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gardens

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AGRONOMY, HORTICULTURE & PLANT SCIENCE DEPARTMENT

Managing Salts in the Home Garden

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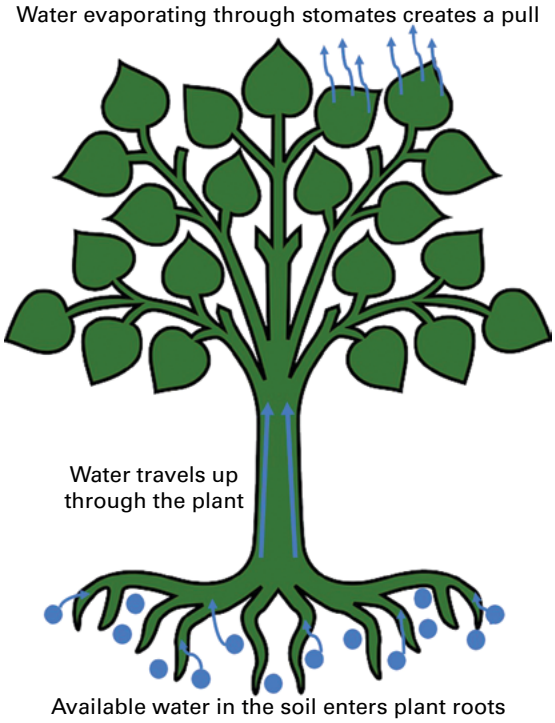
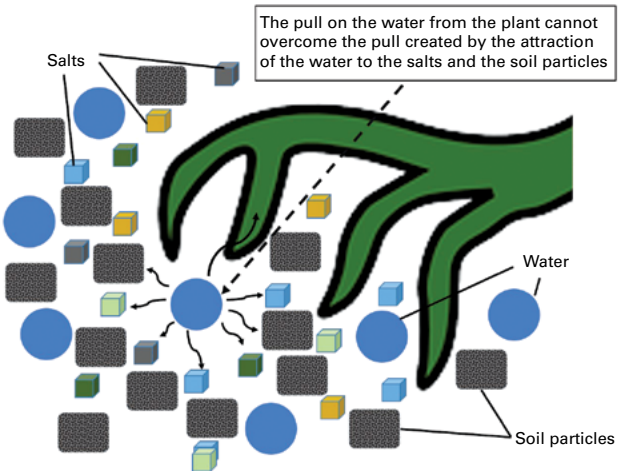
How do salts affect plants?

Most of the nutrients that a plant requires are made available to them in the form of salts. It might be tempting to think that if a little salt is good, more is better. This is not the case with food or with gardens! Just like too much salt can ruin a good dinner, too much salt in the soil can become damaging or fatal to plants—even if they are required by the plant for growth.

Plants take up water from the soil in response to a pressure gradient or "pull" created by the evaporation of water from their leaves into the atmosphere through their stomata. As the soil becomes drier, it becomes more difficult for plants to extract the water they need from the soil because soil particles also attract or pull on water molecules.



However, soil moisture content is not the only factor that influences water uptake in plants. Salts in the soil also have an effect, too. As salts accumulate in the soil, they make it increasingly difficult for plants to extract water from the soil because they too attract water molecules. It follows then, that a dry soil that also has accumulated too many salts will create the most resistance to plant water uptake. In fact, a plant may be growing in a soil that seems to appear moist, but may still be suffering from drought stress if the soil salt content is too high to allow water uptake.



Plants have some mechanisms to help them adjust to soils with too many salts and some plants are more adapted to these conditions than others. But even the most salt-tolerant plants die when there is too much salt in the soil for them to take up water. Soil-plant-water relationships are very complex which makes the management of soil salts very challenging.

Where do the salts come from?

Salts in the soil can come from several sources. The one that gardeners have the least control over is the geologic history of the soil. Much of South Dakota

used to be an ocean. Because of this, some soils and subsoils in South Dakota naturally have high salt content. These soils may naturally be difficult to use for gardening because of this high salt content—particularly when the salt concentrations are near the soil surface.

However, salts can also be added to soils over time. Only distilled water is free of salts. Both ground and surface sources of irrigation water contain at least some dissolved minerals or salts. As they are used for irrigation, the water evaporates or is used by plants, leaving behind at least some of the salts that it contained in the soil. Because of this, it is important to analyze potential irrigation water sources to determine their salt content, in particular, which salt(s) are dissolved in the water.

