BEAR RIVER ZEOLITE BRZ™

FOR SOIL AMENDMENTS AND FERTILIZERS

Three products for recreational, agricultural and home applications:

BRZ™ Soil Amendment

Recreational Turfs and Grasses

Agricultural Crops

Lawns and Gardens

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TREATMENT OF HIGH SALINITY SOILS

INTRODUCTION

High salinity, sodic, and saline-sodic soils are worth very little or nothing. Other than oil and gas or mineral rights, the land is generally worthless.

SALINE SOIL PROBLEMS

- Soil salinity problems generally occur in semiarid or arid areas where there is not enough meteoric water to leach salts from the root zone of the plants.
- Saline soils may be reclaimed by providing good percolation, drainage, and good quality water to leach the salts.
- Saline-sodic soils behave differently than sodic soils and have different reclamation procedures.
- A saline soil is one in which there is an excess of soluble salts of calcium, magnesium, potassium, and sodium. They are generally sulfates, bicarbonates, or chlorides.
- Saline soils are a result of irrigating with high salinity water, a lowering water table that fails to leach the salts, surface migration of salts through a combination of capillary action and osmotic pressure from underlying saline deposits or soils, and evaporation of saline water bodies.
- When the concentration of salts in the soil solution equals or exceeds the osmotic concentration in the plant cells, water uptake is stopped and water moves out of the cells to create plasmolysis or "burning."
- Plants are more sensitive to high salinity during their germination and seedling stages than during later stages when they develop some immunity.
- Soil salinity measures all the ions in the soil (not just sodium), and it is measured by electrical conductivity (EC). The more the ions, the higher the salinity. It is measured in milliMhos (mmhos) per centimeter or millisiemens (mS) per centimeter. Some laboratories report it as milliequivalents per liter (meq/L). Cations are measured as milligrams in the laboratory and converted to milliequivalents to put the cations on an equal basis. The EC values in mmhos/cm or mS/cm are interpreted as follows:

EC LEVEL	PROBLEM
Below 2	No salinity problem
2-4	Restricts growth of sensitive crops
4-8	Restricts growth of many crops
8-16	Restricts growth of all but salt tolerant crops
Above 16	Only a few very tolerant crops make satisfactory yield

SODIC SOIL PROBLEMS

- When the percentage of sodium exceeds 15% of the cation exchange capacity of the soil, the soil is considered "sodic." The sodic condition retards or stops plant growth.
- Sodium, chloride, and boron are toxic ions for plants. Plants may display toxicity symptoms before they are effected by high salt concentrations.
- Sodium is generally toxic to plants at higher concentrations. The main problem with sodium is that it attaches to and disperses clays to restrict percolation.
- Soils with a high accumulation of sodium are characterized by having poor tilth and low permeability making them unfavorable for plant growth. When there is a high concentration of sodium, the ionic sodium attaches to clay particles and causes them to disperse and the permeability of the soil becomes very low.
- Sodic soils can be remediated by the application of gypsum or sulfur. In the case of gypsum, soluble calcium is provided to displace the sodium from the clay and to solubilize the sodium as sodium sulfate. In the case of elemental sulfur, there must be a reserve of free lime (calcium carbonate). The sulfur as a result of bacterial action forms sulfuric acid that attacks the calcium carbonate to provide calcium to displace the sodium from the clay, and solubilize the sodium as sodium sulfate. Generally, if the calcium carbonate content of the soil is less than 1.5% gypsum should be used; if the calcium carbonate content is between 1.5% and 2.5% either gypsum or sulfur can be used; and when the calcium carbonate content is greater than 2.5% sulfur is recommended. Again, the success of these amendments depend on the application of clean water.
- A sodic problem should be corrected prior to seeding.
- Plant growth is important for erosion control and phytoremediation (metals uptake)

SALINE-SODIC SOIL PROBLEMS

- Land application of produced water from conventional natural gas wells and coal bed methane gas wells has produced both sodic and saline soils.
- In the case of saline-sodic soils, it is likely that physical soil problems caused by the sodium (attaching to clays) restrict the leaching of the salts. This can be a significant problem even in wetter climates. Saline soils can be reclaimed in semi-arid and arid climates under the right conditions.

