Texas Agricultural Extension Service
The Texas A&M University System

SCS-1998-02

Irrigation Water Quality

Critical Salt Levels for Peanuts, Cotton, Corn & Grain Sorghum

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Introduction

Salinity is becoming a problem throughout many areas of Texas. As water quality and cropping patterns change, some areas may experience injury and reduced yields as a result of salinity. The susceptibility to salt injury varies by crop and it is important that producers understand why and how to measure salts and how crop susceptibility to salts may differ.

Why Well Water Can Be Salty?

Irrigation water quality is determined by the total amounts of salts and the types of salts present in the water. A salt is a combination of two elements or ions, one has a positive charge (for example, sodium) and the other has a negative charge (such as chloride). Water may contain a variety of salts including sodium chloride (table salt), sodium sulfate, calcium chloride, calcium sulfate (gypsum), magnesium chloride, etc. The types and amounts of salts in water, and thus, the salinity of that water depend on the source. For well water, quality depends on the composition of the underground formations from which the water is pumped. When these

are "marine" (ocean) formations, they commonly will have greater natural salt levels and produce water which is more salty. For surface water supplies, water quality will depend largely on the source of runoff. Drainage water from irrigated land, saline seeps, oil fields, and city and industrial wastewaters commonly will have higher salt levels.

What Problems Can Salty Water Cause?

Salty irrigation water can cause two major problems in crop production: 1) salinity hazard, and 2) sodium hazard. Salts compete with plants for water. Even if a saline soil is water saturated, the roots are unable to absorb the water and plants will show signs of drought stress. Foliar applications of salty water commonly cause marginal leaf burn and in severe cases can lead to defoliation and significant yield loss. Sodium hazard

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is caused by high levels of sodium which can be toxic to plants and can damage medium and fine-textured soils. When the sodium level in a soil becomes high, the soil will lose its structure, become dense and form hard crusts on the surface.

What Tests Should Be Done On Irrigation Water?

To evaluate the salt hazard, a water sample should be analyzed for three major factors:

- Total Soluble Salts
- Sodium Hazard (SAR)
- Toxic Ions

Total soluble salts measures salinity hazard by estimating the combined effects of all the different salts that may be in the water. It is measured as the electrical conductivity (EC) of the water. Salty water carries an electrical current better than pure water, and EC increases as the amount of salt increases. Many people make the mistake of testing only for chlorides, but chlorides are only one part of the salts and do not determine the entire problem.

Sodium hazard is based on a calculation of the sodium adsorption ratio (SAR). This measurement is important to determine if sodium levels are high enough to damage the soil or if the concentration is great enough to reduce plant growth. Sometimes a factor called the exchangeable sodium percentage (ESP) may be listed or discussed on a water test; however, this is actually a measurement of soil salinity not water quality.

Toxic ions include elements like chloride, sulfate, sodium and boron. Sometimes, even though the salt level is not excessive, one or more of these elements may become toxic to plants. Many plants are particularly sensitive to boron. In general, it is best to request a water analysis that lists the concentrations of all major cations (calcium , magnesium, sodium, potassium) and anions (chloride, sulfate, nitrate, boron) so that the levels of all elements can be evaluated.

What Are The Critical Levels?

Agricultural crops differ greatly in their ability to tolerate salts. Some crops have special methods for managing high salt levels inside the plant that allow them to continue to grow and produce. In most cases, critical levels have been established for each crop and each type of salt test or problem. **One of the most confusing factors is that there can be many different units of measurement for the same test**. That is, the numbers have the same relative meaning, but the units of measurement used to express the value are different (much like saying 12 inches or 1 foot).

The Texas Agricultural Extension Service Soil, Water and Forage Testing Laboratory uses standard units of micromhos per centimeter (umhos/cm) for total soluble salts and parts per million (ppm) for individual ions. Other laboratories may use different units of measure which can be calculated by making simple conversions. Table 1 gives a listing of the different tests and corresponding critical values for different units of measurement. These critical values represent the maximum salt level in irrigation water which can be used without reducing crop yield potential. Keep in mind that these values are best estimates. Actual crop response may vary depending on soil type, rainfall, irrigation frequency and weather conditions. Note cotton's ability to tolerate greater levels of salt than other common Texas crops.