Salt can also be added to the soil in the form of fertilizers—organic or commercial. Many gardeners don't realize that some organic materials like manures can also contain high amounts of different salts. Because of this, understanding what each fertilizer contains and then judiciously applying the correct fertilizer is essential.

Other sources of accumulating salts include the salts in irrigation water and the salts used to clear ice and snow from driveways, sidewalks and other hard surfaces. Salt can even be added to the soil if household water that has been treated with a water softener is used to water plants.

How do salts behave in the soil?

All soil particles are negatively charged because of their chemical makeup. The organic matter and clay particles in the soil have more negative charges than the sand particles in the soil. These negative charges on soil particles are what gives soil its ability to be fertile. Since clay soil has more negative charges it is naturally more fertile than sandy soil.

Many plant-required nutrients are positively charged, including potassium, calcium, iron, magnesium, and the ammonium form of nitrogen. These positively charged nutrients (cations) are attracted to the negatively charged surfaces of soil particles, but they can be displaced by other positively charged particles and each other. This process is often referred to as cation exchange. The total amount of negative charge in a soil is its cation exchange capacity.

Are all salts created equal?

Any salt in the soil can limit plant growth if present in high enough concentrations, but not all salts behave in the same way in the soil. Salts like potassium and calcium in the soil help to maintain soil structure. Sodium behaves differently than other salts in the soil because it has a tendency to disperse soil particles. As the sodium levels in a soil rise, the soil structure begins to change or even break down. When a lot of sodium is present in the soil, the soil structure may even be damaged so much that water will no longer percolate through the soil. Soils with high sodium levels inhibit plant water uptake, but also experience drainage and erosion problems. Because of this, soils with high sodium content (often referred to as sodic soils) are much more difficult to remediate than soils that have accumulations of other salts—even though both make growing plants difficult or impossible.

High sodium levels in the soil have stunted the growth of these corn plants by restricting water uptake. Photo credit: Cheryl Reese.

Managing Soil Salts

Soil and Water Testing

The first step to managing a potential soil salt problem is to determine precisely what the problem is. Soil tests should be used to determine whether there are excess salt levels in the soil and whether the excess salt is sodium or another salt. This analysis will help determine the proper course of action. Irrigation water tests should also be conducted, where applicable, to determine the role that your irrigation water plays in the salt accumulation.

South Dakota State University no longer commercially analyzes soil or irrigation water samples but there are many places that offer these analyses.

Soil samples can be sent to several different labs. A list

of potential soil testing labs can be found here: https://extension.sdstate.edu/soil-testing-labs. Be sure the lab you choose knows that you would like to test your soil for salts and that this soil sample is from a lawn or garden.

A list of potential irrigation water testing labs can be found here: https://www.sdstate.edu/water-sample-analysis-and-interpretation. Be sure to discuss with the lab that you want your water sample analyzed for suitability to garden irrigation. Make sure that the water that you use to irrigate is not being treated by your water softener. If it is, take measures to bypass the water softener before proceeding with the water test.

Then what?

First look at the irrigation water results. If the irrigation water has high salt levels or is otherwise not recommended for irrigation by the test results, a new source of irrigation water may be needed. Consider collecting rainfall and storing it for irrigation or routing the downspouts directly to your garden, if possible.

If your irrigation water tests out fine, then look at your soil tests. If high salt levels are indicated in the test results, does sodium make up a large percentage of the salts? If there are high sodium levels in your soil, it may be difficult to remediate. Consult your local extension office and inquire whether high soil sodium levels are a common problem in your area. If high soil sodium levels are a common problem in your area, salt-tolerant crops may be your best option. If they are not, try to determine the cause of salt buildup. Is it from your irrigation water? Is it from salt runoff from adjacent concrete? Is the manure that you've been incorporating high in salt content?

If you can pinpoint the source and high sodium is not characteristic of your soils, take measures to prevent the salt accumulation then take measures to remediate the soil. In soils that are well-drained, a deep soaking with good-quality, low-salt water may help to leach salts down below the root zone. Deep watering may help to push salts down through the soil profile and out of the root zone of your garden vegetables. Remember that this process can take time. Mulching the soil surface will reduce evaporation and prevent salts from being pulled toward the soil surface with the evaporating water.