APPROACH TO PROBLEM

We will assume that water is not available due to the cost of irrigating, the fact that it is an arid area with little rainfall, or the possibility that the well or surface water is saline. This excludes the approach of decreasing the salinity by leaching. The lack of water also preempts the reduction of the sodium by applying gypsum or sulfur.

This scenario leaves another approach: to decrease the content of the salt by applying a cation exchange amendment to absorb the sodium and allow the germination and seedling growth of salt tolerant species. To test this theory, a Canadian group spread a layer one eighth to one quarter of an inch thick of a 30% clinoptilolite product over the soil. At one eighth inch this would amount to 12 tons per acre (tpa), and this application rate would only be economic for a very limited market. What grass was available grew very well. A 90% plus clinoptilolite product such as BRZ™ should reduce the amount of zeolite used. Hopefully the application rate could be cut to 2.5 to 6 tpa depending on the amount of the salinity.

PROPOSED TEST

A sodic area should be mapped into a 10 foot by 10-foot square grid using steel rebar posts. At least three replicates of each test should be planted. The tests should include varying amounts of zeolite, perhaps 2.5, 5, and 7.5 tpa top-dressed. Additional testing options could include:

- Simultaneous and delayed seeding
- Areas where native grasses are already established but are doing poorly
- Typical crops currently being used in surrounding areas such as canola, corn, wheat, barley, timothy, or brome
- Testing of some of the alkali-adapted species (in the table below)

Inland salt grass	Alkali grass	Hordeum brachyantherum
Newhy hybrid wheatgrass	Nuttall alkaligrass	Elymus triticoides
Tall fescue	Tall wheatgrass	Agropyron smithii
Meadow barley	Distichlis spicata	Puccinellia distans
Creeping wildrye	Agropyron hoffmannii	Puccinellia nuttaliana
Western wheatgrass	Festuca arundinacea	Agropyron elogatum

CONCLUSIONS

While the proposed process is the result of physical activities, the reactions are still largely chemical. The calcium and potassium from the Amended BRZ™ will exchange with the sodium in the sodic soil. In order for the process to continue, the sodium forced off of the exchange process becomes "soluble" sodium rather than "exchangeable" sodium and some leaching of the sodium must still be accomplished for the exchange to continue. The efficiency of this process will be governed by a number of factors including the soil particle size or texture, natural and man made salt content of the soil, Amended BRZ™ size and application rate, and the availability of water. Remediation can be accomplished in semi-arid and arid climates.

Soils high in clay content are most adversely affected by the presence of sodium and salts. Sodium only has effects on soil clays. Soils that are sandy are largely unaffected by sodium. High clay content soils are difficult to leach salts through even in the absence of sodium. The addition of Amended BRZ™ will help ameliorate the effects of high clay content.

Sodium in the absence of significant salts, causes clays to swell and/or disperse and translocate through the soil profile. If only swelling has occurred, the effects of high sodium are reversible. Dispersion and translocation of clays due to sodium are generally irreversible. Salts have a negative impact on soils. However, salts tend to flocculate soil clays and negate the swelling and dispersion. The key is to balance the level of salts so that they do not become a toxic issue.

The application rate for the zeolites can be calculated on both a chemical and physical basis. Application rates should be based on a cation exchange goal. Knowing the sodium level of the soils and the exchangeable calcium, magnesium, and potassium level of the zeolite allows for the calculation of the amount of zeolite needed. Testing is very important in determining the best size fraction and application rates for the zeolite in relation to improving the soil hydraulic properties in addition to allowing for the most efficient chemical exchange.

Additional Information on file at Bear River Zeolite Co.