Managing Salts on Sand Putting Greens in Wisconsin

By Dr. Doug Soldat, *Department of Soil Science, University of Wisconsin - Madison*

Salt problems are not common on Wisconsin soils; however, increasing restrictions on potable water supplies will make the use of poorer quality water for irrigation a more attractive option for golf course superintendents. The use of reclaimed (or effluent) water is standard practice for not only superintendents in many western states, but also for those in humid states like Florida where over half of the golf courses are irrigated with reclaimed water (Cisar et al., 2006). Communities such as Green Bay and Waukesha are already encountering difficulties in supplying high quality drinking water to their citizens. These types of situations typically lead to restrictions on the use of potable water for golf course irrigation. Thus, it's fair to say that the arrival of mandated irrigation with effluent water is inevitable in some parts of the state. When that happens, superintendents will have to become very knowledgeable about the problems that can arise from irrigation with low quality water.

A recent survey of the state's golf putting greens and the irrigation water being used gave no indication of excessive levels of soluble salts at present or that salts will become a problem in the future unless superintendents are using irrigation water with high salinity or an elevated sodium adsorption ratio (SAR) as defined in tables 1 and 3, respectively. Effluent water, or treated municipal wastewater is typically of low quality, but can be used with success by altering management practices.

Soil solution contains many soluble salts; including calcium, magnesium, potassium, sodium, chloride, sulfate, bicarbonate, and nitrate. The concentration of soluble salts in the soil solution increases as pure water evaporates

More Control Than You Ever Thought Possible

Now you control the performance of your urea nitrogen.

HYDREXX® is a new fertilizer additive that gives you the power to hold urea-based soluble nitrogen in the soil in usable form for longer periods of time, regardless of environmental factors. You control the rate, and the length of performance.

- Better color & quality
- Increased nitrogen efficiency
- Extended nitrogen availability
- More environmentally sound for soil & turf

