Langdon Research Extension Center – Soil Health Update

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SOIL SALINITY AND SODICITY

Soil salinity and sodicity are on the rise and are major soil health related challenges facing North Dakota farmers. There are about 5.8 million acres affected by soil salinity alone in North Dakota (Brennan, J., and M. Ulmer. 2010. Salinity in the northern Great Plains. Natural Resources Conservation Service, Bismarck, N.D.). That makes it a high priority issue to first understand and then manage these problems in order to sustain the health and productivity of our soils.

Commonly described as saline-spots, alkali-ground, sour-ground or salt-land, these actually are two slightly different problems; soil salinity and soil sodicity.

Saline soils have excessive water soluble salts, which don't allow the plant roots to absorb soil water even under wet conditions and the end result is drought-stressed plants. That process is called osmosis. Soil salinity is determined by analyzing soil electrical conductivity (EC). Generally a soil will be considered saline if it has an EC value of 4.00 or more deciSiemens/meter.

Sodic soils on the other hand have excessive sodium adsorbed (attached) to the cation exchange sites or the negative charges provided by the soil clay and humus fractions, to prevent the positively charged plant nutrients like ammonium (NH4+), calcium (Ca++), magnesium (Mg++) and potassium (K+) from leaching. Contrary to the general belief, this is an excessive sodium problem, not an excessive salt problem. Since this excessive sodium is adsorbed to the cation exchange sites and does not come readily into the soil water, so is also difficult to leach. Excessive sodium damages soil structure by disintegrating soil aggregates and by forming a hard crust or sealing of soil layers, which then leads to other problems like poor soil drainage, soils which are difficult to till, poor seed germination as well as root growth and potential for wind and water erosion. That process is called soil dispersion. Soil sodicity is determined by analyzing either soil exchangeable sodium percentage (Ex. Na+%) or sodium adsorption ratio (SAR). A soil will be considered sodic, if it has an exchangeable sodium percentage of 15 or more or sodium adsorption ratio of 13 or more.

Soil Type	pH	EC (deciSiemens/meter)	Sodium Adsorption Ratio	Exchangeable Sodium %
Saline Soils	No effect	4.00 or more	Less than 13	Less than 15
Sodic Soils	8.5 or more	Less than 4.00	13 or more	15 or more
Saline-Sodic Soils	8.5 or more	4.00 or more	13 or more	15 or more

This table is showing different criteria for saline, sodic or saline-sodic soils.

There are several indirect causes for both soil salinity and soil sodicity in North Dakota however the main source for excessive salts and sodium is the parent material of the soils including the underlying sodium-rich shale. The reason for that are: (1) the periodic intrusions of sea water which deposited marine sediments in the western part of the state (Williston Basin) before the influence of glaciation. Once exposed at the surface as parent material these sediments cause soil salinity/sodicity. (2) Glaciation then mixed and moved these sediments from the bedrock and Canadian Shield rocks together in the central and eastern parts of the state resulting in many poorly drained landscapes and closed basins with shallow saline water-table levels (Natural Conditions for Salt Accumulations in North Dakota by Alex Maianu). The main carrier for bringing these excessive salts or sodium to the soil surface is the groundwater. Not to be confused with the term aquifers, in this article the term groundwater is used only in reference to the zone of soil or sediments saturated with water closest to the soil surface. Groundwater can move upwards to the soil surface either in shape of shallow water-table level or as capillary rise, especially under drier weather conditions.

Management of these problems should involve a mix of mitigation and preventive practices to remediate as well as to stop the future spread. Mitigation of saline soils starts by managing the shallow water-table levels and improvement of soil drainage, as excessive salts/sodium will not leach below the soil water-table level. First step is to intercept any surrounding subsoil water seeps (by planting high water-use efficient crops like alfalfa in 30 feet wide strips along sloughs or ditches) which may be contributing to a high water-table problem. Moderately high water-table levels may be controlled effectively through continuous cropping with late-maturing and deep-rooted crops. In case of a very high water-table level, installation of surface or subsurface drainage systems like tiling might be useful. However before the installation of tiles, soils should be analyzed for their sodium contents as excessive sodium may cause sealing or crusting of the soil layers above or around the tiles. Once that is achieved, salts will leach down with rain water.

Sodic soils require one extra step; application of calcium supplements to displace the excessive sodium from the cation exchange sites and bring it to the soil water. These supplements should be mixed into the soils before the start of the salt leaching process. Common example is gypsum which is CaSO4 on soils high in chlorides whereas calcium chloride should be used on soils high in sulfates. Once sodium is in the soil water it can also be leached with the help of rain water.

General gypsum rate is 4 to 8 tons/acre whereas for exact quantities soils should be analyzed for their sodium contents and cation exchange capacities. At the beginning of the remedial process, one should also start with a salt-resistant crop like barley instead of a sensitive crop like soybean.

Preventive measures include maintaining an optimum water-table level. For moderately high levels, deep-rooted and late-maturing crops like alfalfa, sunflower, safflower and sugarbeets should be planted. In case of a very shallow water-table level, again installation of subsurface drainage systems like tile drainage may become necessary.

Second preventative technique is to minimize the capillary rise of the groundwater towards the soil surface. For clay soils it can rise as high as 8 to 9 feet whereas in case of sandy soils it may be between 1 to 2 feet, due to the differences in the size of the soil pores. This can be achieved by preserving the moisture around the soil surface as capillary rise of groundwater happens from a wet area to dry area. Common ways to do that is by leaving the plant residues as is on the soil surface, by not exposing the surface soil directly to the sunlight, by planting cover crops after fall-harvest, using minimum or no-till practices and by adding soil organic matter.

Once established these problems can affect soil productivity a lot, however are manageable. For more information please use the following link: http://www.ag.ndsu.edu/langdonrec/soil-health.

WIFE meets in Washington, D.C.

Dressed in red, members of Women Involved in Farm Economics of America.

Members of the group were