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Fact Sheet-02-91

SAMPLING AND INTERPRETATION OF LANDSCAPE IRRIGATION WATER

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TAKING A WATER SAMPLE FOR ANALYSIS

Contact the lab you have selected and ask for their procedures for taking a water sample, container and their fee schedules. Tell them that you want a "standard test" for landscape irrigation water. There are three important factors to remember when collecting water samples: avoid contamination of the sample with any foreign material, and make sure it represents a uniform sample and arrives at the laboratory unchanged.

- Sample early in the week to avoid having the sample sit in a lab over the weekend. Wells should be pumped at least 24 hours before collecting to ensure a representative sample.
- Use a clean container and cap supplied by the testing laboratory. The smallest residue left in the container can make a difference.
- Fill the bottle directly from the sprinkler or point of emission.
- Rinse the container and lid several times with the water being sampled unless the instructions tell you otherwise. Collect at least a pint.
- Samples from lakes, streams or ponds should be taken below the surface for a representative sample.
- Tape the bottle shut so that it doesn't leak.
- Some samples may require overnight delivery. If the sample cannot be sent immediately, refrigerate it before sending to the laboratory.

If in doubt, ask the lab to do these tests:

Ammonia (for nitrogen loading)	Carbonates	pH	SAR_{adj}
Bicarbonates	Chlorides	Phosphorus	Sodium
Boron	Magnesium	Potassium	Sulfate
Calcium	Nitrate nitrogen (for nitrogen loading)	Salinity	Total nitrogen (for nitrogen loading)
		SAR	

INTERPRETATION OF TEST RESULTS

All irrigation waters contain dissolved minerals. When irrigation water is applied, most of the mineral salts are left in the soil after the plants have used the water. Most of these mineral salts are beneficial for plant growth but in some cases they may be harmful. The five basic criteria for evaluating irrigation water quality are:

- pH
- Salinity hazard
- Sodium hazard
- Carbonate and bicarbonates as they relate to calcium and magnesium content
- Elements that may be toxic to plants

Table 1. pH VALUES

pH VALUE	INTERPRETATION
< 7.0	Acidic
> 7.0	Alkaline
6.5 to 8.4	Suitable
> 8.4	Possibly high sodium or bicarbonates

pH (Acidity or alkalinity of the irrigation water)

Situation. Most irrigation waters originating in the desert Southwest will be alkaline in nature. Micronutrients such as iron, manganese and zinc may be unavailable to plants due to high pH. Water with a pH over 8.5 may indicate other problems such as high sodium or high bicarbonates. Units are logarithmic, similar to a Richter scale for measuring earthquakes. (Table 1).

General Recommendations. High pH alone may not warrant treatment. Values greater than 8.4 can mean high sodium (Tables 3, 4, 6 or 7) or bicarbonate levels (Table 5). Water with a pH greater than 8.4 should be tested for high levels of sodium and bicarbonates.

Salinity Hazard

Situation. Irrigation water coming directly from the Colorado River does not contain enough salt to cause direct injury to most plants provided drainage is adequate, irrigations are ET-based and appropriate leaching is observed. Some sensitive interior plants however may show signs of distress. Damage may occur under deficit irrigation management. As the salinity level of irrigation water increases (such as with reclaimed water) or if more salt sensitive plants are grown, the leaching fraction should be increased and overhead irrigation should be eliminated (Table 2). Reclaimed water may damage some ornamental plants directly from overhead irrigation. Salinity is generally estimated by determining the electrical conductivity. When sodium levels are significant, Table 4 is used instead.

Table 2. PLANT/SALINITY HAZARD OF IRRIGATION WATER (EC_w)

HAZARD	TDS (ppm or mg/L)	dS/m or mmhos/cm
None	< 500	< 0.75
Slight	500 - 1000	0.75 - 1.5
Moderate	1,000 - 2,000	1.5 - 3.0
Severe	> 2,000	> 3.0

General recommendations. Adjust the leaching fraction to control soil salts at manageable levels, blending irrigation waters, irrigate more frequently to maintain higher soil moisture, break up any drainage problem areas, artificial drainage (drain tiles), spiking and forking, wetting agents, low salt index fertilizers and proper plant selection.

