DETERMINING THE ECONOMIC RESPONSE OF SODIC SOILS TO REMEDIATION BY GYPSUM, ELEMENTAL SULFUR AND VERSALIME IN NORTHEAST NORTH DAKOTA ON TILED FIELDS

Naeem Kalwar (Extension Soil Health Specialist)

Figure 1. The NDSU Langdon Research Extension Center Groundwater Management Research Project Lift Station.

This research report is an extension of an ongoing long-term research trial on a tiled saline and sodic site. **The main objectives of the trial have been:**

- Does existing soil sodicity negatively affect tile drainage performance?
- Will tiling lower soil salinity under wet and dry weather conditions?
- Does the tile-drained water increase salinity and sodicity levels of the surface water resources?

This abbreviated report only summarizes annual soil electrical conductivity (EC) and sodium adsorption ratio (SAR) results. If information about the trial background, objectives, location, site description, design, methodology and complete set of data collected annually is needed, please contact the NDSU Langdon Research Extension Center:

Mail: 9280 107th Avenue NE, Langdon, ND 58249
Phone: (701) 256-2582
Email: ndsu.langdon.rec@ndsu.edu

RESULTS AND DISCUSSION

Considering the main objectives of the study, this report includes the statistical analysis of soil EC (salinity) and SAR (sodicity). Differences in these properties are compared at the time of tiling versus after applying the soil amendments (treatments) on tiled land. The treatment means of EC and SAR represent 2014 and 2016-2023 results of three replications for the zero to four-foot soil depths. In addition, water quality results of the tiled-drained field were compared with the results of upstream and downstream water samples.

Annual Changes in Weather

Changes in the soil chemical properties are greatly influenced by fluctuations in the weather such as annual evapotranspiration and rainfall and resulting groundwater depths and capillary rise of soil water. The annual growing-season rainfall and potential evapotranspiration (Penman) data was collected from the NDAWN (North Dakota Agricultural

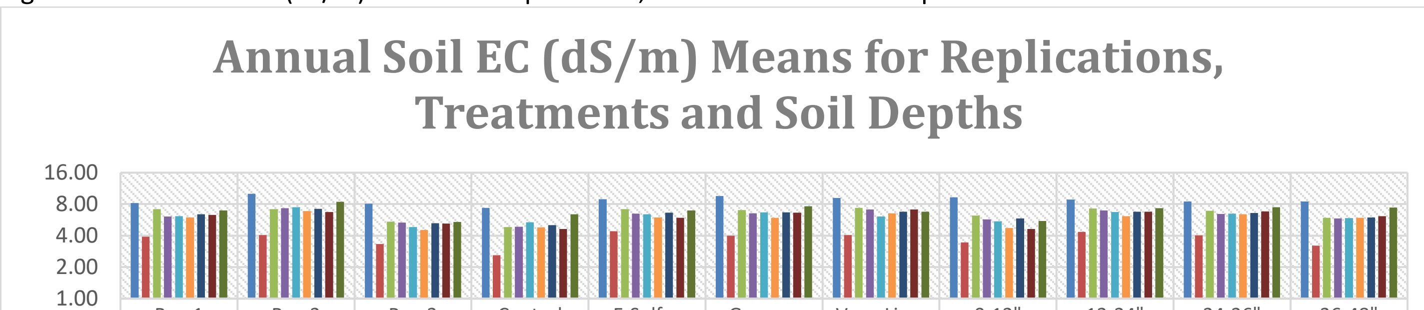
Weather Network) Langdon Station from May 1 to October 31. The average annual growing-season groundwater depths were calculated by averaging the weekly measurements for the same time period.

Increased evapotranspiration versus rainfall generally result in lower groundwater depths with less leaching of water-soluble salts, increased capillary rise of soil water and a slower breakdown of soil amendments. A smaller gap between these two could result in shallower groundwater depths. However, under good soil water infiltration and improved drainage, not only excess salts can be moved out of the fields but soil amendments can also produce favorable results. A smaller gap between evapotranspiration and rainfall will also result in reduced capillary rise of soil water (wicking up) as capillary water moves from higher to lower moisture levels. The 2016 average growing-season groundwater depths were the shallowest. Groundwater depths in 2018 and 2023 were the deepest.

Differences in Soil EC (Salinity) Levels

Soil EC levels have been directly related to the annual growing-season rainfall and resulting moisture levels in the topsoil. Details of soil EC levels are shown in Figure 2.

Figure 2. Annual soil EC (dS/m) means for replications, treatments and soil depths.



