing these issues early in your planning can help you be a more successful gardener!



Increased salts in root zone can result in decreased water uptake by plant.

Irrigating with water high in soluble salts can also damage plant leaves, cause desiccation (burn) of the leaf material and discoloration of fruit. Table 1 shows general guidelines for evaluating the potential for effects on plant growth based on the electrical conductivity (EC) of irrigation water.

Table1. General guidelines for salinity hazard of irrigation water based electrical conductivity[a]

Limitations for use	Electrical Conductivity (dS/m)
None	≤ 0.75
Some	0.76 - 1.5
Moderate[1]	1.51 - 3.00
Severe[2]	2 ≥ 3

[1]Leaching required at higher range.
[2]Good drainage needed, and sensitive plants may have difficulty at germination.
[a]Adapted from: http://extension.colostate.edu/topic-areas/agriculture/irrigation-water-quality-criteria-0-506/

Evapotranspiration is the transfer of water vapor from the land to the atmosphere and includes evaporation AND transpiration. Transpiration is the biological process by which cell water in plant leaves evaporates.

Sodic describes soils high in sodium, specifically. These soils are much more challenging to manage and are sometimes called "black alkali." They typically have very poor drainage caused by a loss of soil structure. A soil test is the only way to diagnose sodic soils. Leaching salts without the addition of calcium can make sodic soil conditions even worse.

For more information see:

- bit.ly/salinesoils
- bit.ly/irrigationwater
- bit.ly/salinitysalt
- bit.ly/salinityturf

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