Agronomy Facts

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Waypoint ANALYTICAL

Understanding the Difference between Saline and Sodic Soils

Soil is a dynamic system that can be affected by several factors which have the potential to produce imbalances within the soil system. In turn, these imbalances can have adverse effects on crop health. Two common factors that affect crop health in some regions are soil soluble salt content (salinity) and soil sodium content (sodicity).

Soils with a high soluble salt content are called **saline soils**. This condition can occur in several ways: evaporating water leaving behind a high concentration of salts, the use of saline irrigation water, or ground water high in salt derived from parent rock material migrating upwards in the soil system. When excess salt is present within the plant root zone, plants can become water-stressed and begin to wilt. When the soil's salt concentration surpasses the concentration in the plant, water is driven from the plant in what is commonly referred to as a chemically-induced drought. Saline soils can result from high concentrations of calcium, magnesium and sodium salts (chlorides, sulfates, carbonates). In saline soils, since the overall soluble salt content in the solution is high, negative side effects from any ion in particular are negligible.

Sodic soils, on the other hand, are soils with high sodium levels in comparison to magnesium and calcium. This can also occur from the use of saline irrigation water, sodium leaching from parent rock material, or from being within close proximity to a highly salted winter roadway. Sodic soils are often more detrimental than saline soils because elevated levels of sodium result in soil dispersion, or a loss of soil structure. This results in soil compaction that has an adverse effect on plant health. Soil structure is responsible for maintaining soil pores that allow for the movement of air, water and nutrients. In a sodic soil, this vital nutrient transport network becomes limited. Plants become both nutrient- and water-stressed. Soil appearance can help to indicate the presence of a sodic soil. When dry, the soil will lack a surface structure, breaking away in crusty chunks. Wet soil, on the other hand, will appear waterlogged as a result of the inability of the water to penetrate the soil structure. Sodic soil conditions also have the potential to raise the soil pH above 7.

If the potential for saline or sodic (or a combination of both) conditions exist, it is important to monitor these soil factors. Both sodic and saline soils may display a crust-like surface when the soil water content has evaporated (Figure 1). Sodic soils may appear to have dark brown crusts on the surface as organic matter disperses. When the elevated soluble salt content is concentrated near the soil surface, the soil may develop a white crusty appearance.

Figure 1: Example of sodic soil conditions observed in the field. A discernible dark surface crust that prevents water penetration is present. Saline soils may also show crusting, although white in color.

Although visual inspection can assist in troubleshooting these issues in the soil, confirmation by a laboratory analysis is recommended. Soil salinity can be determined by testing the soluble salts of the soil by electrical conductivity (EC, measured in dS/m). The higher the soluble salt content, the higher the degree of salinity (Table 1). A sodic soil can be verified by evaluating the sodium absorption ratio (SAR) by means of a soil:water saturated paste. The SAR measures the ratio of sodium ions to calcium and magnesium ions. A SAR at or above 13 implies a sodic soil. Accurate identification of these problems allow for proper remediation of the soil system.

Remediation of saline and sodic soils can be labor intensive. In order to improve soil quality in a saline soil, the excess soluble salts need to be removed or reduced. This is typically accomplished by leaching the salts deeper into the soil system using a high volume of water. The water source must have a lower salinity than the current soil conditions. To evaluate the effectiveness of the leaching process, test the soil salinity before and after treatment.

Sodic soils also require a leaching step in remediation. But prior to this step, the abundance of sodium ions bound to soil particles must be replaced with calcium. Calcium is exchanged using high calcium amendments that do not increase pH, such as gypsum. Once the sodium ions have been displaced from exchange sites and soil equilibrium with calcium has been established, soil leaching to remove the sodium can occur. It is important to allow for this exchange to occur so that the sodium is removed, rather than the newly introduced calcium. Because sodic soils are resistant to water penetration, the leaching step can be an extremely slow process. Saline-sodic soil treatment is similar to sodic soil treatment, but additional calcium treatments may be necessary as the soil shifts from saline-sodic to sodic during the leaching process.

Following treatment of saline, sodic, or saline-sodic soils, thorough evaluation of the improvement in the soil system is recommended. A soil depth study, conducted in six inch increments to a final depth of two feet, can be used to assess the extent of removal of the problem ions from the plant-root zone.

Early laboratory diagnosis of these in-field problems allows for more immediate treatment of the soil. Once visible symptoms have persisted, the remediation and overall management of these soil conditions could become much more costly and complex. If you are from a region where these conditions are common, regular testing will allow for this potentially difficult situation to become more manageable.

Table 1: Classification of saline and sodic soil types

Classification	Electrical Conductivity (dS/m)	Soil pH	Sodium adsorption ratio (SAR)	Soil field conditions
Normal	<2.0	<8.5	<13	normal
Slightly Saline	2.0 – 4.0	<8.5	<13	normal
Saline	>4.0	<8.5	<13	normal
Sodic	<4.0	>8.5	>13	poor
Saline-Sodic	>4.0	<8.5	>13	variable

*All measurements above require a soil:water saturated paste extraction

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