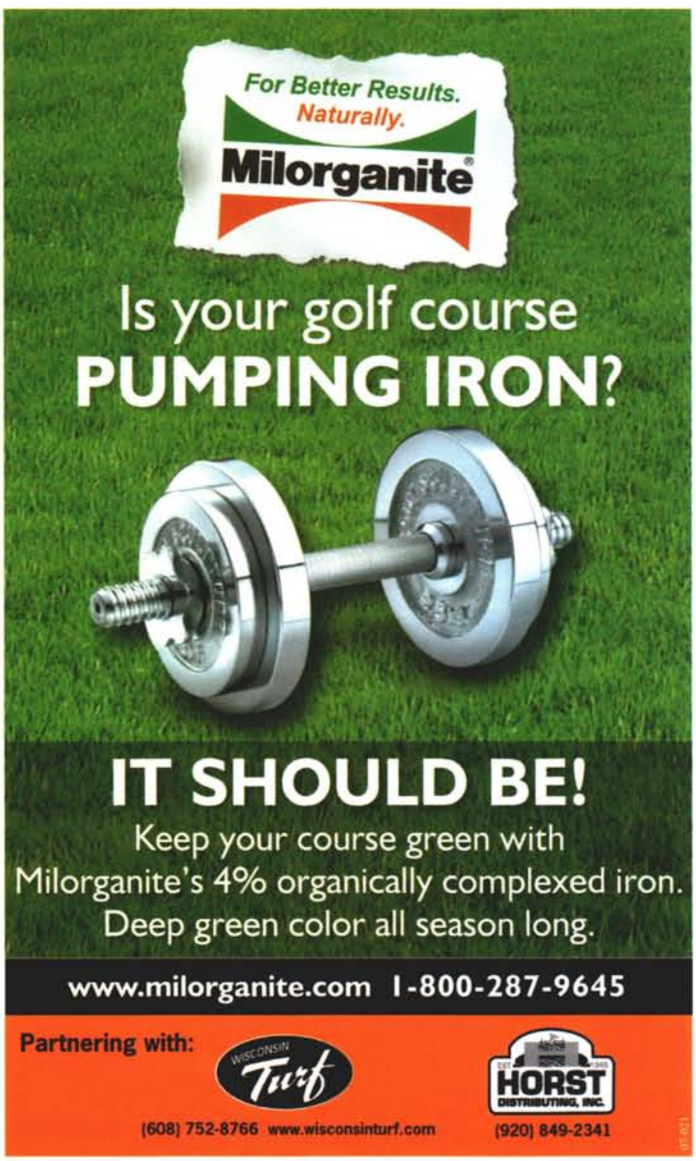
HYDREXX®
PROFESSIONAL NITROGEN STABILIZER

StabilizedNitrogen™ allows you to manage nitrogen for your specific conditions. See research at www.stabilizednitrogen.com.

HYDREXX and *StabilizedNitrogen* are trademarks of AGROTAIN International, LLC.

from soil and transpires through the plant into the atmosphere. Evapotranspiration, the sum of evaporation and transpiration, creates a suction gradient pulling water from deeper layers towards the soil surface. When this water evaporates or is taken up by the plant, soluble salts are left behind. Heavy irrigation cycles or rainfall dissolve accumulated salts and move them into deeper soil layers or into drains where they are removed from the root zone. However, efficient removal of salts depends entirely on good drainage. Salinity problems can develop where salts are continually added through poor quality irrigation and drainage is poor. Most areas with poor drainage remain unaffected by salt problems because water quality is suitable.

A number of years ago, I had the opportunity to work at a golf course in Northern Illinois that switched from a surface water source to effluent water because the effluent water was more reliable (the stream would occasionally run dry) and had a lower salt content during the summer months. So obviously, water quality problems are not confined to effluent water sources alone. Salt-related problems can occur from poor quality groundwater, but problems are more common with surface water sources in Wisconsin. Surface water sources tend to be more variable than groundwater sources and therefore will require more intensive monitoring. Salts can enter surface water bodies during the early spring runoff of road salt, and salinity of surface water will usually increase from spring to summer.



The abnormally dry conditions probably led to a recent Noernet thread on flushing sand greens. Leaching, charging, or flushing are three terms that are used loosely to describe a variation on the practice of moving large amounts of water through a sand-based root zone in response to the real or perceived accumulation of salts in the root zone. This practice has become popular on sand greens that were designed to handle movement of large amounts of water. The practice of moving vast quantities of water through sand greens varies from running irrigation heads all night, to closing the drain valve, saturating the root zone, and then opening the valve. Researchers at Ohio State University define "charging" as the practice of applying water until drain flow reaches a constant (maximum) level. For recently constructed USGA greens this number ranged between 1.9 and 3.4 inches. For new California greens (sand root zone with no gravel blanket) 3.7 - 6.2 inches of water was required to "charge" the root zone (Prettyman and McCoy, 2000).

However, purifying as this practice may sound, potential pitfalls exist. Aging sand root zones accumulate organic matter which increases the water holding capacity and decreases the infiltration rates. A flushing, or charging event on a sand green with poor drainage could intensify summer stress symptoms during a hot, humid summer. Excess water that does not infiltrate will runoff and saturate the lowest points in the surrounds, creating additional problems in those areas. Therefore, flushing, or charging a sand root zone should not be done on instinct alone. It would be beneficial to have information suggesting that the grass is experiencing symptoms from salinity stress before applying a large volume of water.

Management of high salinity levels on soils with limited infiltration capacity requires a different technique. On these areas small excesses of water should be applied when soil salinity builds up to unacceptable levels. The easiest way to accomplish this is to irrigate at 100% of estimated evapotranspiration (ET). Evapotranspiration estimates are based on climatic conditions. Measurements of ET from turfgrass areas have found the actual ET is around 80% of estimated ET. Therefore, irrigating at 100% of estimated ET will result in a small amount of drainage, and will help to slowly move salts out of the root zone. If ET is not used, leaching salts can be a guessing game. For daily ET readings visit: http://www.soils.wisc.edu/wimnext/et/wimnet.html. You can also get daily emails of local ET by sending in your coordinates.