	Rep 1	Rep 2	Rep 3	Control	E-Sulfur	Gypsum	VersaLime	0-12"	12-24"	24-36"	36-48"
2014	8.19	10.05	8.08	7.40	8.91	9.58	9.20	9.29	8.84	8.48	8.49
2016	3.90	4.04	3.32	2.60	4.40	3.99	4.04	3.44	4.35	4.01	3.22
2017	7.18	7.18	5.44	4.82	7.18	7.02	7.38	6.23	7.28	6.93	5.93
2018	6.09	7.31	5.34	4.87	6.48	6.53	7.12	5.73	6.95	6.46	5.84
2019	6.15	7.46	4.83	5.37	6.40	6.69	6.11	5.47	6.72	6.51	5.88
2020	5.97	6.89	4.55	4.80	5.95	5.91	6.54	4.73	6.12	6.41	5.94
2021	6.39	7.23	5.26	5.05	6.64	6.69	6.80	5.85	6.80	6.58	5.95
2022	6.30	6.75	5.22	4.63	5.94	6.64	7.14	4.64	6.78	6.81	6.13
2023	6.97	8.44	5.42	6.41	6.96	7.65	6.77	5.54	7.30	7.50	7.44

2014 2016 2017 2018 2019 2020 2021 2022 2023

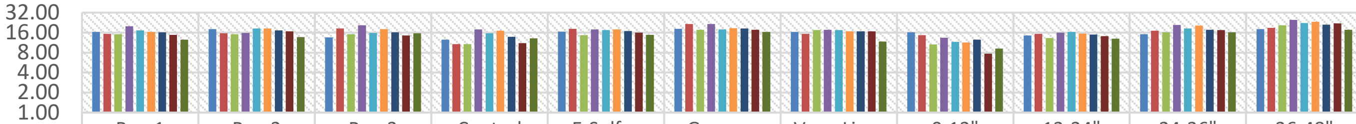
Soil EC levels in 2016, were significantly lower despite shallow average annual growing-season groundwater depths due to excess rainfall and improved drainage under tiling. EC levels increased again in 2017 and that trend continued in 2018-2023 despite the land being tiled and the average annual growing-season groundwater depths were mostly deeper than the depth of the tiles. That was a result of increased capillary rise of soil water due to low rainfall and higher evapotranspiration. This proves that tiling the land is just one tool in the toolbox and lowering soil EC levels will need an optimum combination of low enough groundwater depths combined with sufficient rain and good soil water infiltration to push the salts into deeper depths. Sufficient rain will also result in higher moisture levels in the topsoil resulting in decreased capillary rise of groundwater and water-soluble salts.

Differences in Soil SAR (Sodicity) Levels

Changes in soil SAR levels have been inconsistent. That could be due to dry weather resulting in slow breakdown of soil amendments for lowering sodicity. The major change in the SAR level was in 2022 in the 0-12-inch depth that significantly decreased versus 2014-2021. That trend continued in 2023. Details of soil SAR levels are shown in Figure 3.

Figure 3. Annual soil SAR means for replications, treatments and soil depths.

Annual Soil SAR Means for Replications, Treatments and Soil Depths



	Rep 1	Rep 2	Rep 3	Control	E-Sulfur	Gypsum	VersaLime	0-12"	12-24"	24-36"	36-48"
2014	16.30	18.02	13.58	12.59	16.59	18.37	16.34	16.20	14.47	15.10	18.11
2016	15.31	15.68	18.38	10.72	18.27	21.52	15.32	14.63	15.34	17.06	18.79
2017	15.10	15.22	15.15	10.77	14.72	17.65	17.49	10.59	13.25	16.12	20.67
2018	19.86	15.89	20.73	17.95	17.96	21.64	17.75	13.35	16.09	20.88	24.99
2019	17.21	18.39	15.78	15.63	17.50	17.87	17.49	11.56	16.28	18.38	22.28
2020	16.43	18.44	17.99	17.09	17.84	18.76	16.78	11.36	15.41	20.45	23.26
2021	16.21	17.25	16.21	13.94	16.98	18.55	16.77	12.50	14.97	17.63	21.14
2022	14.83	16.79	14.49	11.13	15.98	17.65	16.73	7.74	14.13	17.53	22.10
2023	12.62	13.78	15.64	13.09	14.79	16.36	11.81	9.24	12.94	16.21	17.66

2014 2016 2017 2018 2019 2020 2021 2022 2023

SUMMARY

Research data and observations are not conclusive at this point. Since most soils in North Dakota are clayey, the general belief is that these soils will infiltrate water slower. That is true if we only compare clayey soils with silty or sandy soils. However, a clayey soil with high to very high dispersion or swelling will infiltrate water much slower than the same clay type not having these issues. Reducing soil dispersion and/or swelling combined with no or minimum-till practices and practices that help increase organic matter will improve soil particle aggregation, structure, pore space and water infiltration.

Below are the answers for the three objectives of this long-term research trial:

Does existing soil sodicity negatively affect tile drainage performance?

Soil sodicity has negatively affected the performance of tile drainage at this site despite heavy rains and standing water at the soil surface. It takes days for the lift station pump to start draining the excess water. There is slow soil water infiltration due to dispersion caused by sodicity. Another evidence of slower water infiltration is there is very little change in groundwater depths for three to five days even after a heavy rain.

Will tiling lower soil salinity under wet and dry weather conditions?

Tiling lowered soil salinity (EC) levels under wet weather in 2016. With drier weather, salinity levels have actually increased again in 2017-2023 compared to 2016 despite tiled-land. That is because of the lack of rain water to force excess water-soluble salts into deeper depths and increased rise of capillary water due to increased evapotranspiration.

Does the tile-drained water increase salinity and sodicity levels of the surface water resources?

Based on the 2015-2021 water quality analysis results, tile-drained water has added conductivity, total dissolved solids and SAR to the drainage ditch or the surface water resource. Over time depending upon the site-specific soil chemistry, tile drainage water can add salts and sodicity to the surface water resources. Water samples could not be taken in 2022 and 2023 due to dry weather.