Saline Irrigation

As the availability of fresh water for irrigation dwindles, water containing dissolved soluble salts can help quench irrigation needs.

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Alden Pines Country Club *near Ft. Meyers, FL, is an example of how turfgrass managers are coping with saline environments. The course is located on the Gulf of Mexico. Its irrigation water has an EC reading of 10 dS/m. The entire facility is planted with Adalayd Seashore paspalumgrass.*

Irrigation is becoming a major cultural practice throughout the United States for turf and ornamental plants.

Providing adequate supplemental water insures a consistant, healthy, vigorously growing landscape when rainfall is inadequate or infrequent.

Obtaining ample quantities of good quality water is becoming difficult as irrigation demands increase and fresh water supplies dwindle. Often lower quality water with high amounts of dissolved soluble salts is used in order to obtain adequate amounts of irrigation.

The principle soluble salts found in water are the chloride and sulfate salts of sodium, calcium, and magnesium.

The original source of these materials was from weathering of primary minerals. The oceans have become the eventual reservoir of soluble salts as water has moved through the hydrological cycle. Along coastal regions of the country, seawater is intruding into fresh water supplies and contaminating them by increasing the

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soluble salt levels.

In the interior regions of the country, ancient saline marine deposits in geological layers add soluble salts to rainwater as it passes through the layers. This process has occured throughout the country and virtually all the fresh water supplies have some amount of dissolved salts.

Amount of salts

The amount of salts in water determines the degree of salinity and to a large extent the overall water quality. Salinity is determined by a conductivity meter which measures the electrical conductivity (EC) of a water sample.

This is determined as the inverse of the resistance of an electric current as it is passed between two probes in a salt solution.

Electrical conductivity is determined in units of Siemans per meter (S/m) or in the older units of mhos per centimeter (mhos/cm). Generally, electical conductivity is reported in tenths of Siemans or Deci-Siemans per meter (dS/m) which are equal to the old reporting unit of millimhos per centimeter (mmhos/cm).

Electrical conductivity is the preferred salinity measurement because it expresses all the salts that are associated with possible salt stress on plants from saline irrigation. The electrical conductivity and concentration of dissolved salts (parts per million - ppm) are directly related units depending on the salts present.

A sodium chloride solution of 1 dS/m is equal to 640 ppm soluble salts. Other salt solutions vary from 550 to 700 ppm for every 1 dS/m. Salinity of water samples are often compared to seawater which has an EC of 41.5 dS/m and about 35,000 ppm dissolved salts. Irrigation water has been classified into four catagories based on the salinity hazard (See Table 1). These limits were determined by the U.S. Salinity Laboratory based on the relationship between the electrical conductivity of the water and the electrical conductivity of soils to which the water has been applied.

TABLE 1.
Classification of Saline Irrigation Water.

Salinity Class	Electrical Conductivity (dS/m)	Concentration of Dissolved Salts (ppm)	Comments
Low	<0.25	<160	Low salinity hazard.
Medium	0.25-0.75	160-480	Some leaching required.
High	0.75-2.25	480-1440	Good drainage required & salt tolerant plants.
Very high	>2.25	>1440	Excellent drainage required & very salt tolerant plants.

TABLE 2.
Recommended Irrigation Amounts For Saline Water.

Irrigation Water EC (dS/m)	Maximum Plant Salinity Tolerance Level, Measured By Saturated Soil Paste Extract (dS/m).		
	4 (Low)	8 (Medium)	16 (High)
	inches of water required to replace evapotranspiration losses and provide adequate leaching.		
0.00	1.5	1.5	1.5
1.00	2.0	1.7	1.6
2.00	3.	2.0	1.7
3.00	6.0	2.4	1.8

Obtaining ample quantities of good quality water is becoming difficult ...

Water with EC readings of less than 0.75 dS/m are considered to be suitable for irrigation without many problems. The successful use of water above this level depends on the soil conditions and plant tolerance to salinity. The quality of irrigation water is also influenced by other specifications.

Amount of sodium

The amount of sodium is of prime concern because it is often found in the largest amounts. Excessive sodium destroys soil structure. Sodium is also an antagonistic ion that will displace potassium and can limit the availability of iron, manganese and phosphorus in soils.

Boron in irrigation water is rarely a problem with turfgrasses because boron accumulates in leaf tips which are removed by regular mowing. Other landscape plants may be more sensitive to boron levels.

High concentrations of chloride, sulfate, and bicarbonate ions can cause specific injury under certain soil conditions.

