IRRIGATION WATER ANALYSIS GUIDELINES

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

TERMINOLOGY: part per million = ppm = mg/L = 1,000 ug/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.
ppm or mg/L = milliequivalents per liter (meq/L) x EW of analyte < = less than > = greater than 325,851 gals per acre-foot of water.

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)
			Hardness = ppmCa x2.497 + ppmMg x4.118 + ppmFe x1.792											
SEVERE ☆☆☆	?	>9	>6	>6	?	>8.5	?	>10	<0.2 >3.0	>8.0	>0.2	>1.5	>1.5	>2.0
INCREASING ☆☆	>3	3-9	3-6	3-6	>0.1	1.5-8.5	>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	0.2-0.7	<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	TDS = ~x 640 if<5.0 dS/m		x 1	x 1	x 1	x 1

COMMENTS AND ACTION	Avoid irrigating when hot and windy. Maximize rotation speed and droplet size.	Irrigate heavily prior to rainy season to facilitate leaching by better quality rain-water.	Require at least 1 meq/L to avoid restricted water infiltration. Clogging problems increase above a combined Ca+Mg level of 3 meq/L.	See comments below.	Levels found only above a pH of about 8.3 and related to high sodium.	1 meq/L equates to 200 lb of lime (83% neutralizing value) per ac-ft of water. Unsightly deposits may be left on crop.		1 meq/L = approx 100 lb Cl per ac-ft of water.	mmhos/cm divided by 1.15 = approx tons of "salt" per ac-ft of water.	High pH may reduce pesticide activity or increase precipitation.	*May become toxic if more than 0.2 ppm.	Not toxic in aerated soils, but may leave unsightly deposits.	*May become toxic if more than 0.2 ppm Usually, only in acidic soils.	*May become toxic if more than 2.0 ppm Usually, only in acidic coarse-textured soils.
	Trees and vines are the most sensitive to salt burn.	Gypsum may be required beforehand.	Approx 250 lb of gypsum/ac-ft of water will raise Ca by 1 meq/L... depending on purity.	High Mg may result in an inverse Ca:Mg ratio, leading to poor water infiltration.		Acidify to pH 6.5 to decompose 50% of bicarbonates. Ask lab to do a titration with a selected acid.		Maintain close to field capacity.	If too low, see adj SAR If too high, see Chloride.	Low pH may be corrosive below 4.5.	* Assuming about 3 ac-ft of water is applied annually.			

POTENTIAL PROBLEM MAY BE…	PHOSPHORUS ppm	POTASSIUM ppm	NITRATE ppm	SULFATE ppm	BORON ppm	TDS ppm	ADJ. SAR ratio	LANGELIER SAT INDEX
SEVERE ☆☆☆	?	?	?	?	>6.0	>2000	>9.0	>2.0
INCREASING ☆☆	2 -10	10-50	45-150	100-1000	0.5-6.0	450-2000	6.0-9.0	0.2-2.0
LOW ☆	<2	<10	<45	<100	<0.5	<450	<6.0	<0.2
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. "+" value = potential problem of precipitation of $CaCO_3$. "-" value = potential problem of corrosivity.
COMMENTS AND ACTION	Excessive P may lead to precipitation in high-Ca water. Restrict fertigation to <200 ppm P_2O_5 (~500 lb/ac-ft).	Excessive K may lead to soil surface sealing. Restrict to crop requirements.	Excessive NO_3 will contaminate ground water. Test wastewater also for TKN. Restrict to crop requirements. x 0.2259 = N x 4.4266 = NO_3	Excessive SO_4 combined with Ca may lead to unsightly deposits on foliage and fruit. Sulfur burners may be used for both acidification and biocidal effect.	Excessive B tends to be crop-specific, but generally unsatisfactory for all crops if above 4 ppm and applied annually.	Maintain soils close to field capacity to minimize plant stress. 735 ppm = 1 ton of "salt" per ac-ft of water.	Soil permeability more of a problem with low salinity water. (maintain above 0.2 dS/m)	

POTENTIAL PROBLEM MAY BE…	OTHER CLOGGING FACTORS IN DRIP IRRIGATION TSS mg/L	SULFIDE mg/L	BACTERIA maximum number per mL (CFU/mL)
SEVERE ☆☆☆	>100	>2.0	>50,000 (5 x 10^4)
INCREASING ☆☆	50-100	0.5-2.0	10,000-50,000 (1x10^4 - 5x10^4)
LOW ☆	<50	<0.5	<10,000 (1 x 10^4)

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 hour of the irrigation cycle. Repeat as necessary.

Acidifying water to pH 6.5 will both increase effect of chlorine 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 = $\frac{0.006 \times \text{desired ppm chlorine} \times \text{flow rate}}{\text{\% strength of sodium hypochlorite}}$

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

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

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

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 ppm chlorine x flow rate of 100 gph

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

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