Evidence of salt stress can be gathered by monitoring the quality of the water itself via field or laboratory testing. Soil properties can also be monitored in the field and lab.

Monitoring irrigation water and soils that are suspected to be affected by salts are important practice regardless of the irrigation water source. Two important aspects of irrigation water quality, salinity and sodium hazard are discussed below. Practical field and laboratory monitoring techniques to be used diagnostically are also considered.

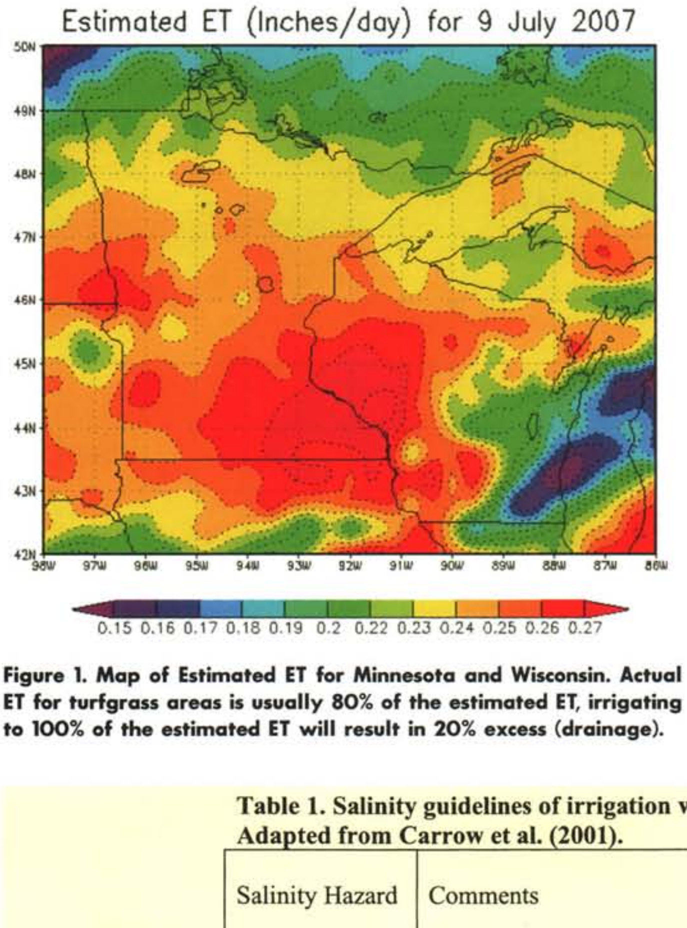


Figure 1. Map of Estimated ET for Minnesota and Wisconsin. Actual ET for turfgrass areas is usually 80% of the estimated ET, irrigating to 100% of the estimated ET will result in 20% excess (drainage).

Water and Soil Salinity

High levels of salt in the soil solution can cause a condition known as physiological drought. Physiological drought occurs when salt accumulation in the soil inhibits water uptake by the turf. The accumulation of salts occurs as pure water is lost through evapotranspiration. Salt accumulation occurs more rapidly when high salt-content irrigation water is used. Fertilizer burn and dog spots are two specialized cases of physiological drought.

The salt concentration, or salinity, at which physiological drought occurs is different for different species and cultivars, and varies with management practices such as mowing height. In general, annual bluegrass, colonial bentgrass, and velvet bentgrass are more susceptible to salinity stress than creeping bentgrass. Modern creeping bentgrass cultivars like 'L-93', Penn G-2, A-1, A-2, and A-4 are more tolerant of high salinity than 'Penncross' (Marcum, 2001).

