IRRIGATION WATER ANALYSIS GUIDELINES

DISCLAIMER: No warranty is made, expressed or implied, concerning crop performance as a result of following these guidelines

TERMINOLOGY: parts per million = ppm = mg/L = lb per million lb water.   ppm x 2.72 = lbs/acre-foot of water,   e.g. 10 ppm = 10 x 2.72 = 27.2 lb per acre-foot of water

milliequivalents per liter (meq/L) x EW of analyte = ppm or mg/L   "Less than" symbol = "<"   "Greater than" symbol = ">"

Sources: A & L Western Ag Labs, and Larry Schwankl, UC Irrigation Specialist
Prepared by Mark Battany, Farm Advisor

POTENTIAL PROBLEM MAY BE…	SODIUM meq/L (sprinkler)	SODIUM meq/L (surface)	CALCIUM meq/L	MAGNESIUM meq/L	CARBONATE meq/L	BICARBONATE meq/L	CHLORIDE meq/L (sprinkler)	CHLORIDE meq/L (surface)	E.C. mmhos/cm or dS/m	pH	COPPER ppm (toxicity)	IRON ppm (clogging)	MANGANESE ppm (clogging)	ZINC ppm (toxicity)
SEVERE	?	> 9	> 6	> 6	?	> 8.5	?	> 10	> 3.0	> 8.0	> 0.2	> 1.5	> 1.5	> 2.0
INCREASING	> 3	3 - 9	3 - 6	3 - 6	> 0.1	1.5 - 8.6	> 3	4 - 10	0.7 - 3.0	7.0 - 8.0		0.1 - 1.5	0.1 - 1.5	
LOW	< 3	< 3	< 3	< 3	< 0.1	< 1.5	< 3	< 4	< 0.7	< 7.0		< 0.1		< 0.1
CONV. TO ppm	x 23.00	x 23.00	X 20.04	x 12.15	x 30.00	x 61.02	x 35.46	x 35.46	x 640 = TDS		x 1	x 1	x 1	x 1

COMMENTS AND ACTION

- **SODIUM (sprinkler):** Avoid irrigating when hot and windy. Maximize rotation speed and droplet size. Trees and vines are the most sensitive to salt burn.
- **SODIUM (surface):** Irrigate heavily prior to rainy season to facilitate leaching by better quality rain water. Gypsum may be required beforehand.
- **CALCIUM:** Require at least 1 meq/L to avoid restricted water infiltration. Clogging problems increase above a combined Ca+Mg level of 3 meq/L. Approx. 250 lb of gypsum/ac-ft of water will raise Ca by 1 meq/L, depending on purity.
- **MAGNESIUM:** See comments below. High Mg may result in an inverse Ca:Mg ratio, leading to poor water infiltration.
- **CARBONATE:** Levels found only above a pH of about 8.3 and related to high sodium.
- **BICARBONATE:** 1 meq/L equates to 200 lb of lime (83% neutralizing value) per ac-ft of water. Unsightly deposits may be left on crop. Acidify to pH 6.5 to decompose 50% of bicarbonates. Ask lab to do a filtration with a selected acid.
- **CHLORIDE (sprinkler):** 1 meq/L = approx 100 lb Cl per ac-ft of water. Maintain close to field capacity.
- **CHLORIDE (surface):** mmhos/cm = approx tons of "salt" per ac-ft of water. If too low, see adj SAR. If too high, see Chloride.
- **pH:** High pH may reduce pesticide activity or increase precipitation. Low pH may be corrosive below 4.5.
- **COPPER:** * May become toxic if more than 0.2 ppm. * Assuming about 3 ac-ft of water is applied annually.
- **IRON:** Not toxic in aerated soils, but may leave unsightly deposits.
- **MANGANESE:** May become toxic if more than 0.2 ppm. Usually, only in acidic soils.
- **ZINC:** May become toxic if more than 2.0 ppm. Usually, only in acidic coarse-textured soils.

