BEAR RIVER ZEOLITE BRZ™

Soil Research Review

Benefits from studies cannot be claimed by Bear River Zeolite, Co. due to U. S. and Canadian government restrictions. This document was prepared to provide a compilation of information from zeolite (clinoptilolite) studies as a resource.

Clinoptilolite is a mineral component of altered volcanic rock. The unique ability of clinoptilolite to capture ammonium (NH_4^{+1}) is well documented in research. Clinoptilolite holds ammonium through its high cation exchange capacity (CEC) and frees organically bound nitrogen (energy) to plants instead of oxidizing to water soluble nitrates and nitrites that pollute the ground water and the atmosphere as ammonia (gas). Clinoptilolite provides temporary storage for ammonium during livestock digestion, in manure, and in compost.

Clinoptilolite is also able to store up to 55% of its weight in water in its permeable pore space. This ability to store water maintains soil moisture for plant hydration in dry conditions or arid climates.

The following content highlights land application benefits for plants, soils, and the micro-organisms that provide nutrients for plant growth and vitality.

Plant growth

- Significant increase in root and shoot growth due to a higher level of mineralization in the soil and the moisture to deliver plant nutrients.
- Impressive initial growth with clinoptilolite combined with poultry manure is thought to be due to the increase in nitrifying micro-organisms in the rhizosphere.

Soil systems

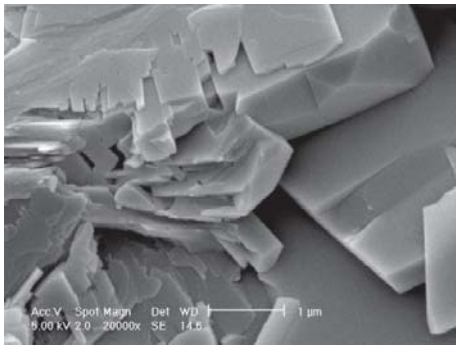
Greater runoff and groundwater contamination results from structureless soil lacking the capacity to hold water. Poor soil can result from repeat applications of nitrogen, phosphorus, potassium (NPK) fertilizers and failure to maintain soil organic matter (OM) with the addition of livestock waste, compost or digestate. In the latter situation, microbes have limited nutrient sources and rapidly decompose soil OM, resulting in soil that is unable to hold water.

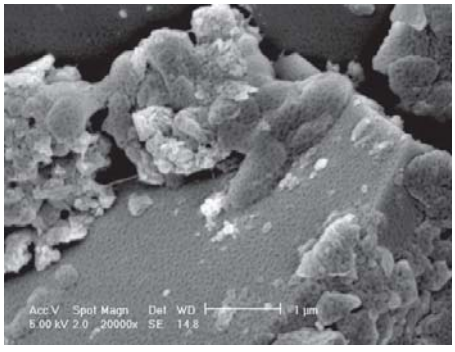
Improved soil structure

- Moderate physical strength, lack of clay minerals, high pore space and permeability provide a material which promotes aeration to provide oxygen in soil.
- Moisture held in the clinoptilolite channelways reduces the drying rate of soils.
- Soil improvements benefited plant growth the following season
- Fungal species decreased by half due to the proliferation of mycolitic bacteria
- Calcium exchanged from clinoptilolite acts as a buffer to reduce acidification

Supports micro-organisms beneficial to plants

- When added to moist soil, clinoptilolite in combination with a nitrogen source gradually exchanges held ammonium that is oxidized by nitrifying micro-organisms and significantly raises the level of microbials in the soil.
- Clinoptilolite increases aeration for aerobic bacteria development.
- Provides a moist surface to support micro-organism colonization.





Left image:
Dry clinoptilolite surface

Right image:
Amended clinoptilolite from moist soil substrate shows clusters of densely packed micro-organisms with other granular particles.

Images used with the permission of Peter J. Leggo

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CATION EXCHANGE

Reports indicate approximately 40 to 70 % nitrogen losses from applied fertilizers, which can leach directly to the water table and pollute aquifers. The High CEC (Cation Exchange Capacity) of clinoptilolite allows it to hold nitrogen (ammonium) from manure and fertilizer, reducing nitrogen losses.

Clinoptilolite has two methods of holding fluids and plant nutrients:

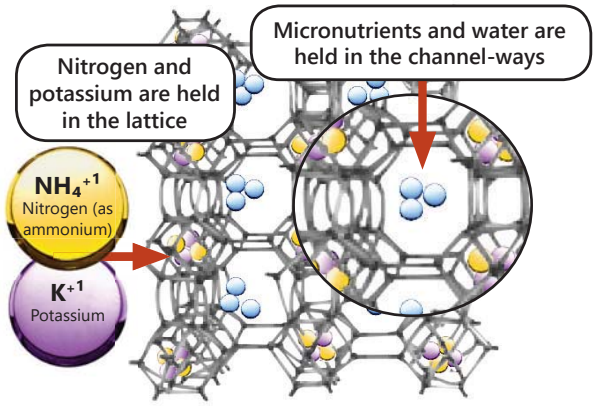
Absorption

Clinoptilolite will absorb water or other liquids. Water and other plant nutrients that are held in this position are loosely held and are water soluble. Water permeates through the growth zone to the aquifer in sandy soils. The addition of clinoptilolite will hold the water in the growth zone.

Adsorption

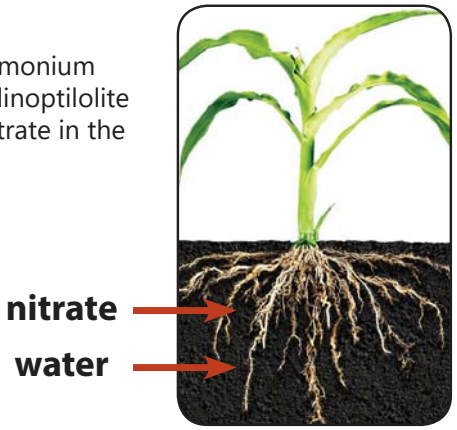
The second method is adsorption by cation exchange. Clinoptilolite is a negatively charged cation exchange agent. As a result of its high cation exchange capacity, clinoptilolite is able to exchange various cations (ions with a positive charge) into its lattice depending on their molecular size, competing cations, and concentrations. During the cation exchange process, cations move from the clinoptilolite mineral lattice and are replaced by other cations, which are held in a non-water soluble state within the lattice.

Clinoptilolite holds cations such as ammonium (nitrogen), potassium, calcium, and other plant nutrients. The cations and plant nutrients are held in the growth zone and are accessible to plants on a demand basis. The nitrogen held in this position will not burn the plant.



Clinoptilolite lattice and channel-ways

Micro-organisms oxidize ammonium (NH_4^+) exchanged from the clinoptilolite lattice to gradually deliver nitrate in the plant root zone.



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Additional Information on file at Bear River Zeolite Co.

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