Electrical conductivity (EC) is a reliable estimate of the potential for salinity problems with irrigation water. Electrical conductivity is often converted to total soluble salts (TSS), also called total dissolved salts (TDS), by multiplying the EC value by a conversion factor of 640. For simplicity, only EC guidelines are reported. Table 1 illustrates two sets of interpretations for evaluating irrigation water for potential for salinity problems. Over the past several years, Dr. Kussow collected and analyzed water samples from 63 golf courses in Wisconsin. Of the 63 water samples the average EC was 0.49 dS m^{-1}, low or medium depending on whose interpretations you consult in Table 1. The highest EC was 1.22 dS m^{-1}. At that level, keeping a close eye on EC throughout the year is warranted - if this sample was a surface water sample, we might anticipate the EC to fluctuate throughout the year.

If the prospect of salt accumulation keeps you awake at night, it's probably a good idea to invest in a portable EC meter. This tool will allow for the instantaneous assessment of EC. Coupled with the guidelines shown in Table 1, you can get a feel for whether or not it's reasonable to assume salinity as an issue that requires attention. In addition, soil EC can be measured via a saturated paste

Table 1. Salinity guidelines of irrigation water based on electrical conductivity (EW). Adapted from Carrow et al. (2001).

Salinity Hazard	Comments	Westcot and Ayers (1985)	Richards (1954)
		EC - dS m^{-1}	
Low	No detrimental effects on plants or soils are expected.	<0.75	<0.25
Medium	Salt stress may occur on sensitive plants, preventable with moderate leaching.	0.75 – 1.50	0.25 – 0.75
High	Salt stress on most plants, leaching and good drainage necessary.	1.50 – 3.00	0.75 – 2.25
Very High	Unacceptable for most plants, good drainage, frequent leaching required.	> 3.00	>2.25

Table 2. Sensitivity of various cool season grasses to soil EC levels. Soil salinity levels are greatly influenced by EC of irrigation water. Adapted from Harivandi et al (1992).

Sensitivity	Turfgrass Species	EC at which symptoms may appear
Sensitive	annual bluegrass, colonial bentgrass, Kentucky bluegrass, rough bluegrass, velvet bentgrass	3 dS m^{-1}
Moderately sensitive	creeping bentgrass, fine fescues	3 – 6 dS m^{-1}
Moderately tolerant	perennial ryegrass, tall fescue	6 – 10 dS m^{-1}

Table 3. Sodium hazard guidelines of irrigation water according to Richards (1954). Adapted from Carrow et al. (2001).

Sodium Hazard	Comments	Sodium Adsorption Ratio of Water (SAR)
Low	Can be used to irrigate almost all soils without structure deterioration.	< 10
Medium	Permeability hazard on fine-textured soils with high CEC. Best used on soils with good drainage.	10 - 18
High	Structure deterioration and infiltration reduced on most soils. Intensive management required.	18 - 26
Very High	Generally unacceptable for irrigation.	> 26

extract. If you want to avoid the lab fee and two-week turnaround time, a handheld soil EC meter can be used. Soil EC varies with soil moisture content, so it's best to measure soil EC at field moisture capacity. Guidelines for the tolerance of several grass species to soil salinity levels are shown in Table 2. More detailed instructions about operation are included in the user manuals. Water EC probes start around $100 and cost around $400 for a dual soil/water probe.

Sodium Hazard

Another potential problem with using poor quality water for irrigation is sodium hazard. When sodium ions are high relative to calcium and magnesium, clay aggregates will disperse into individual clay particles leading to a reduction in pore size and a greatly reduced infiltration rate. In addition, soil aeration is decreased and the soil becomes more sensitive to traffic. Sodium-affected soils are difficult to reclaim, because substantial leaching is required but prevented by the chemically-altered soil structure. The sodium adsorption ratio (SAR) is a measure of the potential for irrigation water to lead to poor soil structure caused by excess sodium. The SAR is normally calculated by the water testing laboratory and listed on the report. Table 3 shows classifications of SAR for irrigation waters. These classifications were developed for soils with appreciable clay content, and therefore they overestimate the potential for water to cause problem in sand root zones. Sand root zones have very low clay contents, and therefore any sodium-induced dispersion will have a small effect on pore space distribution and soil structure.

