Microbial Mitigation of Salinity

The presence of salt in soil alters the physical structure by interacting with soil particles, reducing soil porosity, and limiting root access to oxygen and water. Salt induces physiological drought and toxicity stress in plants, causing chlorosis, ion imbalances, and enzyme disruptions. High salinity in soil creates drought even when water is present, because the high salt content is difficult for roots and microorganisms to uptake the water due to an osmotic gradient.

Bacteria that grow when salt is both absent and present in high concentrations are considered halotolerant. There are a range of bacteria that are slightly tolerant such as Pseudomonads in 2-8% salinity to moderately halotolerant bacteria in 18-20% salinity.

Halotolerant bacteria respond to drought conditions by producing or absorbing osmoprotectants such as glycine betaine, ectoine, proline and trehalose.

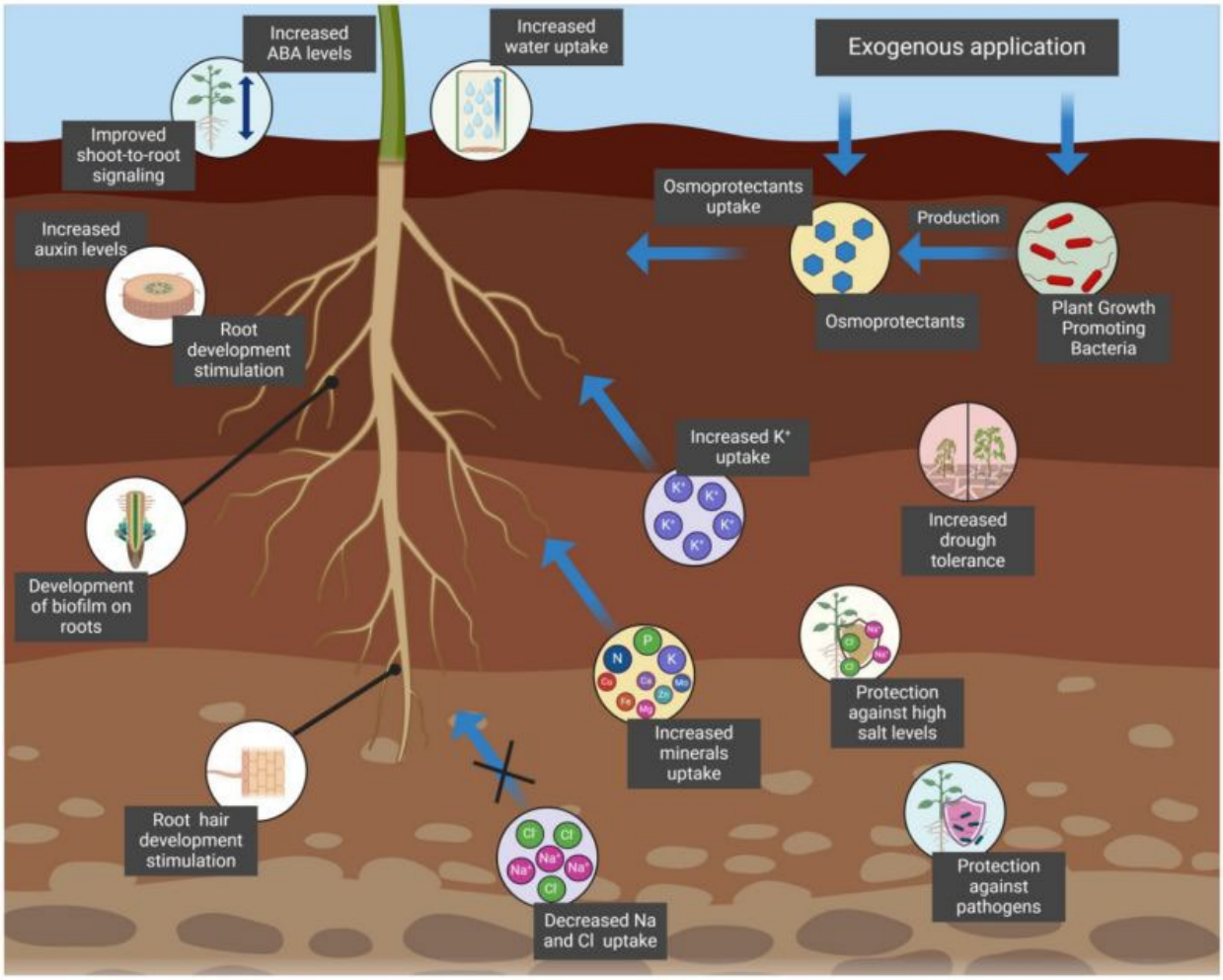
Osmoprotectants protect plant cells against damage from high salts concentration and protect cell turgor by retaining water. They also stabilize proteins, enzymes, and cell membranes while helping to limit oxidative damage. Their activity extends beyond individual bacterial cells. Exopolysaccharides and biofilms can bind Na^+, retain moisture, and create protected microbial microhabitats around the root.

Osmoprotectants can influence the soil by contributing to nutrient availability, altering soil pH, and affecting the cation exchange capacity (CEC), all of which are essential for plant growth and microbial activity.

Halotolerant plant growth-promoting bacteria can support osmolyte accumulation, selective K^+ uptake, antioxidant protection and photosynthetic performance, helping plants maintain growth under saline conditions.

Osmoprotectants hold significant promise for agriculture, particularly in improving soil structure, water relations, and plant stress tolerance.

Image: Effects of osmoprotectants and halotolerant bacteria bioaugmentation at the soil–plant interface. (credits: Goszcz et al. 2025;DOI:10.1093/femsre/fuaf020).



Goszcz,A., et. al. 2025. Bacterial osmoprotectants—a way to survive in saline conditions and potential crop allies, FEMS Microbiology Reviews, Volume 49.

Kempf B, Bremer E. 1998. Uptake and synthesis of compatible solutes as microbial stress responses to high-osmolality environments. Arch Microbiol.;170:319–30.

Mehta, D., Vyas, S. 2023. Comparative bio-accumulation of osmoprotectants in saline stress tolerating plants: A review. Plant Stress. Volume 9.100177, ISSN 2667-064X,

Rahman, S. S., Siddique, R., & Tabassum, N. (2017). Isolation and identification of halotolerant soil bacteria from coastal Patenga area. *BMC research notes*, *10*(1), 531