lead to an increased sodium hazard when used for irrigation because these residual carbonates will bind with available calcium and magnesium in the soil, eliminating some of the effect those minerals could have in neutralizing any sodium surplus. High residual carbonates have the effect of adjusting the effective SAR to even higher levels than actually measured. RSC is reported in units of milliequivalents per liter (meq/l).

Table 1. Irrigation Water Suitability.

Water Quality Factor	*Degree of Problem*		
	None	*Moderate*	*Severe*
EC (µmho/cm)	750	750-3000	>3000
SAR	<6	6-9	>9
Boron (ppm)	<0.75	0.75-2.0	>2.0
Chloride (ppm)	<92	92-230	>230
RSC (meq/l)	<1.25	1.25-2.5	>2.5

Rating Water Quality

Your irrigation water test report will have printed recommendations based on the measured levels of total salt, sodium, and boron. There are a number of different ways of classifying the suitability of water for irrigation use. The suitability is often the accumulation of several different factors, most importantly total salinity, sodicity, boron, chlorides and residual carbonates. Moderate hazards in several factors may be tolerable, while a severe hazard in one area may be enough to make water unusable for irrigation. An online interactive water test interpretation is available at: soiltesting.okstate.edu/water-test-interpretation-program.

Nitrate

Nitrate (NO_3) in irrigation water is not a quality problem for plants. It can be a health concern in drinking water, however. To avoid the possibility of leaching excess nitrates to ground water, it is a good practice to account for any nitrate added through irrigation water when calculating how much nitrogen fertilizer to apply to achieve your yield goal. Applying 1 inch of irrigation water with a nitrate content of 1 ppm NO_3 as N adds 0.23 pounds of nitrogen per acre to your crop.

Related Extension Publications

PSS-2912 Drinking Water Testing
L-256 Understanding Your Livestock Water Test Report
L-296 Understanding Your Household Water Test Report
MWPS-14 Private Water Systems Handbook. Midwest Plan Service, Ames, IA.
PSS-2401 Classification of Irrigation Water Quality

Hailin Zhang
Director, SWFAL Laboratory

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President for Agricultural Programs and has been prepared and distributed at a cost of 42 cents per copy. Revised 0716 GH.

Understanding Your Irrigation Water Test Report

L-323

Oklahoma Cooperative Extension Service

Division of Agricultural Sciences and Natural Resources

Oklahoma State University

UNDERSTANDING YOUR IRRIGATION WATER TEST REPORT

The OSU Soil, Water and Forage Analytical Laboratory (SWFAL) provides an inexpensive but comprehensive analysis of water to evaluate its suitability for irrigation of crops and landscape plants. Water testing is an important first step in irrigation development to determine if your water source contains salts which could damage your soil, reduce crop yields, or even kill your plants.

One pint of water is enough for testing. It can be collected in any clean plastic container. Take the sample to your county Extension office. They will collect your payment and send your sample to the laboratory. Results of the test are normally returned within one week.

Your water will be tested for the following factors:

1. Sodium (Na)	10. Bicarbonate (HCO_3)
2. Calcium (Ca)	11. Hardness
3. Magnesium (Mg)	12. Alkalinity
4. Potassium (K)	13. Total Dissolved Solids (TDS)
5. Nitrate (NO_3)	14. Electrical Conductivity (EC)
6. Chloride (Cl)	15. pH
7. Sulfate (SO_4)	16. Percent Sodium (Na%)
8. Boron (B)	17. Residual Carbonate (RSC)
9. Carbonate (CO_3)	18. Sodium Adsorption Ratio (SAR)

The most important factors to consider in irrigation water quality are: (1) total salt content as measured by electrical conductivity (EC) or total dissolved solids (TDS); (2) sodium hazard as measured by sodium adsorption ratio (SAR) or sodium percent sodium (Na%); and (3) boron.

Pure water is a poor conductor of electricity. Water with increasing amounts of salt conducts electric current more and more effectively. The SWFAL reports electrical conductivity (EC) in units of micromhos/cm (μmho/cm). Other laboratories may report conductivity in units of millimhos/cm (mmho/cm) or deciSiemens/m (dS/m), which are 1000 times larger than μmho/cm.

TDS and EC

Total dissolved solids (TDS) are an indication of the total salt content of water. It is measured in units of milligrams per liter (mg/l) or parts per million (ppm). Both EC and TDS evaluate the overall effect of salinity and do not indicate the concentration of individual salts.

The effect of total salt content makes it more difficult for growing plants to take up water from the soil. The additional energy the plant must exert to overcome the pull of the salt on the water in the soil around its roots reduces the performance of the plant, leading to stunted growth, lower yields and in extreme cases, death of the plant.

The severity of salinity effects vary widely among plant species. Plants such as Bermudagrass and cotton are very tolerant, being unaffected until the electrical conductivity of soil water reaches about 7,000 μmho/cm. In contrast, strawberries and green beans are salt-sensitive, experiencing yield reductions when the electrical conductivity reaches 1,000 μmho/cm.

Sodium

Sodium (Na^+) is one mineral that requires special attention in irrigation water. Sodium can become toxic to many plants at high concentrations.

Sodium toxicity usually is seen as a burning along the edges of mature plant leaves. The toxic effects of sodium accumulate over time, so the burning effect in older leaves will eventually move toward the center of the leaf as the leaf ages. Woody perennial plants like citrus, deciduous fruits and nuts are normally most sensitive to sodium.

Another serious problem of sodium in irrigation water is its dispersive effect on soil clays. In soils with significant clay content, sodium will cause the clay particles to separate from each other. Dispersion in soil is the reverse process to aggregation (Ca and Mg promote aggregation). As a result of clay dispersion, soils will have poor physical properties. This results in a massive or puddled soil with low water infiltration, poor tilth and surface soil crust formation. The clay will clog the soil pores, causing a thin layer of slowly permeable material near the soil surface. This dramatically reduces the rate at which soil can absorb water. This sodicity hazard is most serious in fine-textured soils, especially those with expanding clays. Sodicity hazard is measured by SAR or by sodium percentage.

The effect of sodium can be counteracted or reversed by adding calcium to the soil. Calcium, usually in the form of gypsum, is added to the soil when the SAR of the topsoil reaches a critical threshold level.

Boron

Boron (B) is another mineral of particular importance in irrigation water. It is an essential micronutrient to plants, but it can become toxic at very low concentrations. Sensitive plants, such as nuts, deciduous fruits, and grapes experience toxic effects when the boron concentration in the soil reaches 1 ppm. Even the most tolerant plants, such as asparagus and alfalfa are affected once the soil boron concentration is 4 ppm. Boron toxicity symptoms are similar to those of sodium, with the burning effect beginning at the edges of older leaves. Woody perennial plants are generally most sensitive to boron.

Chloride

High concentrations of chloride ions (Cl^-) can cause injury to woody perennials, burning the edges of mature leaves. Other plants can also be injured by high-chloride water, especially if leaves are wet by sprinkler irrigation when the air temperature is high and humidity is low.

Residual Carbonates

Water with high concentrations of carbonate and bicarbonate relative to the concentrations of calcium and magnesium has a high residual carbonate level (RSC). This type of water can