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TURF LINE NEWS

Sodium Affected Soils

by
Ken Clancy, P.Ag.

Though not a plant food nutrient, sodium plays a critical role in soil and turfgrass health. The primary problem posed by high sodium is not a toxicity hazard, but a rapid decline in soil structure that can begin when sodium base saturation exceeds the critical 5% level. High sodium reduces soil permeability, resulting in drainage and compaction problems that cause a decline in turf vigor. For the turfgrass manager it's critical to understand how sodium accumulates in the soil and what steps can be taken to amend a high sodium levels.

Pass the Salt

It's often assumed that elevated levels of soil sodium are directly related to elevated levels of soluble salts. This perception is probably based on our familiarity with sodium-chloride (NaCl), but the reality is quite different. In fact, the salts we deal with in turfgrass agronomy occur in numerous forms, and more often than not don't include any sodium at all.

A soil high in sodium, also known as a "sodic" soil, is one in which sodium occupies an excess amount of space on soil exchange sites. As soil sodium levels increase soluble calcium levels decrease. And its soluble calcium that gives soil its friable, loamy, permeable structure. A continued decline in soluble calcium brought on by ever increasing soil sodium causes the soil to lose these favorable structural properties, resulting in impaired drainage and increased compaction. Left untreated, a sodic soil will eventually see decline in turf vigor. Toxicity arising from the sodium ion itself is rare, due to the fact that problems with soil structure usually arise well before sodium can build to toxic levels.

A soil high in salt, also known as a "saline" soil, is one in which soluble salt levels impair turf health by making it difficult for the plant to extract water from the soil. In such circumstances the turfgrass plant will experience physiological drought, even to the point of death, regardless of soil moisture levels. The salts in question are usually water-borne, comprised of calcium, sodium and magnesium in combination with bicarbonate, sulfate and chloride. Sodium salts are critically important because, as noted above, they have the potential to impair soil structure. High soluble salts usually occur in soils with a persistent drainage problem or when soluble salts are present at high levels in irrigation water.

Though sodium can be involved in each condition, it's important to note that a saline soil quite often contains very little sodium. Moreover, soils high in sodium are often low in soluble salts. The two problems do arise simultaneously, in a worst case scenario condition known as a "saline-sodic" soil.

Base Saturation is the Key

The key to understanding the implications of high soil sodium is in understanding the concept of Base Saturation. Potassium, magnesium, calcium, hydrogen and sodium are the principle soil cations. They are reactive ions and inherently have positive electrical charges of varying strength. Clay and organic matter particles in the soil inherently have a negative

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PO Box 770
Enderby, BC
V0E 1V0

Phone: 250-838-6414
Fax: 250-838-6968
www.fusionfert.com

electrical charge, acting as exchange sites on which the positively charged cations, including sodium, try to attach. This electrical attraction creates an antagonistic relationship among the cations and they are in constant competition for available space on soil particles. As a result, an excess of one cation often leads to a deficiency of another.

Soil scientists have determined the optimum cation balance, one that maximizes soil health and nutrient availability. This concept, known as Base Saturation, is usually expressed in percentage terms or as a set of ideal ratios. Base Saturation is sometimes criticized for having little practical value, but in my opinion its “big picture” assessment of soil health makes it an essential tool – one that should be included in any soil test report. Consider the critical role base saturation plays in amending soil pH. When we apply lime, we’re reducing hydrogen base saturation while increasing the base saturation of calcium and magnesium in order to correct a broad imbalance in the soil.

Optimum Base Saturation Percentages are intended as a general guideline only and will be affected by with soil texture				
Hydrogen	**Potassium**	**Magnesium**	**Calcium**	**Sodium**
0-5%	2-7%	15-20%	65-75%	0-5%

Base saturation is no less important when we asses the potential hazard posed by soil sodium. As the chart above indicates, the ideal sodium base saturation level is 0-5%. When sodium levels accumulate beyond the critical level of 5%, a corresponding decline in soluble soil calcium creates a collapse in soil structure and a decrease in permeability. When sodium base saturation exceeds 7-8%, most natural “loam” soils begin to experience obvious problems with drainage and compaction. Beyond 9-10% the structure of a soil can be compromised so severely that turf may not be able to survive the ensuing permeability problems.

