Grow YOUR SOIL

Soil Science Spotlight

If we understand a soil, we can improve it

Saline and Sodic Soils

Whenever we irrigate crops to produce food, there is a risk of accumulating salts in the soil from the irrigation water used. Examples of human-induced salinity and sodicity in soils abound from irrigated agriculture in ancient Mesopotamia to the current San Joaquin Valley in California. The FAO estimates that 10% of our agricultural soils are affected by salinity and sodicity (1).

Excessive salts in a soil can significantly reduce its fertility and productivity, by making it difficult for plant roots to take up soil water in the presence of high levels of salts. Water moves from the soil into the crop roots due to the differences in osmotic potential between the soil and roots. If soil water has a lower concentration of salts than the roots, then water will naturally move from an area of lower salt (higher water concentration) like the soil to an area of higher salt concentration (lower water concentration) like the roots. If, however, the soil water has a similar or greater concentration of salts than the roots, then the water will not move into the roots as easily and the plants could wilt and die. In addition, soils high in sodium lose their soil structure, making it more difficult for air and water to move into the soil, which is vital for beneficial soil microbial populations, the soil's resistance to wind and water erosion, the ability of roots to grow deeply into the soil, and the crops to thrive.

How does this occur, how do we prevent it, and how do we fix it?

All irrigation water contains salts like calcium, magnesium, potassium, and sodium to varying degrees. When irrigation water is applied, the salts it contains are added to the soil along with the water. If insufficient irrigation water is applied, some of the water from the application will evaporate and leave salts behind to accumulate on the soil surface. In addition, capillary action from the soil pores will cause soil water to slowly rise to the surface, bringing with it soil salts. When the soil water evaporates, additional salts are added near the soil surface. Once significant levels of salts accumulate, they can be seen as a white layer on top of the soil, as shown below:

https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd589210&ext=pdf

Since it can be difficult and costly to modify the salt concentration of irrigation water, prevention generally occurs by adding sufficient irrigation water to ensure that water moves the salts past the root zone of most crops. This prevents the majority of the salts from being left at the surface or rising to the surface through capillary action. In general, one would want to avoid frequent, light applications of irrigation water which tend to favor soil evaporation, little leaching and salt accumulation. Soils that are saline, defined as having an electrical conductivity greater than 4 dS/m and a sodium saturation content less than 15%, can be remedied by adding large amounts of irrigation water to the soil which leaches the majority of the salts below the crops' root zone.

GROW BIOINTENSIVE® agriculture allows a farmer to use less water for a variety of reasons, while still adding enough water to leach salts and prevent saline or sodic soils to form. Close spacing and continually cropping prevents surface evaporation and the transport of soil salts to the surface, all the while increasing the yields per unit of area. In addition, by focusing on improving the organic matter content of a soil, GROW BIOINTENSIVE® farmers increase the ability of a soil to take in water, create a resilient soil structure, and increase the cation (salt) exchange capacity, so higher levels of salts can be tolerated. If necessary, the farmer may also consider growing crops more tolerate of saline or sodic conditions.

Soils with high amounts of sodium (even sodium levels above 5% are detrimental) cannot be remedied simply by leaching due to their loss of soil structure which prevents good water infiltration. Gypsum (calcium sulfate) must be added, which allows the calcium to displace the sodium and reestablish cation bridges between organic matter and clay particles that facilitates good soil structure. The application of gypsum is then followed by the addition of large amounts of irrigation water to leach the sodium in the soil water below the root zone. To leach 50% of the salts from saline and sodic soils, generally 6 inches (15 centimeters) of irrigation water per foot (30 cm) of root zone must be added. Twelve inches (30 cm) of irrigation water per foot (30 cm) of root zone will leach approximately 80% of the salts, and 24 inches (60 cm) of water per foot (30 cm) of root zone will leach 90% of the salts.

During leaching, no crops should be growing in the soil, since they will not benefit from a flooded, saturated soil. If possible, minimize evaporation by covering the soil being leached with shade netting or mulch. If water infiltration of the soil is slow, it may be necessary to create a border around the soil that can hold 6 inches (15 cm) or more of water, so that the soil can be completely flooded and the water infiltrate at the pace the soil allows, rather than have to monitor for water running off the surface of the soil.

After flooding, it is helpful to retest the soil's electrical conductivity and/or sodium saturation level depending on whether the soil was saline or sodic. Knowing the salt concentration and overall irrigation water quality, monitoring the salt and sodium concentrations of the soil, using GROW BIOINTENSIVE® sustainable and organic farming and avoid frequent, light irrigation water applications are effective strategies for preventing human-induced soil salinity and sodicity.

1. Shahid S.A., Zaman M., Heng L. (2018) Soil Salinity: Historical Perspectives and a World Overview of the Problem. In: Guideline for Salinity Assessment, Mitigation and Adaptation Using Nuclear and Related Techniques. Springer, Cham. https://doi.org/10.1007/978-3-319-96190-3_2