Soil amendments may help reduce problems with sodium. Adding organic matter that is low in sodium can help restore or improve soil structure, making it possible for water to percolate and move salts down through the soil. Some manures have high sodium levels, so be cautious in what you choose to apply. Under certain conditions, adding elemental sulfur or gypsum can help by displacing sodium from the exchange sites in the soil and replacing it with calcium. Refer to *The Management and Identification of Saline and Sodic Soils in the Northern Great Plains* for more specific information on adding sulfur or gypsum.

If these measures are unsuccessful, consider relocating your garden to a place with lower sodium salt levels.

If the high salt levels in your soil are primarily due to salts other than sodium, a deep soaking with clean water should still help as long as your soil is well-drained. Even though drainage tile could help, the cost and hassle of installation generally eliminates drainage tile as an option for most home gardens. In addition, the water and dissolved salts must be drained to an appropriate location. If you are considering installing drain tile, be sure to follow all local, county and state regulations for handling the discharge.

In some cases, drain tile can make soil salt problems worse rather than better. Refer again to the publication above more specific information.

In the meantime, what should I plant?

All plants have sensitivity to salts in the soil, but the sensitivity varies from species to species. Sensitivity also varies by growth stage (i.e., seedlings are more sensitive than mature plants). Asparagus is probably the most salt tolerant garden vegetable. Grapes show moderate sensitivity to soil salts, but most small fruits and fruit trees are sensitive to soil salts. The most sensitive vegetables and small fruits are beans, carrots, onions, parsnips, peas, radishes and strawberries. These sensitive vegetables and fruits may experience severe yield losses even in soils with only mild salt problems. Your soil test results should give some insight as to the severity of the salt problem in your garden. For more specific information, see *Salt/Salinity Tolerance of Common Horticultural Crops in South Dakota.*

Salt/Salinity Tolerance	Vegetable
Tolerant	Asparagus
Moderately Tolerant	Beet, red; Squash, scallop; Squash, zucchini
Moderately Sensitive	Broccoli; Brussel Sprouts; Cabbage; Cauliflower; Celery; Corn, sweet; Cucumber; Muskmelon; Pepper; Potato; Pumpkin; Spinach; Sweet Potato; Tomato; Turnip; Watermelon
Sensitive	Bean; Carrots; Onion; Parsnip; Pea; Radish; Strawberry

If the problem is moderate to severe, tolerant and moderately tolerant plants may be your best choices. As long as salt levels haven't exceeded the maximum threshold for a plant, the plant may still grow, but remember that seedlings may have a hard time getting established and overall yield will be reduced based on the severity of the salt accumulation. You may want to compensate by planting at closer spacing than usual.

What else can I do to help my plants?

Use mulches to reduce evaporation from the soil surface, hold in soil moisture and encourage more percolation down through the soil profile. Keep the soil continuously moist to prevent plant stress, but be careful not to overwater your vegetables. Watering in the morning is best because foliage will not be wet overnight and plants will be prepared for the heat stress of the afternoon.

If efforts to reduce the salt concentrations in your garden are unsuccessful and gardening has become difficult or impossible, consider moving your garden to an alternate location. Many communities are offering plots that can be rented for gardening. As an alternative, consider constructing raised garden beds on top of your current garden location. Fill the raised beds with an artificial potting media or soil from another location that does not have high salt concentrations. If your irrigation water has high salt content, using it to irrigate the raised beds may eventually lead to salt buildup in the beds too.

How can I prevent salt accumulation problems in the first place?

In soils that naturally have high salt concentrations, there may be little that can be done to prevent the accumulation of salts in the soil. Still, there are some options to consider.

Be sure never to use softened water to water your garden, raised beds or containers.

If your irrigation water contains a lot of salts, consider a different water source, if possible. Rain water collection may be an alternative. This "clean" water may help to flush salts down through the soil and out of the root zone of your vegetables. You may determine to water sensitive crops like onions and carrots with "cleaner" water and use your regular irrigation water for your asparagus or beets.

It is also important not to add excess nutrients to the soil as many of these are in the form of salts. Fertilize based on soil test results. Many nutrients are naturally plentiful in soil. By testing your soil and fertilizing based on those recommendations, you won't be adding more nutrients (salts) to the soil than your plants need. Try to add only the recommended nutrients at the recommended rate, based on the soil test results. This can be difficult because single nutrient commercial and organic fertilizers are not commonly available.

For more detailed information on salinity or sodicity problems refer to *Salt/Salinity Tolerance of Common Horticultural crops in South Dakota*.

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