SOIL HEALTH & LAND MANAGEMENT

NDSU EXTENSION SERVICE

IMPROVING SOIL HEALTH AND PRODUCTIVITY OF SODIC SOILS

Sodic soils impact approximately 10% of agricultural land in North Dakota and have productivity index's that range from 20-70 depending on the severity. Sodic soils are characterized as having high amounts of sodium (Na^{+}), relative to calcium (Ca^{2+}) and magnesium (Mg^{2+}), on their exchange sites. When this happens, swelling and dispersion cause disorder of clay and organic matter (OM). As a result, these soils have low productivity and poor soil health, making them difficult to remediate.

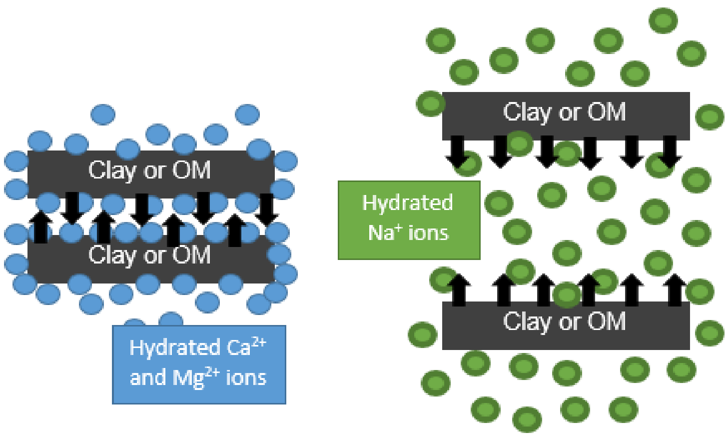


Figure 1. Calcium and magnesium are strongly bound to the clay or organic matter which allows the particles to stay together. However, in sodic soils, (1) the Na^{+} ion has a large hydration ring, which causes it to be loosely bound to the particles, and (2) twice as many Na^{+} ions, compared to Ca^{2+} and Mg^{2+}, are attracted to the clay and organic matter exchange sites because of the charge. Swelling occurs when the Na^{+} ions become hydrated. Once the particles separate, the soil is dispersed.

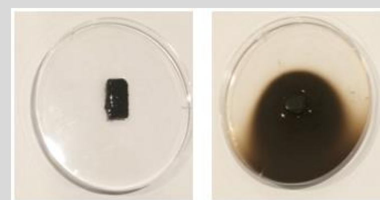
Poor soil health characteristics of sodic soils are:

- Surface crusting causing poor germination
- Restricted water infiltration and air movement
- Increased bulk density inhibiting root growth
- Poor trafficability when wet due to swelling and poor soil structure
- Na^{+} toxicity to plants causing reduced yields

To improve the productivity of sodic soils requires:

1) A source of Ca^{2+} or Mg^{2+} (soil amendment) to increase the electrical conductivity (EC) and replace Na^{+} on the exchange sites
2) Proper subsoil drainage to remove excess Na^{+}
3) Downward moving, high quality water to transport amendments deeper into the soil profile

What does dispersion look like?



Left: FLOCULATION
Sodic soil cube placed in saturated gypsum solution

Right: DISPERSION
Sodic soil cube placed in water dispersed after 20 minutes

The Ca^{2+} in the gypsum ($CaSO_4$) replaces the Na^{+} on the exchange sites when an amendment is added which reduces the swelling and dispersion of the clay and organic matter.

Primary Contact:
Dr. Tom DeSutter
thomas.desutter@ndsu.edu
Compiled by: Maria Breker

Funded by:

North Dakota Soybean Council
Our World Is Growing.

Alfalfa

The perennial crop alfalfa was chosen as an intermediary crop because it provides an extensive root system for building aggregates to improve infiltration and enhance the efficiency of amendments.

Treatments

Solubility is important when choosing amendments. The more soluble the product, the better chance it has to react within the soil.

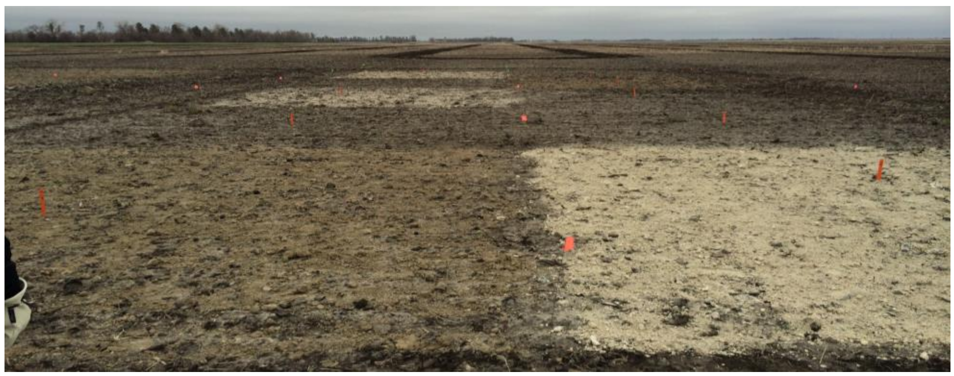
Treatment	Solubility (g/L)
K-Mag	280
FGDG	2
Spent Lime	0.6

RESEARCH CONDUCTED

Two sites were established near Delamere, North Dakota in the spring of 2014. One site had tile installed in 2013 and the other site is surface drained (non-tiled). Both sites are on the Aberdeen-Ryan silty clay loam, sandy substratum soil complex. Both sites were divided into 4 replications that consisted of 10, 20 x 20 ft plots that included 9 treatments and a control.

Table 1. Amendment treatments included:

TREATMENT	RATE (Tons/acre)		
Flue-Gas Desulfurization Gypsum (FGDG)	5	15	30
Sugarbeet Spent Lime	5	15	30
Potassium-Magnesium Sulfate (K-Mag)	1	2.5	5



Many factors must be considered when the objective is to improve the productivity of sodic soils. First and foremost, there must be an understanding of the %Na and EC within the soil profile, how much and where is it located?

At these two sites, the sodic zone is located at the 6-12" depth with %Na values around 12%, but Na^+ is present throughout the profile. In the 0-6" depth, the high rate of FGDG had the lowest values of %Na, but high variability of %Na across all treatments in the topsoil did not allow for a detection of differences in %Na from the control. The treatments and their rates of application did not impact yields and quality of alfalfa at the tiled site, but the high rates of K-Mag reduced the yield at the non-tiled site. If the initial EC is above 2 mmhos/cm, K-Mag may increase the EC to an intolerable level for plant growth, due to its high solubility.

It is important to keep in mind that sodic soil remediation takes many years to accomplish, especially in climates where evapotranspiration rates are higher than precipitation. However, using amendments and a perennial crop can reduce the adverse physical effects of Na^+ and improve the health of the soil.