Soils are a key to the continued use of saline irrigation water. Good drainage is essential to leach soluble salts through the soil profile. The better the drainage, the more successful saline irrigation can keep the soil level of soluble salts within tolerable limits.

Soil texture

Soil texture also influences the use of saline irrigation water.

Sand soils with low moisture holding capacities will concentrate the soluble salts quicker than finer textured soils as moisture is lost by evapotranspiration. Sand soils are usually the best-suited for saline irrigation applications, but they must not be allowed to dry in order to prevent intolerable salt levels.

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TABLE 3.
Salt Tolerance of Turfgrass Species.

Salt Tolerance	Species
Good	Zoysiagrass
	Seashore paspalumgrass
	Bermudagrass
Fair	Creeping Bentgrass
	St. Augustinegrass
	Tall Fescue
Poor	Perennial Ryegrass
	Red Fescue
	Bahiagrass
	Kentucky Bluegrass
	Centipedegrass
	Colonial Bentgrass

Soluble salts are measured in soils by the same basic method as water samples. A conductivity instrument measures the electrical conductivity from a water extract from a soil. The electrical conductivity readings of soils are two to 10 times greater than the irrigation water applied to them.

Good drainage is essential to leach soluble salts through the soil profile.

Soils with EC readings of 2.0 to 4.0 dS/m are considered to have low salt levels. Soils with EC readings of 4.0 to 12.0 dS/m have medium salinity levels. When soil readings are above 12.0 dS/m, soils are considered to have high salt levels.

To maintain a certain salt level in the soil for plant tolerance, saline water must be applied at rates exceeding evapotranspiration to leach excess salts through the soil (See Table 2).

For example, to replace 1.5 inches of water lost by evapotranspiration, approximately a week's worth of plant water use, rainwater with 0 dS/m would not increase the salinity, so 1.5 inches of irrigation would be sufficient.

TABLE 4.
Salt Tolerance of Various Turf Cultivars Used For Golf Courses.

Salt Tolerance	Creeping Bentgrass	Bermudagrass
Most	Seaside	Tifdwarf
↓	Arlington	Tifgreen
	Congressional	Tifway
	Cohansey	Tiflawn
Least	Penncross	Common

As the salinity of irrigation water increases, irrigation amounts more than the evapotranspiration amount must be applied because of the tendency to concentrate salts in the soil.

The larger amounts of water applied as irrigation salinity increases tend to keep soil salts at tolerable levels and to leach excess salts. Rainfall with saline irrigation is a definite benefit because it will aid in leaching and diluting soluble salts.

Salt stress

Applying saline water can cause salt stress and injury to plants by both direct and indirect means. Direct salt injury occurs with the accumulation of salts on the surface or ions within the plant. Reduction in plant growth and other metabolic processes such as photosynthesis are a result of direct salt injury.

Indirect salt stress and injury are caused by altering the plant environment particularly in the soil.

Osmotic stress is dehydration of the plant by removing water from the plant into the soil because of a salt concentration gradient. Some nutrient deficiencies are an indirect result of saline conditions causing suppression of nutrient absorption.

The most common example of this is the antagonistic effects of sodium on the uptake potassium into the plant. Plant resistance to salt stress varies greatly. Some plants avoid salt stress by either excluding salt absorption, extruding excess salts, or by diluting absorbed salts.

Other plants tolerate salt stress by adjusting their metabolism to withstand direct or indirect injury. In most cases the mechanism of salt tolerance in plants is a combination of methods.

Salt tolerance

Evaluation of salt tolerance of turfgrasses and ornamental plants has largely been done by observation of plants growing along the ocean or in saline sites. These observations have been further investigated by researchers in California and Florida.

Turfgrass species have been classified according to salt tolerance (See Table 4). Only a few turf species grow well under saline conditions. The grasses require good drainage and moist conditions to produce good quality turf.

Adequate leaching is also essential. Cultivars within a species often show a wide range of salt tolerance (See Table 4).

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Sometimes cultivar differences are greater than species differences. Most turfgrass comparisons are based on the salt levels which cause a 50 percent reduction in top or root growth.

Landscape plants like turfgrasses have a wide range of salt tolerances. Problems with these plants are often more pronounced because of direct salt injury. Landscape plants do not often have leaves removed like mowing turf, hence salts can accumulate in the leaves. Local soil and environmental conditions greatly influence salt tolerance.

More specific recommendations of salt tolerant landscape plants are available from most cooperative extension offices.

A few simple guidelines should be followed to successfully grow plants using saline irrigation.

First, use the best quality water available. Provide excellent drainage and excess irrigation to leach excess salts.

Finally, use the most salt tolerant plants for your location. **WT&T**

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