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Irrigation Water Quality

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Most irrigation water in Oregon is of excellent quality. Occasionally a deep well yields water that is too salty for irrigation, or contains constituents that are detrimental to plants or soils.

Water can be of poor quality for irrigation because of the amount of impurity (salt) it contains or the kinds of impurities present. The table of guidelines for interpretation of water quality for irrigation (next page) lists the most common sources of irrigation water problems.

Since water quality is a minor problem in Oregon, virtually no local research has been conducted. The interpretive information comes from southern California, Utah, and Nevada. Considering the climatic differences, standards from California may be too restrictive for Oregon conditions. Experience over many years has indicated that this information is reasonably satisfactory for Oregon, even considering the climatic differences.

Irrigation water quality can be evaluated with a water-quality test. County offices of the OSU Extension Service have a list of laboratories that offer water testing services (see "For More Information"). For assistance in interpretation of water tests, contact your county Extension office.

Assumptions in the Guidelines

Water-quality guidelines in the table cover the wide range of conditions encountered in irrigated agriculture. Several basic assumptions have been used to define the ranges of usability. If you use water under very different conditions, you may need to adjust the guidelines. Wide deviations from the assumptions might result in wrong judgments on the usability of a particular water supply, especially if it is a borderline case.

The basic assumptions in the guidelines are:

Yield potential: Normal, good crop management is assumed when the guidelines indicate no restrictions on use. A "restriction on use" indicates that there may be a limitation in choice of crop, or use of special management practices may be needed to maintain full production capability. A "restriction on use" does *not* indicate that the water is unsuitable for use.

Site conditions: Drainage is assumed to be good, with no uncontrolled water table present within 5 feet of the surface. Soil textural class ranges from sandy loam to clay loam with no restrictive layering. Rainfall does not play a significant role in meeting crop water demand or leaching requirement. In western Oregon, rainfall plays an important role.

Methods and timing of irrigations: Normal surface or sprinkler irrigation methods are used, providing an acceptable uniformity. Water is applied as needed, and the crop utilizes a considerable portion of the available stored soil-water (>50 percent) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF] $\geq$15 percent).

The guidelines are too restrictive for specialized irrigation methods, such as micro-irrigation, which require daily or frequent irrigations and require special management and provide more options for using poorer quality water on many crops.

Water uptake by crops: Crops differ in water uptake patterns, but crop plants take water from wherever it is most readily available. About 40 percent of crop water is taken from the upper quarter of the rooting depth, 30 percent from the second, 20 percent from the third, and 10 percent from the lowest quarter.

Each irrigation leaches the upper root zone, maintaining a relatively low salinity. Salinity increases with depth and is greatest in the lower part of the root zone. The average whole root zone salinity of the soil-water is three times that of the applied water.

Salts leached from the upper root zone accumulate to some extent in the lower root zone. Salts are moved below the root zone by sufficient leaching. The higher salinity in the lower root zone becomes less important if adequate moisture is maintained in the upper, "more active" root zone. Winter precipitation can be quite important in providing this leaching.

Restriction on use: The "Degree of restriction on use" shown in the table is divided into three degrees of severity: none, slight to moderate, and severe. A change of 10 to 20 percent above or below a guideline value has little significance if considered in proper perspective with other factors. Field studies, research trials, and observations have led to these divisions, but management skill of the water user can alter them. Values shown are applicable under normal field conditions prevailing in most irrigated areas in the arid and semiarid regions of Oregon.

