TURF **TIPS**

Managing Saline & Alkaline Soil: Irrigation Water Quality

Irrigation water can create or correct saline and alkaline soil depending on the quantity and type of dissolved salt in the water. Salt concentration in irrigation water reduces available soil moisture, which limits plant growth. The type of salt dissolved can be detrimental to soil structure, which reduces water infiltration. These two measurements and their interpretation will be discussed

Amount of Salt: Total Dissolved Salts

The total salt content of a water sample is reported as the electrical conductivity (EC_w). The units of measurement are usually millimhos per centimeter (mmhos/cm). Chemically pure water does not conduct electricity, but water with dissolved salt does. As reference points, Lincoln city water has EC_w of 0.65 and ocean water has a EC_w of 60.

A more tangible unit of measurement is ppm or lbs of salt per acre foot. The EC_w can be converted to these more tangible units as follows: EC_w X 640 = ppm and ppm X 2.72 = lb.s/acre foot. For example, an EC_w of 2.0 mmhos/cm equals 1,280 ppm of salt or 3,841 lbs of salt per acre foot of water applied. From this example, it is easy to understand how salts in irrigation water can quickly contribute to the salinity of soils. Irrigation water quality based on EC_w is as follows:

Table 1. Total Salts in Irrigation Water Based on ECw

		Total Salts Expressed As	
Classification	EC_w (mmhos/cm)	ppm	lbs./ acre foot
Low Salinity	<0.25	<160	<435
Medium Salinity	0.25-0.75	160-480	435-1,306
High Salinity	0.75-2.25	480-1,440	1,306-3,917
Very High Salinity	>2.25	>1,440	>3,917
% of CEC	1.5%	9.9%	71.6%

With reasonable irrigation practices, there should be no salinity problems with irrigation water with EC_w of less than 0.75. Increasing problems can be expected between EC_w 0.75 and 2.25. An EC_w greater than 2.25 will cause severe problems, except for a few salt-tolerant crops, Nearly all irrigation waters that have been used successfully for a considerable time have EC_w less than 2.25 mmhos/cm.

Type of Salt: Sodium Absorption Ratio (SAR)

The big three salts in water are calcium, magnesium, and sodium in combination with chloride, sulfate, and bicarbonate. Trace amounts of iron, manganese, boron, nitrate, silicate, potassium, lithium, and phosphorus are usually present, but contribute very little to the salinity. However, one must be aware of salt toxicity, such as boron and lithium, and overhead irrigation leaf-burn due to sodium and chloride. As a note, sodium and chloride can be toxic to crops, but in most cases, soil water permeability becomes a hazard before sodium or chloride has a toxic effect on plant growth. In a few plants, notably avocados, this may not be true.

In terms of affecting soil structure and water infiltration, the most important salt type is sodium. However, sodium alone provides little information about the water quality and its effect on soil water infiltration. Irrigation water with high sodium could be usable provided the calcium and magnesium levels in the water are high. Therefore, the sodium absorption ration (SAR) concept developed, which expresses sodium as a ratio to calcium plus magnesium.

The SAR measurement has been further revised by correction for bicarbonate levels in the water. To take the bicarbonate effect into account, an adjusted SAR is calculated. This correction is necessary because sodium in the irrigation water increases during soil drying and calcium decreases due to precipitation (tie up) by bicarbonate. This process increases the SAR and soil pH. This same process can be observed in a home shower or tub. As the water dries, lime or water spots form.

The interpretation of SAR on soil water infiltration is based on EC_w. For a given SAR, water infiltration rates increase as the salinity increases. Therefore, a higher SAR can be tolerated as the irrigation water salinity increases. Conversely, low SAR waters can be dangerous to the soil if EC_w is low. The effects of SAR on soil infiltration adjusted for EC_w are shown in the interpretation guidelines in Table 2.

Table 2. Effects of SAR on Soil Infiltration Adjusted for ECw

	Degree of Restricted Use or Caution		
SAR	None	Slight to Moderate	Severe
0-3	EC_w >0.7	EC_w 0.7-0.2	EC_w <0.2
3-6	EC_w >1.2	EC_w 1.2-0.3	EC_w <0.3
6-12	EC_w >1.9	EC_w 1.9-0.5	EC_w <0.5
12-20	EC_w >2.9	EC_w 2.9-1.3	EC_w <1.3
20-40	EC_w >5.0	EC_w 5.0-2.9	EC_w <2.9

The salt and minerals dissolved in irrigation water are often left in the soil as water evaporates or is taken up by the plant. This results in soil salinity and SAR usually being 1.5 to 3 times greater than the water used to irrigate them (assuming good drainage and leaching exists). With poor drainage and leaching, soil salinity and SAR could be 10 times greater than that of the irrigation water. Therefore, it is important to remember that management of irrigation water is directly dependent on soil drainage conditions.

Conclusion

Irrigation water quality is determined by salt concentration and type. As salt concentration increases, plant-available moisture decreases, which restricts crop growth. The sodium danger is best expressed as a ratio of sodium to calcium plus magnesium. As the SAR increases, the water infiltration rate decreases.