Countera-*SALT*: successfully managing salinity

We have discussed in past issues of *SportsTurf* understanding salinity measurements and causes of salinity. This final article recaps what salinity and specifically sodium (Na) does to plants and soils, and discusses how to beat back the a-SALT with general management.

Low levels of salts, including Na, are not dangerous to most turfgrasses. If salt levels accumulate in the rootzone to high enough concentrations, it is difficult for turfgrasses to uptake water. This is because solutes (salts dissolved in water) *like* water, and want to hold on to it. Think of the result as a tug-of-war game, where water is the rope: on one end are the turfgrass roots, on the other end are solutes. The more solutes present, the more muscle at the salt end of the water rope. Furthermore, like many organisms, turfgrasses try to achieve a balance between the salt levels inside and outside their cells. Thus, a turfgrass grown in salt affected soil or irrigated with saline water must exert more energy to extract water from the soil. This results in a type of water/drought stress. Turfgrasses spend more energy trying to simply survive, instead of using the water for routine metabolic processes.

Certain solutes [especially sodium (Na), chloride (Cl), bicarbonates (HCO_3) and boron (B)] that are passively taken up with water can concentrate within the turfgrass and result in ion toxicity. Ion toxicities are most evident in roots and leaves since they are the main points of entry for water to enter the plant. Certain turfgrasses are more tolerant than others. For example, in general, warm-season grasses such as bermudagrass and seashore paspalum are more tolerant than cool-season grasses like bentgrass. How? Many warm-season grasses have salt glands that secrete salts from leaves (pretty cool, right?).

When Na is the specific salt in either water or soil, plant uptake of Na increases and Na can begin to block uptake of and displace calcium (Ca), magnesium (Mg), ammonium (NH_4^+) and potassium (K) within plant cells. When salinity (definition in next section) levels in water are very low, supplemental Ca, Mg, and K may be needed for plant nutrition.

SALTS AND SOILS STRUCTURE

Salinity is when acid-base pairs form from K, Ca, Mg, sulfate (SO_4), HCO_3, Cl and Na. Fine soil particles (silt and clay) and organic matter flocculate (bind together) into aggregates in the presence of Ca and Mg ions from these pairs. Calcium and Mg dominated salinity improves soil porosity, increases soil stability, and creates an optimum environment for root penetration and growth. This trend holds true with high salinity too. Thus, simply because salinity is high does mean a negative change in soil structure.

However, if Na is the dominant ion contributing to the water salinity, it will displace Ca and Mg in soils (those primarily clay based, or with organic matter). Due to its single charge, Na does not "bridge" soil particles together. In fact, it has the quite opposite effect. The large ionic swarm and its appetite for water result in dispersion or spreading of soils. This results in individual soil particles plugging pore spaces and a reduction in total soil porosity. Sodium affected soils compact easily when dry too. The end result? Poor water infiltration, air movement and root penetration. The reason only fine textured soils and soils with considerable organic matter are affected is because they have many negative binding sites (AKA cation exchange capacity) with which salts can react. For this reason, the structure of sand based rootzones with low cation exchange capacity will minimally be affected by Na.

If irrigating with a water source with very low salinity (pure water), ions that are present on the cation exchange site will leave the soil colloid and dissolve into soil solution. When this happens, there are fewer bridges keeping soil colloids aggregated. The end result of pure water application to soils is dispersion of aggregates and loss of pore spaces, very similar to changes in soil structure resulting from high concentration of Na. Soils compact easily and the loss of pore space results in poor water infiltration, air movement, and root penetration. In this scenario too, soil texture and the amount of organic matter present are important factors determining the extent of damage that can occur. The finer the texture and more organic matter present (thus greater CEC), the greater potential for dispersion. Coarse sands with low CECs are less affected.

MANAGEMENT OPTIONS

Both proactive and reactive management strategies can help you navigate any salt tempest. Monitoring both the salinity of your water source (EC) and the total dissolved salts (Ca, Mg, Cl, Na) within your soil are necessary to determine how to effectively manage a salinity issue, or prevent one from starting. If after you begin monitoring your water and soil, you determine that soil EC levels remain too high, whether due to water source, storm event, or excessive fertilization, there are a few steps you can take to manage the problem and reduce the risk of turfgrass damage. It is important to keep in mind that native soils will many times be different in texture and CEC than constructed rootzones, so make sure to sample all areas separately.

Grow salt tolerant grasses. If the irrigation water supply is salty and investing in alternative treatment/dilution methods is not viable, consider growing only salt tolerant species.

Apply a leaching requirement or reclamation requirement. In a nutshell, increase your irrigation volume to make sure that water (and salts with it) is always draining past the rootzone. A leaching requirement is used when there is not a problem, but you are concerned that you may start to have one (due to changing water quality, drought, etc.). A reclamation requirement is used when there is already a build up of salt within the soil. There are many ways to calculate these requirements, contact the authors if you need to determine one.

Monitor soluble salt levels in the soil. By monitoring soluble salt levels consistently you can adjust irrigation volumes to help compensate for higher salt levels, or decrease irrigation rates when salts have been flushed from the soil. Monitoring soluble salt levels also will determine if there is Na problem. Increasing Ca and Mg in soils or saline water can reduce Na-induced particle dispersion, and some of the more noticeable detrimental plant effects. (See

May 2012 issue about how to monitor; you can find article, "Is your turf under A-salt?" at www.sportsturfonline.com.)

Adjust fertilizer source and/or reduce fertilization rates. If irrigation water contains excess soluble salts, send a water sample to a soil-testing lab for an irrigation water analysis. This analysis will help to determine the ions that are readily available from the water source. Using this data, the nutrients supplied by the fertilizer can be reduced to account for those readily available from irrigation water. If adjusting fertilizer nutrient levels is not an option, simply lower the rate at which the turfgrass is fertilized (if possible) to reduce excess salt presence in substrate/soil. Especially for soluble fertilizers, since they directly contribute to higher salt levels, applying a lower rate with more frequency may also assist in ensuring that the soil is not overloaded with salt at any given time.

Apply an amendment. This is done ONLY when either (a) the water source is pure, or (b) Na has been identified as the main salt constituent. The most common amendment used is gypsum. It can be applied in a granular form or injected in line into the irrigation water. Gypsum replaces Na with Ca. Other Ca sources work as well. If adequate Ca is available in the soil, applying acid to reduce the soil pH and release the Ca may be effective. Look for a future article focusing on amendments. Contact the authors if you need assistance on determining options.

Blend "salty" with clean water. Whatever the source of high EC in water, if there is another source (whether municipal, pond, well, etc.) that can be used to dilute the "salty" water, use it to decrease the salt levels and reduce plant stress attributed to high substrate EC. For most turfgrasses, the target is to reduce to ≤ 2 dS m-1. Contact the authors for additional help.

Change to a different water source entirely. If EC readings of current water are so high that it is not feasible to continue using a particular source, find an alternative source.

Install a reverse osmosis system. If no alternative or mixing source of water is available and growing turfgrasses at this particular location is critical, a reverse osmosis system may be the most viable method for producing quality water that can be used for irrigation purposes. These systems have improved greatly in the last few years; however, they tend to be expensive and the wastewater, a salt-rich brine, must be disposed of. With most reverse osmosis systems, once the water has been cleansed (desalinated), Ca and Mg are added back and or the water is blended with rain fed/storm water so the water is not too pure.

The salinity reduction strategies above can help reduce and/or alleviate salt stress, but keep in mind that each strategy is only as effective as the monitoring data from which you make your management decisions. ■

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