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Guidelines for Interpretation of Water Quality for Irrigation[1]

Potential irrigation problem	Units	Degree of restriction on use		
		None	Slight to moderate	Severe
Salinity, water availability influence[2]				
EC_w	dS/m or millimhos/cm	<0.7	0.7–3.0	>3.0
TDS	mg/L or ppm	<450	450–2,000	>2,000
Salinity, infiltration influence				
If SAR[3] = 0–3 and EC_w =		>0.7	0.7–0.2	<0.2
= 3–6 =		>1.2	1.2–0.3	<0.3
= 6–12 =		>1.9	1.9–0.5	<0.5
= 12–20 =		>2.9	2.9–1.3	<1.3
= 20–40 =		>5.0	5.0–2.9	<2.9
Specific ion toxicity *(affects sensitive crops)*				
Sodium (Na)[4]				
Surface irrigation	SAR	<3	3–9	>9
Sprinkler irrigation	me/L	<3	>3	
Chloride (Cl)[4]				
Surface irrigation	me/L	<4	4–10	>10
Sprinkler irrigation	me/L[5]	<3	>3	
Boron (B)	mg/L or ppm	<0.7	<0.7–3.0	>3.0
Trace elements (see your OSU Extension agent)				
Miscellaneous effects *(affects susceptible crops)*				
Nitrogen (NO_3-N)[6]	mg/L	<5	5–30	>30
Bicarbonate (HCO_3)	me/L	<1.5	1.5–7.5	>7.5
pH[7]			6.5–8.4 (normal range)	

[1] Adapted from Ayers and Westcott, 1985. These parameters may be overly restrictive for Oregon climatic conditions.

[2] EC_w = electrical conductivity, a measure of the water salinity, reported in decisiemens per meter at 25°C (dS/m) or equivalent units, millimhos per centimeter (mmho/cm). TDS (total dissolved solids), reported in milligrams per liter (mg/L).

[3] SAR = sodium adsorption ratio (sometimes reported as RNa). Applicable only in eastern Oregon. Standard SAR only, not adjusted. The relationship between EC, SAR, and infiltration usually does not apply if soil pH is below 7. At a given SAR, infiltration rate increases as water salinity increases. Evaluate the potential infiltration problem by SAR as modified by EC_w. Adapted from Rhoades, 1977, and Oster and Schroer, 1979.

[4] Most tree crops and woody plants are sensitive to Na and Cl; for surface irrigation use the SAR values shown. Most annual crops are not sensitive; for surface irrigation use the salinity tolerance tables from Ayers and Westcott, 1985, p. 31. With overhead sprinkler irrigation and low humidity (<30 percent), Na and Cl may be absorbed through the leaves of sensitive crops.

[5] To convert ppm to me/L, divide ppm/L by the following values for each component: Na—23, Cl—35, HCO_3—61, and B—11.

[6] NO_3-N means nitrate nitrogen reported in terms of elemental N. NH_4-N and organic-N should be included when wastewater is being tested.

[7] Fertilizer applications can change water and soil pH and have an effect on the potential toxicity of ions in the irrigation water.

For More Information

OSU Extension publications

A List of Analytical Labs Serving Oregon, FG 74, by J. Hart (Oregon State University, Corvallis, revised 1997). No charge.

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Other publications

Ayers, R.S., and D.W. Westcott. 1985. Water Quality for Agriculture. FAO Irrig. and Drain. Paper 29, Rev. 1.

California Fertilizer Association. 1985. Western Fertilizer Handbook. 7th ed. The Interstate Printers & Publishers. Inc., Danville, IL.

Oster, J.D., and F.W. Schroer. 1979. Infiltration as influenced by irrigation water quality. Soil Sci. Soc. Amer. J. 43:444–447.

Rhoades, J.D. 1977. Potential for using saline agricultural drainage waters for irrigation. Proc. Water Management for Irrigation and Drainage. ASCE, Reno, NV, 20–22 July 1977, pp. 85–116.

U.S. Salinity Laboratory Staff. 1954. Diagnosis and Improvement of Saline and Alkali Soils. USDA Handbook No. 60. U.S. Gov. Print. Office, Washington, DC.

Soil and water analyses are based on procedures used in the OSU Central Analytical Laboratory. This publication was reviewed by Extension personnel in Oregon, Washington, and Idaho.

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