Sodium Hazard (SAR and SAR_{adj} ; see also Specific Ion Toxicity)

Situation. Continued use of water having a high SAR can lead to a breakdown in the physical structure of the soil (Table 3). This results in the soil becoming hard and compact when dry and increasingly impervious to water penetration. With extremely low salinity irrigation water, even low SAR water should be used cautiously (Table 4). For waters containing significant amounts of bicarbonate, the adjusted sodium adsorption ratio (SARadj) is used. The sodium hazard of irrigation water is also dependent upon the total salt concentration. Consequently, the potential for developing an impermeable soil is dependent on the salinity, SAR of the water and the leaching imposed. Sodium may be directly toxic to sensitive plants.

Table 3. SAR (SARadj) HAZARD OF IRRIGATION WATER

	None	Slight to Moderate	Severe
Surface applied	< 3.0	3.0 – 9.0	> 9.0
Sprinkler applied	< 3.0	< 3.0	

General recommendations. Change irrigation sources, blend irrigation water with water lower in sodium levels, frequent aerification, applications of sulfur, gypsum, or sulfuric acid injection. Consider the economics behind your decisions.

Table 4. SAR/SALINITY HAZARD OF IRRIGATION WATER (EC_W)

If SAR is:	0-3	3-6	6-12	12-20	20-40
and EC_W (dS/m) is:					
None	> 0.7	> 1.2	> 1.9	> 2.9	> 5.0
Slight	0.7	1.2	1.9	2.9	5.0
Moderate	0.2	0.3	0.5	1.3	2.9
Severe	< 0.2	< 0.3	< 0.5	< 1.3	< 2.9

Carbonates and Bicarbonates.

Situation. Irrigation water with a pH value (above 8.4) may indicate that the water contains high levels of carbonates and bicarbonates (Table 1). Carbonates and bicarbonates tend to “tie up” calcium and magnesium during soil drying. This makes the sodium present potentially more damaging. High carbonates and bicarbonates in water essentially increases the sodium hazard of the water greater than indicated by the SAR (Table 5).

Table 5. BICARBONATE (HCO_3) HAZARD OF IRRIGATION WATER (meq/L)

None	Slight to Moderate	Severe
< 1.5	1.5 - 7.5	> 7.5

An adjusted SAR value (SARadj) may be calculated for water high in carbonates and bicarbonates (Table 3). These calculations can best be made by the laboratory that does the testing. Using the two values from Tables 3 and 5 allows a better estimation of the sodium buildup in the soil from continued use of this type of water. The adjusted SAR, and knowledge of soil properties, helps determine management practices when using high bicarbonate water.

General Recommendations. This is frequently the reason sulfuric acid injection is promoted for use in irrigation water. When sulfuric acid is injected, the bicarbonate ion begins to dissociate (break apart) at around a pH of 6.2 and carbon dioxide is given off. It is further argued that sulfuric acid injection allows the calcium and magnesium to stay in solution thus lowering the potential damage caused by sodium. The other options available are to amend the soil with gypsum (soils with low free calcium) or sulfur (soils with high lime content) followed by leaching. The economics of each of the treatment methods should be considered before deciding on the best option.

Resdiual Sodium Carbonate (RSC).

*Situation***.** RSC (Table 6) tells you how much calcium and magnesium is in your water compared to carbonates and bicarbonates. This value may appear in some water quality reports. Although not used often, RSC gives similar information to SAR_{adj}

General Recommendations. Same recommendations as carbonates and bicarbonates.

Table 6. RESIDUAL SODIUM CARBONATE (meq/L)

HAZARD	RSC VALUE
Low	< 1.25
Medium	1.25 to 2.5
High	> 2.5

Specific Ion Toxicity (Levels of specific ions are too high).

Situation. Some ionic constituents in irrigation water may be directly toxic to plants (Tables 7 and 8). This toxicity may occur at very low concentrations as it does with boron. Or it may require significantly higher concentrations as with sodium and chloride. However, this is dependent on which ion it is and is influenced significantly by irrigation management.