The average SAR for the 63 sampled waters was 0.8, nowhere near a value that would be cause for concern. Additionally, the greatest SAR value found was 4.2. While these findings indicate that sodium hazard is not a universal concern in Wisconsin. In fact, the fear of sodium hazard has resulted in tons and tons of un-warranted applications of calcium to golf courses across the US. Calcium is indiscriminately marketed as a nutrient that improves drainage and soil structure among other things. However, this claim turns out to only be true for fine-textured soils with appreciable amounts of sodium - conditions that are rare in Wisconsin. Unfortunately, field testing of sodium hazard is not possible. Soil and water samples must be sent in for laboratory testing.

Conclusions

Salt problems have been rare in Wisconsin due to adequate rainfall and high quality irrigation water. However, poor quality water sources can be found in the state, and future use of effluent water will increase the incidence of salt problems. Management of salt problems involves basically the over-application of water to leach salts out of the root zone. On sand-based systems, large amounts of water can be applied at one time to alleviate the problem. For soils with lower infiltration rates, irrigation must be applied gradually by applying amounts slightly greater than ET. Because of the potentially negative agronomic consequences of applying excess water, it is best to be sure salt issues exist. Vigilant testing and monitoring of soil and water are key to a superintendent's success in potentially salt-affected areas. Know what's in your water and know how it may change during the season. Most times the water quality is poorest when you need it most.

One final note: I have spoken with superintendents who irrigate with high quality water but still notice a significant visual response the day following a large leaching or flushing event. I suspect the response is not a result of salt leaching, but more likely can be attributed to the alleviation of moisture stress and an increase in population of soil microbes, which tend to dislike dry conditions. The increase in microbe population will result in an increase in available nitrogen shortly after the soil is re-wetted. The same green-up can likely be achieved with irrigation amounts much smaller than a traditional flushing event. Additionally, heavy irrigation cycles on sand root zones may need to be followed with a potassium application, as a recent study found a 22% decrease in available potassium following the application of 5.5 inches of irrigation over 22 hours (Hathaway et al., 2007).

References

Carrow, R.N., D.V. Waddington, and P.E. Rieke. 2001. Turfgrass soil fertility and chemical problems: assessment and management. Ann Arbor Press. Chelsea, MI

Cisar, J.L., M. Reuter, G. H. Snyder, and M. A. Fidanza. 2006. The Use of Non-Saline Reclaimed Water for Golf Course Irrigation in Florida. Applied Turfgrass Science.

Harivandi, M.A., J.D. Butler, and L. Wu. 1992. Salinity and turfgrass culture. P. 207-229. In D.V. Waddington, R.N. Carrow, and R.C. Shearman (eds.). Turfgrass. Series No. 32. American Society of Agronomy, Madison, WI.

Hathaway, M., N. Radwich, L. Stowell, and W. Gelernter. 2007. Effect of leaching greens on soil chemistry. Pace Turfgrass Research Institute. 5 p.

Marcum, K.B. 2001. Salinity tolerance of 35 bentgrass cultivars. HortScience. 36:374-376.

Prettyman, G., E. McCoy. 2000. Charging and flushing high-sand greens. Golf Course Management. 68(5):48-53.

Richards, L.A. (ed.). 1954. Diagnosis and improvement of saline and alkaline soils. USDA Handbook 60. U.S. Gov. Print Office, Washington, DC.

PENDELTON
TURF SUPPLY

Ed Witkowski
414-640-6447
pendeltonturf@tds.net

Mike Kozlowski
414-640-2284
mkozlowski1@wi.rr.com

Todd Fregien
414-640-2265
pendeltonturf@tds.net

805 Ela Avenue
Waterford, WI 53185
Phone: 262-534-3334
Fax: 262-534-2990

SATISFACTION GUARANTEED

FULL LINE OF TURF PRODUCTS
CHEMICALS • TEE & GREEN SUPPLIES
TIRES & TUBES • NEW PRODUCT INFORMATION

QUALI-PRO
AQUATROLS®
BASF PROFESSIONAL TURF
EC GROW
JACKLIN SEED
Riverdale
Jay-Mar, Inc.
Liquid Golf Course & Turf Fertilizers