

ZEOLITE'S ROLE IN AMELIORATING SALT-AFFECTED SOILS

The official newsletter of Green Zeolite Co.



Soil Salinization and its Negative Impact

The Hidden Threat

Today, the soil faces many challenges that jeopardize its integrity and that of agricultural systems. One of these significant challenges is soil salinization, which is closely linked with irrigated soils. Although it is hard to determine precisely, it is clear that the area of salinized soils is increasing. It has been estimated that worldwide 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity, which is a significant component of desertification.

Based on scientific studies, soil salinization occurs when there is a gradual increase, gain, or accumulation of soluble salts in the soil, such as NaCl and Na_2SO_4 . It is a suboptimal condition, characterized by electrical conductivity (EC) exceeding 4.0 dS m^{-1} and the exchangeable sodium percentage (ESP) below 15. This condition exposes plants to salt stress.

Salt stress inhibits plant growth, causing plants to experience osmotic stress. This reduces photosynthesis activity in leaves, leading to chlorosis, and accelerated leaf aging. Salinity also reduces the absorption of macro (N, P, and K) and micro (Ca and Mg) nutrients due to nutritional imbalance and ion toxicity. These effects impact plant metabolism, ultimately resulting in decreased growth and yield.

SOIL SALINIZATION CAUSES

Excessive irrigation with poorly drained irrigation systems

Deforestation or loss of vegetation cover

Overuse of fertilizers and other chemical inputs

Climate conditions/change

High groundwater tables

Ameliorants, such as chemical methods (e.g., gypsum, calcite lime, calcium chloride) and organic fertilizers (e.g., animal manure, straw, biochar), are used to remove salts from the root zone. However, these conventional methods are expensive, disruptive, impractical for large areas, and have limited effectiveness in overcoming salt stress.

Zeolite emerges as a standout natural solution, offering effectiveness and affordability. It is a porous volcanic rock, consists of hydrated aluminosilicate minerals. Its multifaceted role as a soil ameliorant addresses various soil issues by enhancing both physical and chemical properties. Its unique attributes make it a valuable tool in combating salinity.

Mechanisms of Action of Zeolite

Salt stress occurs due to an increase in soil electrical conductivity (EC). Zeolite, with its high cation exchange capacity (CEC) and porosity, plays a significant role as a cation exchanger and adsorbent, as it has the ability to selectively bind and release ions. Zeolite possesses exchangeable ions such as Mg^{2+} , Ca^{2+} , and K^{+} . By exchanging Na^{+} ions for Ca^{2+} ions, zeolite forms Na-Zeolite and increases the soil's CEC. As a result, the electrical conductivity (EC) of saline soils decreases.

Zeolite enhances soil efficiency and prevents salinity by absorbing excess sodium ions from the soil. Moreover, it gradually supplies essential nutrients to plants based on their needs. Zeolite's magnesium and calcium compounds, comprising around 20%, are released to plants as required. Zeolite's aluminum oxide activates and strengthens fine roots, promoting rapid growth and healthy plant development.

Many studies have shed light on the relationship between silicon and its role in addressing soil salinity. Our natural zeolite product contains a significant amount of silicon dioxide (SiO_2), contributing to the overall silicon content in the soil. Silicon has been shown to benefit plants under salt stress conditions by reducing the uptake and translocation of sodium (Na^{+}) and chloride (Cl^{-}) ions to shoots, improving plant-water relations, and aiding in salt dilution. It also helps mitigate osmotic, oxidative, and ionic stress caused by excessive salt. Using our zeolite product can provide an additional advantage for plant health in saline soils.

The application of natural zeolite to saline soils has promising results. Studies have shown significant improvements in growth parameters, such as plant height, leaf number, root weight, and overall yields. Zeolite application on saline soils increases leaf area, biomass, nutrient uptake, nucleic acid formation, and cell multiplication. These findings highlight the potential of zeolite as a valuable tool in salt-affected soils.

