Understanding Water Quality

TURF TIPS

The monitoring of irrigation water for salt content is an important component of an overall turf management program. Irrigation water can create saline and/or alkaline soil, depending on the quantity and type of salt dissolved in the water. Salt concentration in irrigation water reduces available soil moisture, which limits plant growth.

Total Dissolved Salts

Chemically pure water does not conduct electricity, but water with dissolved salt does. The total salt content of a water sample is measured by electrical conductivity (ECw), reported as millimhos per centimeter (mmhos/cm). A more tangible unit of measurement is parts per million (ppm) or pounds of salt per acre foot. The ECw can be converted to these units as follows:

ECw x 640 = ppm

ppm x 2.72 = lbs/acre foot

Example: ECw of 2.0 mmhos/cm equals 1,280 ppm of dissolved salt or 3,481 pounds of salt for every foot of water applied. If over the irrigation season 24 inches of water is applied, the final annual total of salt is 6,962 pounds. From this example, it is easy to understand how salts in irrigation water can quickly increase the salinity level in the soil.

The following table is a quick rating of irrigation quality based on the ECw:

Water Classification	Dissolved Salts Expressed As: ECw (mmhos/cm)	Dissolved Solids (ppm)	Total Salt (lbs./acre ft.)
Low Salinity	<0.25	<160	<435
Medium Salinity	0.25-0.75	160-480	435-1306
High Salinity	0.76-2.25	481-1440	1307-3917
Very High Salinity	>2.25	>1440	>3917

Measured electrical conductivity is an indicator of the potential problems in plant growth associated with increasing quantities of salt. Ultimately, the effect of using irrigation water with varying levels of salt is dependent upon the soil's ability to percolate water.

Degree of problems associated with increasing quantities of salt:

ECw (mmhos/cm)	ECw (mmhos/cm)
<0.75	Little/no plant growth problems associated with normal irrigation
0.75-2.25	Potential plant growth problems with salt sensitive plants
>2.25	Severe plant growth problems; select only salt-tolerant plants

Types of Salt: Sodium Absorption Ratio (SAR)

The major types of salts dissolved 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 as well, but with natural water sources, they contribute very little to the overall salinity concentration. Effluent water (or water spiked with fertilizers) may be the exception; even with low concentration, one needs to be aware of potential toxicities of boron and lithium, and leaf burning from sodium and chloride.

The most common problem associated with high salt concentrations is the degradation of soil structure. This process (deflocculation) is the breaking up of soil particles into the individual soil texture components (sand, silt and clay). The effect is a decreasing rate of water infiltration. As infiltration decreases, salt concentrations increase at the soil surface. The cation most responsible for this process is sodium. However, the measurement of sodium alone provides little information about water quality and its effect. Water with high sodium can be usable, provided the calcium and magnesium levels are also high. Because of this, the sodium absorption ratio (SAR) was developed. This calculation expresses the sodium in comparison with the calcium plus magnesium.

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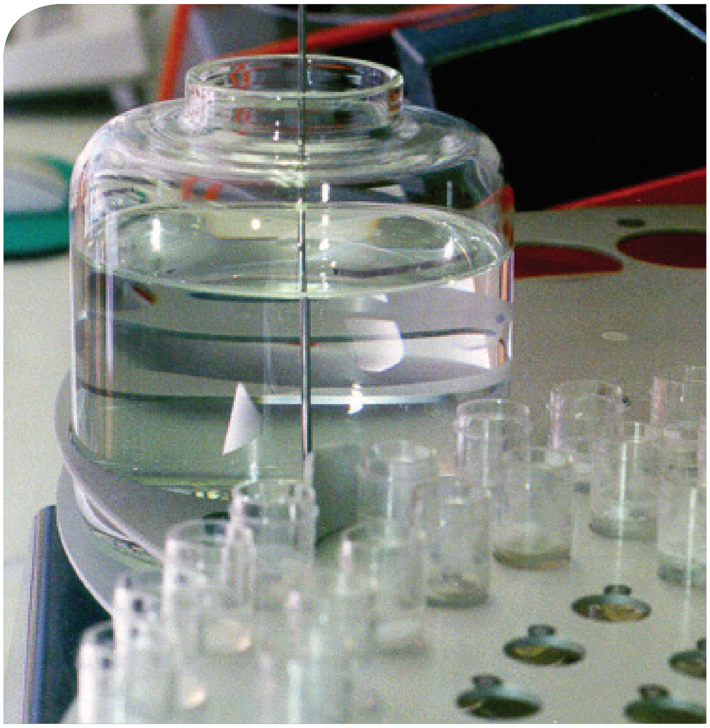

The SAR measurement has been further revised by correcting for bicarbonate (HCO_3) levels in the water. High bicarbonates will enhance a sodium problem. This calculated value is referred to as SARadj. A correction is necessary because sodium in the irrigation water increases in concentration during soil drying, while calcium levels in the soil decrease due to a reaction with bicarbonate. The calcium will precipitate out in the soil as calcium carbonate (free lime), resulting in increased soil SAR and pH values.

$$Ca(HCO_3)_2 \xrightarrow{\text{(Soil Drying)}} CaCO_3 + CO_2 + H_2O$$

Degree of Problems Associated with Increasing SAR Values:

SAR	Potential Problems
1.0-9.0	Low Sodium: may be used with little harmful effect
10.0-18.0	Medium Sodium: problem with buildup on fine textured soils
19.0-26.0	High Sodium: sodium buildup on most soil types, high leaching rate needed
>26.0	Very High Sodium: unsuitable for most uses

Soil Drainage

The salt and minerals dissolved in irrigation water are often left in the soil as the water evaporates. This results in the soil salinity and SAR values building in to 1.5 to three times higher than the SAR and salinity content in the irrigation water (assuming good drainage conditions). With poor internal drainage conditions, both soil salinity and SAR could increase by up to a factor of ten. Therefore, it is important to remember that management of irrigation water is directly dependent upon soil drainage conditions.

Conclusion

Monitoring the quality of irrigation water is a vital component in managing plant health. The measurement of salt concentrations and the type of dissolved salt within the water determine irrigation water quality. When salt concentration increases, plant available moisture decreases, resulting in restricted plant growth. The problems associated with high sodium levels are best expressed as a ratio of sodium to calcium plus magnesium (SAR). As the SAR level increases, soil structure is diminished and water infiltration rates are reduced, leading to even higher levels of salt and sodium.