Management Factors

Irrigation water with a salt level near the critical value is referred to as "marginal" quality water. In some cases, marginal quality water can be used to produce a crop recognizing that some level of yield reduction (10 - 75%) may occur. Plants can continue to grow in the presence of low salts, but the yield potential will never be maximized. Plants grown in salty soils or irrigated with salty water are always in a drought stressed condition.

Management systems for marginal quality water must be carefully designed. Major factors which

Table 1. Critical Values for Salts in Irrigation Water for Major Crops

Measurement	Peanuts	Corn	Grain Sorghum	Cotton
Total Dissolved Salts (Electrical Conductivity or Total Dissolved Solids[1])				
micromhos per centimeter (umhos/cm)	2100	1100	1700	5100
microsiemens per centimeter (uS/cm)	2100	1100	1700	5100
millimhos per cm (mmhos/cm)	2.1	1.1	1.7	5.1
decisiemens per meter (dS/m)	2.1	1.1	1.7	5.1
parts per million (ppm)	1344	704	1088	3264
milligrams per liter (mg/L)	1344	704	1088	3264
Sodium Adsorption Ratio				
No units (just a number)	10	10	10	10
Toxic Ions (Resulting in Foliar Injury)				
Boron				
parts per million (ppm)	0.75	2.0	3.0	3.0
milligrams per liter (mg/L)	0.75	2.0	3.0	3.0
milliequivalents per liter (meq/L)	0.075	0.2	0.3	0.3
Chloride				
parts per million (ppm)	400 - 500	533	710	710
milligrams per liter (mg/L)	400 - 500	533	710	710
milliequivalents per liter (meq/L)	11 - 14	15	20	20
Sodium				
parts per million (ppm)	400 - 500	533	710	710
milligrams per liter (mg/L)	400 - 500	533	710	710
milliequivalents per liter (meq/L)	17 - 21	23	31	31

[1] *Different units of measurement for total soluble salts represent the same critical value.*

must be considered include soil type, internal drainage, irrigation system and methods (rates, frequency) and cropping systems. Growers should consult an experienced agronomist or irrigation specialist for assistance in planning a management strategy for use of marginal quality irrigation water.

How To Get A Water Test

Water analyses can only be accurate if the sample is taken correctly. Please use the following guidelines when collecting a well water sample for irrigation water quality analysis.

Containers

Samples should be collected in a clean, plastic bottle with a screw cap. Thoroughly wash bottles before taking samples to eliminate any contamination. An 8 ounce plastic, disposable baby bottle is the best kind of container to use. It is commonly recommended to rinse the container several times with the water to be tested before collecting the final sample. Always clearly identify each container with a specific sample identification (well site). When mailing samples, place the bottles in a box or pack them with a soft packing material (newspaper or styrofoam) to prevent crushing.

Collecting The Water Sample

For well water, allow the pump to operate for at least 20 minutes, or longer, before taking the sample to be sure the water is representative of what is being applied. Take the water sample at the pump so that residues from the lines do not contaminate the sample. If two or more wells supply an irrigation system, one sample may be taken from the system after pumping (flushing) for at least one hour. However, if the water test indicates a problem, all wells supplying the system will need to be tested individually to determine the source of the problem. Sometimes one poor quality well can dramatically reduce the quality of the mixture.

Testing also should be done on irrigation water obtained from ponds, reservoirs, streams or other surface water sources. Samples can be obtained by collecting water from a faucet near the pumping station after operation for 20 minutes or longer. For proposed irrigation water sources where no pump is present, samples can be obtained by attaching a clean bottle to a pole or extension and collecting and mixing several samples into a "composite" which is sent to the laboratory.

Package and mail all samples to the laboratory as soon as possible to prevent chemical changes in the water due to storage. Keep good records of the date and location of each sample. This can best be done by keeping a copy of the Laboratory Information Sheet which must be submitted with each sample.

In most cases, a Routine Irrigation Water Analysis is the most appropriate test to request for irrigation water. Regardless of the laboratory selected, be certain that the analysis includes the three major factors: 1) total soluble salts, 2) sodium hazard (SAR), and 3) individual potentially toxic ions. For special cases or if uncertain, contact your local County Extension Office for information.

Also for additional information see our website at:
http://www.taexsoilcrop.tamu.edu

Partial funding for this publication was provided by the Natural Resource Conservation Service through the Environmental Quality Incentives Program (EQIP).

Revised 10/4-2000

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