Soil Texture Can Play a Role

In general, the more clay and organic matter a soil contains the more prone it is to problems at lower sodium base saturation levels. That’s because the drainage properties of fine textures soils, those that by definition have high clay or organic matter fractions, are entirely dependent on their soil structure. For some high clay soils, drainage problems may become evident when sodium base saturation starts to creep above the critical 5% level.

Conversely, constructed sand soils such as those in modern golf greens can tolerate higher sodium base saturation levels. That’s because they not only have low clay and organic matter fractions, their permeability properties derive from large, coarse textured soil particles. As a result, some constructed sand soils may not experience drainage problems until sodium base saturation exceeds 9% or more.

Determine the Quality of Your Water

The primary cause of soil sodium accumulation is poor quality irrigation water, but its not just water-borne sodium that creates the problem. A number of other factors influence the sodium permeability hazard of irrigation water, such as bicarbonate and calcium levels. When analyzing your irrigation water quality, the Residual Sodium Carbonate (RSC) formula and the Adjusted Sodium Absorption Ratio (SARadj) take these variables into account.

The RSC formula is a quick test, indicating if the properties of irrigation water will create “room” for sodium to accumulate in the soil. RSC subtracts the water’s level of calcium and magnesium from its level of carbonate and bicarbonate. A positive value indicates that excess bicarbonate and carbonate levels will be free to react with the soil’s soluble calcium and magnesium, thus giving sodium room to accumulate on soil exchange site. It’s important to note that the RSC formula does not include sodium, so its hazard assessment is somewhat inconclusive.

The SARadj formula is perhaps the single most important tool in determining if your water poses a sodium permeability hazard. This relatively complex model accounts for all the ions that impact soil sodium accumulation (bicarbonate, carbonate, sodium, calcium and magnesium).

The following critical levels can be considered general guidelines in assessing the sodium permeability hazard of your irrigation water. If all three are high, then it's probable that your soil is accumulating sodium.

Key Irrigation Water Sodium Hazard Guidelines

RSC: > 2
SAR adj: > 9

Conclusion: Amending Sodic Soils

Managing soil sodium is really about maintaining optimum levels of soluble soil calcium. In order to amend a sodic soil, sodium must simply be replaced with calcium, which is usually accomplished with high rates of Gypsum (calcium sulfate). Calcium has a more powerful electrical charge than does sodium, so with the proper rates of application gypsum will ultimately displace soil sodium. Irrigation then leaches the free sodium through the soil profile, restoring the soil's physical properties.

If irrigation water poses a sodium permeability hazard a number of treatment strategies can be employed, depending on water quality and soil type. For soils that aren't calcareous and have a limited ability to supply their own soluble calcium, irrigation water gypsum injection should be considered. Under this process, the amount of gypsum required to "overpower" the water's sodium can be determined. For soils that are calcareous and can supply soluble calcium, irrigation water acid injection may be the best option. Rather than supplying calcium, this process reduces the sodium hazard by destroying water-borne bicarbonates before they react with soluble calcium. Though the tactics may be different, the goal of both treatment methods is to maintain an optimum calcium base saturation level.

Irrigation water treatment has become a hot topic in recent years, in part due to the increased reliance on poor quality municipal effluent water. But treatments are often over-prescribed or sold to treat sodium related problems that simply don't exist. Before making amendment decisions ensure that your soil and irrigation water quality analysis is conducted by an accredited, reputable laboratory. Moreover, seek the advice of a Professional Agrologist before deciding on your amendment or treatment options.

Sources: Turfgrass Soil and Chemical Problems (Carrow, Waddington and Rieke), Western Fertilizer Handbook (California Fertilizer Association).

Ken Clancy is a Professional Agrologist specializing in turfgrass fertility with Fusion Turf Nutrition. He can be contacted by e-mail at ken@fusionfert.com