OTHER CLOGGING FACTORS IN DRIP IRRIGATION

POTENTIAL PROBLEM MAY BE…	PHOSPHOROUS ppm	POTASSIUM ppm	NITRATE ppm	SULFATE ppm	BORON ppm	TDS ppm	ADJ. SAR ratio	LANGELIER SAT INDEX	TSS mg/L	SULFIDE mg/L	BACTERIA maximum number per mL (CFU/mL)
SEVERE	?	?	?	?	> 6.0	> 2000	> 9.0	> 2.0	> 100	> 2.0	> 50,000 (5×10^4)
INCREASING	2 - 10	10 - 50	45 - 150	100 - 1000	0.5 - 6.0	450 - 2000	6.0 - 9.0	0.2 - 2.0	50 - 100	0.5 - 2.0	10,000 - 50,000 (1×10^4 - 5×10^4)
LOW	< 2	< 10	< 45	< 100	< 0.5	< 450	< 6.0	< 0.2	< 50	< 0.5	< 10,000 (1×10^4)
CONVERSIONS	x 6.22 = lb P_2O_5/ ac-ft water	x 3.26 = lb K_2O/ ac-ft water	x 0.61 = lb N/ ac-ft water	x 0.90 lb SO_4-S/ ac-ft water	x 2.72 = lb B/ ac-ft water	/ 640 = approx Ecw of water	Adjusted for CO_3, HCO_3	An indication of alkalinity or corrosivity of water.			

COMMENTS AND ACTION

- **PHOSPHOROUS:** Excessive P may lead to precipitation in high-Ca water. Restrict fertigation to <200 ppm P_2O_5 (~500 lb/ac-ft).
- **POTASSIUM:** Excessive K may lead to soil surface sealing. Restrict to crop requirements.
- **NITRATE:** Excessive NO_3 will contaminate ground water. Test wastewater also for TKN. Restrict to crop requirements.
- **SULFATE:** Excessive SO_4 combined with Ca may lead to unsightly deposits on foilage and fruit. Sulfur burners may be used for both acidification and biocidal effect.
- **BORON:** Excessive B tends to be crop-specific, but generally unsatisfactory for all crops if above 4 ppm and applied annually.
- **TDS:** Maintain soils close to field capacity to minimize stress. 735 ppm = 1 ton of "salt" per ac-ft of water.
- **ADJ. SAR:** Soil permeability more of a problem with low salinity water.
- **LANGELIER SAT INDEX:** High = potential problem of precipitation of $CaCO_3$. Low = potential problem of corrosivity.
- **OTHER CLOGGING FACTORS (TSS, SULFIDE, BACTERIA):** Chlorination of irrigation water susceptible to clogging by the above may often provide sufficient maintenance. Ensure at least 1 ppm residual chlorine at the end of the line, and inject at each irrigation. Where bacterial slimes are severe, a continuous injection of 5-10 ppm may be necessary. Certainly, 10-20 ppm for the last half hour of the irrigation cycle. Repeat as necessary. Acidifying water to pH 6.5 will both increase effect of chloriine and help dissociate high bicarbonates. Inject separately from chlorine and upstream of filter station. Seek further advice on all of the above.

SOME USEFUL CONVERSIONS

CHLORIDE: Approximately 75 lb chloride accompanies every 100 lb potash applied through potassium chloride, and 50 lb accompanies every 30 lb calcium with every 20 gallons of calcium chloride.

CHLORINE: Approximately 13 lb chloride accompanies every acre-foot of water treated with 10 ppm chlorine, due to traces of sodium chloride in sodium hypochlorite ("chlorine bleach").

1. Sodium Hypochlorite (chlorine bleach):

Chlorine Injection rate/hr = $\dfrac{0.006 \times \text{desired ppm chlorine} \times \text{flow rate}}{\%\text{ of strength of sodium hypochlorite}}$

e.g.   2 gallons per hour = $\dfrac{0.006 \times \text{desired 17.5 ppm chlorine} \times \text{flow rate of 100 gph}}{5.25\% \text{ chlorine}}$

2. Calcium Hypochlorite (12.8 lb/100 gal water = 1% chlorine solution):

e.g.   10.5 gallons per hour = $\dfrac{0.006 \times \text{desired 17.5 ppm chlorine} \times \text{flow rate of 100 gph}}{1.00\% \text{ chlorine}}$

3. Chlorine gas, although less expensive, is hazardous to apply. Illegal in some areas.

e.g.   21 lb chlorine gas per day = 0.012 x 17.5 x flow rate of 100 gph

Other methods of water treatment include sulfur burners, ozone and a variety of other products. Seek further advice.