Boron. Irrigation waters containing more than 1.0 ppm boron (B) may cause accumulation of boron to toxic levels when used for irrigating sensitive plants.

Chloride. Some ions like chloride can be directly absorbed into the leaves during sprinkler irrigation. Foliar damage from sprinkler irrigation is particularly acute during periods of high temperature and low humidity. Turfgrass is not particularly sensitive to high levels of chlorides, boron or sodium. However, many ornamental plants may be.

Table 7. TOXIC LEVELS OF SPECIFIC IONS (meq/L)

	None	Slight to Moderate	Severe
Boron	< 1	1 – 3	> 3
Chloride	< 4	4 – 10	> 10
Sodium	< 3	3 – 9	> 9

Other ions. Although not as common in irrigation water in the Western United States, occasionally other elements may be potentially toxic to plants (Table 10). This frequently varies from plant to plant.

As an example, elements like fluoride added to drinking water at very low levels may be toxic to interior plants like Dracaena. Usually irrigation water applied to the soil can be higher in these elements if the water is used for short periods of time since soils have a tremendous ability to “lock up” such elements, making them less available. A different value must be used (water used continually) if the water is intended as a permanent water supply.

General Recommendations. If overhead irrigation is being used, convert to an irrigation delivery system that is soil applied (such as drip, nutrient film, pulse or even low angle heads). Switching to a different plant or cultivar more tolerant may be necessary.

Table 8. ELEMENTS THAT MAY BE TOXIC (ppm)

Element	Long-Term Use	Short-Term Use
Aluminum	1.000	20.00
Arsenic	1.000	10.00
Cadmium	0.005	0.05
Chromium	5.000	20.00
Cobalt	0.200	10.00
Copper	0.200	5.00
Fluoride	1.000	15.00
Iron	5.000	20.00
Lead	5.000	10.00
Manganese	2.000	20.00
Nickel	0.500	2.00
Selenium	0.050	0.05

Conversion Factors.

Laboratories will report values in different units depending on their protocol. These values (such as milligrams per liter, parts per million) are equivalent. The following table will help you to convert these values.

Table 9. WATER QUALITY CONVERSION TABLE

FROM	TO	MULTIPLY BY
ppm	mg/L	1.0
ppm	mmhos/cm	0.00156
ppm	dS/m	0.00156
ppm	µmhos/cm	1.56
ppm	pounds per acre ft	2.7
ppm	**meq/L**	
bicarbonate	bicarbonate	0.0164
boron	boron	0.303
calcium	calcium	0.050
carbonate	carbonate	0.033
chloride	chloride	0.028
magnesium	magnesium	0.082
sodium	sodium	0.043
sulfate	sulfate	0.021
mg/L	ppm	1.0
mg/L	dS/m	0.00156
mg/L	mmhos/cm	0.00156
mg/L	µmhos/cm	1.56
mg/L	pounds per acre ft	2.7
mmhos/cm	dS/m	1.0
mmhos/cm	ppm	640
mmhos/cm	mg/L	640
mmhos/cm	µmhos/cm	1000
dS/m	ppm	640
dS/m	mg/L	640
dS/m	mmhos/cm	1.0
dS/m	µmhos/cm	1000
µmhos/cm	mmhos/cm	0.001
µmhos/cm	dS/m	0.001
µmhos/cm	ppm	0.640
µmhos/cm	mg/L	0.640
meq/L	**ppm**	
bicarbonate	bicarbonate	61
calcium	calcium	20.0
carbonate	carbonate	30.0
chloride	chloride	35.5
magnesium	magnesium	12.2
potassium	potassium	39.1
sodium	sodium	23.0
sulfate	sulfate	48.0

Trms
mg/L- milligrams per liter
mmhos/cm – millimhos per centimeter
µmhos/cm –micromhos per centimeter **dS/m** – decisiemans per meter
meq/L – milliequivalents per liter
ppm – parts per million

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