Understanding Irrigation Water Analysis

The concept of water quantity is well understood by everyone, but water quality is much less understood. When you consider crop inputs, there is no other input that is applied at the rates that water (226,500 lbs/acre inch) and its contents are applied, and yet many producers give no attention to what is contained in the water. Below is discussion of some parts of the water analysis that should be given special attention.

Sodium—Sodium causes soils to disperse or lose soil structure. As soil structure deteriorates soil compaction or tightness will increase and water infiltration, water percolation and root growth are all decreased. If irrigation water contains greater than 50 ppm sodium, it can begin to adversely affect soil structure, dependent upon how much free calcium is also included with the irrigation water and in the soil. If the soil contains 2% or greater sodium, any additional sodium from irrigation water will only compound the soil structural difficulties already present. Soils with magnesium levels greater than 22% will also compound the soil structural problems accentuated by the sodium.

Amendments are needed to offset the ill effects of the sodium in irrigation water. Common amendments used are gypsum, elemental sulfur, and sulfuric acid. Elemental sulfur or sulfuric acid is used only in soils with high pH and/or soils with greater than 70% calcium. These two amendments will react with the calcium present in the soil to form gypsum. Gypsum can be used in all soils regardless of pH and is usually the most cost effective.

Gypsum Requirement Based on Irrigation Water Analysis
Pounds/Acre/Year

	Inches of Irrigation Water/Year					
Sodium, PPM	**1"**	**2"**	**4"**	**6"**	**8"**	**10"**
50	17	34	68	102	136	170
75	25	50	100	150	200	250
100	34	68	136	204	272	340
125	41	82	164	246	328	410
150	50	100	200	300	400	500
175	58	116	232	348	464	580
200	66	132	264	396	528	660
225	74	148	296	444	592	740
250	83	166	332	498	664	830
300	100	200	400	600	800	1000
350	116	232	464	696	928	1160
400	132	264	528	792	1056	1320

SAR (Sodium Adsorption Ratio)-- Sodium adsorption ratio is a calculated factor based on the sodium, calcium and magnesium levels found in the water. It is calculated using the following equation: meq./l sodium/[meq./l calcium + meq./l magnesium)$_{sq.rt.}$/2].

There is some question as to whether magnesium should be included in this equation. Although the magnesium ion is composed of two positive charges similar to calcium, its hydrated radius is much larger and will tend to cause soil particles to disperse similar to sodium.

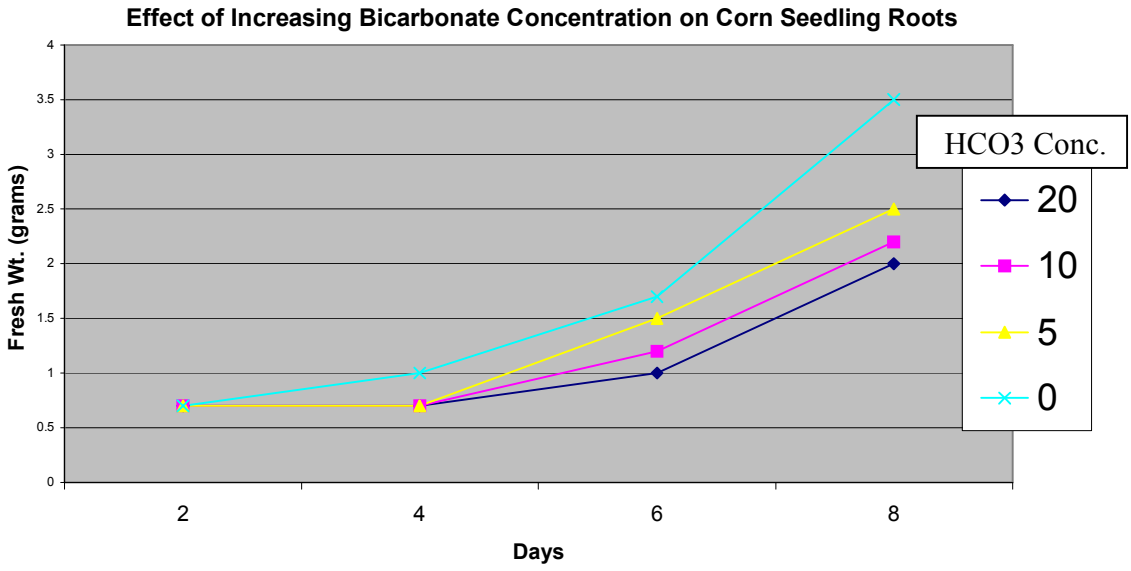
As the SAR increases above 1 it becomes of greater concern and could cause potential problems. An SAR greater than 2.5 will likely cause water permeability problems.

The best amendment for those fields where water with high SARs is used is to either inject gypsum into the water or soil-apply gypsum. If soil applied, more frequent applications at lower rates are usually preferred to assure good soil infiltration.

EC (Electrical Conductivity)-- Electrical Conductivity is a measure of the salt content of the irrigation water. The salt content should not be confused with the sodium or SAR tests. The salts are both positively charged ions such as calcium, magnesium potassium and sodium and negatively charged ions such as bicarbonate, carbonate, chloride and sulfate. As the electrical conductivity increases so does the salt content. Crops vary to the degree of sensitivity to salts, but most crops will tolerate levels of 1.1 or less with no effect on yield. Excess salinity may cause moisture stress within the plant. However, too pure of can also be detrimental. Water with too few of salts can lead to surface soil dispersion and soil crusting. Irrigation water should contain a minimum of at least 20 ppm calcium and have an EC of at least .5 to prevent surface soil dispersion.

Bicarbonate-- Bicarbonate is often overlooked in irrigation water analysis. The presence of high levels of bicarbonates will precipitate with calcium when the soils dry. The result is an increase of sodium relative to the calcium. This will lead to the development of thin surface crusts where the sodium-dominated layer may be only 1/8' thick, but can impede water infiltration and increases runoff.

Bicarbonate is also toxic to roots and reduces shoot growth, reduces uptake of phosphorus and many of the micronutrients.



Elevated bicarbonate levels in the water may also result in an unattractive white calcium carbonate deposit on plants and fruits under rapid evaporation.

Bicarbonate levels greater than 100 ppm are sufficient to cause concern. Concentrations of bicarbonates greater than 200 ppm may pose a severe potential hazard.

Since bicarbonate reacts with calcium to form calcium carbonate and render the calcium unavailable in high pH soils, amendments that will react with the bicarbonate to neutralize it are quite effective. This would include any acids or acid forming amendments. Gypsum, although not acid forming, is effective in supplying calcium to react with the bicarbonate or to replace calcium that has been removed from soil solution by the bicarbonate.

Approximate Gypsum Requirement to Offset Bicarbonates in Irrigation Water*

Bicarbonates, ppm	1"	4"	6"	10"
200	60	240	360	600
300	175	700	1050	1750
400	290	1160	1740	2900
500	405	1620	2430	4050
600	520	2080	3120	5200

*** These rates may be adjusted based on the calcium levels in the irrigation water. Assumes calcium level in water of 150 ppm.**

Chloride— Chlorides in high concentrations can inhibit plant growth. Overhead irrigation can cause leaf burn or leaf drop especially when the rate of evaporation is high. Gravity irrigation is much less of a concern if chloride levels are high. There is differences in tolerance between plant species, but most row crops will tolerate levels less than 200 ppm.

Boron— Excess boron can be toxic to plants. Symptoms of boron toxicity include necrotic spots near the leaf edge, leaf puckering or deformed roots. If irrigation water analyses are less than .75 ppm there is little concern with all crops. Wheat and sunflowers and soybeans can be affected if levels exceed .75 ppm. Corn is usually not affected until the level exceeds 2 or 3 ppm. Alfalfa and sorghum are very tolerant of high boron levels (> 4 ppm) in irrigation water.

Calcium is affective in helping tie-up boron and reduce plant uptake. Lime can be used if the pH of the soil is low. On high pH soils gypsum can provide a good source of calcium to react with the boron.

Iron—Iron seldom causes any known plant problems except a brown staining on leaves and fruit. It can form deposits of iron oxides that will block fine irrigation capillaries, sprinkler heads and pump components. Brownish slime can also be produced by iron bacteria which can also block irrigation equipment. Black sludge from manganese bacteria may also have a similar effect. These elements can be removed through ozone treatment and filtration.