Soil Salinity

Assessing and managing it in irrigated landscapes

BY AMIR HAGHVERDI, LAOSHENG WU, JANET HARTIN, AND LAURENT AHIABLAME

Soil salinity refers to the concentration of total dissolved salts in the soil. The dissolved salts release cations (positive charge) and anions (negative charge) to water.

The major cations contributing to soil salinity include:

1. Calcium
2. Magnesium
3. Sodium
4. Potassium.

Meanwhile, the major anions contributing to soil salinity are:

- Chloride
- Sulfate
- Carbonate
- Nitrate.

Salts in soil and water come from different sources, including weathering of parent material, transported from other places by wind or water forces, or by human activities. Water-soluble salts can be found anywhere, yet soil-salinity problems mainly occur in arid and semi-arid regions.

Salinization (or salt-accumulation process) can take place in irrigated areas where water salinity is high, soil drainage is poor, or leaching is not enough. As plants uptake water to meet transpiration demand and water evaporates from the soil surface, salt tends to accumulate in the active root zone. In areas with shallow groundwater, evaporation may cause upward movement of water, resulting in salt accumulation. Recycled water used in many sports fields and parks for landscape irrigation usually contains a higher level of salinity compared with the local potable water. Excessive use of soil amendments and fertilizers can also contribute to soil salinization. Besides, over-application of fertilizers may also cause

TOP PHOTO: DONALD SUAREZ, USDA SALINITY LABORATORY

SOIL SENSORS CAN BE USED TO ESTIMATE BULK SOIL ELECTRICAL CONDUCTIVITY AND SOIL MOISTURE, PROVIDING VALUABLE INFORMATION FOR IRRIGATION AND SALINITY MANAGEMENT.

groundwater contamination through leaching and should be avoided.

NEGATIVE EFFECTS OF SALINITY

■ **Osmotic stress:** Excessive salt accumulation increases the osmotic pressure, making it difficult (energy-consuming) for plants to uptake water from the soil. Therefore, readily available water that otherwise would be available for uptake in the plant root zone diminishes, and plants experience "chemical drought." The symptoms often are similar to water stress, including damaged leaves, stunted growth, wilting, and, in severe cases, even death.

■ **Specific ion toxicity to sensitive plants:** High concentration of some ions (e.g., sodium, chloride, and boron) in the root zone can be toxic to sensitive plants and cause an imbalance in plant nutrients, leading to landscape plant damage.

■ **Soil surface sealing and reduction of infiltration:** High salinity and sodium adsorption ration (a measure of the amount of sodium relative to calcium and magnesium) may negatively affect soil structure by causing the breakdown of soil aggregates and dispersion of clay particles. This, in turn, may substantially reduce the rate of water entering the soil (infiltration rate).

HOW TO ESTIMATE SALINITY

Salinity is frequently expressed in terms of Total Dissolved Solids (TDS), which indicates the weight of residue remaining after evaporating a given volume of water. The standard unit of measure of TDS is milligrams per liter (mg/L) or parts per million (ppm). Since electrical conductivity (EC) of the water is highly correlated with the concentration of soluble salts, soil and water salinity is often measured by electrical conductivity (EC, dS/m = mmho/cm). Higher EC means a higher level of salinity because pure water is a poor electricity conductor.

Monitoring changes in soil salinity is necessary for proper management of salt-affected soils. Soil samples can be collected from parks or sports fields and submitted to a reputable soil-testing laboratory to measure soil salinity. The standard laboratory procedure is to saturate the soil sample, extract the water containing salt from the soil, and measure the EC of the saturated extract using an EC meter.

A practical field method to measure the apparent soil EC (ECa) in a relatively short period of time is the use of contact and non-contact on-the-go sensors. A contact device continuously records measurements while it is pulled by a vehicle and is best suited to large areas because of the speed of measurement. Non-contact sensors, unlike contact devices, can be carried by one worker and are more suitable for smaller

CONTACT (TOP) AND NON-CONTACT (BOTTOM) ON-THE-GO SENSING PROVIDES QUICK MAPPING OF APPARENT SOIL ELECTRICAL CONDUCTIVITY AND CAN BE USED FOR ESTIMATION OF SOIL SALINITY AND OTHER SOIL PROPERTIES SUCH AS SOIL MOISTURE AND SOIL TEXTURE.

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EFFICIENT IRRIGATION AND SALINITY MANAGEMENT GUARANTEES HIGH QUALITY OF LANDSCAPE PLANTS.

areas. The ECa readings are automatically paired with the coordinates of each location using GPS technology. Finally, a map of ECa is produced and used to study the accumulation of salt and delineate salinity-management zones, if needed. Since soil properties other than salinity also affect ECa readings, they should be compared with lab-measured soil-salinity levels. In addition to on-the-go devices, soil sensors can be buried in the root zone to provide continuous measurements of soil ECa and soil-water status. This type of information is very useful for irrigation and salinity management.

HOW TO MANAGE SALINITY

■ **Irrigation management:** Excessive salts must be leached out of the root zone to sustain satisfactory landscape performance. Leaching requirement (LR) is the amount of additional irrigation application required to flush excess salts out of the effective root zone (the soil zone where most roots that uptake water are located). LR depends on both the irrigation water quality and salinity sensitivity of plants. In freely draining soils, a relatively low LR is sufficient for most landscape species irrigated with low-saline water.

Achieving a high uniformity in irrigation is necessary to ensure effective leaching. While sprinklers can be used for leaching, proper design of application rate may be necessary to avoid potential runoff and to provide enough time for adequate drainage. Drainage should be improved for fine texture soils (clayey), layered soils with low hydraulic conductivity, and soils with compacted layers. Improving the soil's physical condition increases leaching efficiency and enhances natural drainage during the rainy season.

■ **Salt-tolerant species:** Different landscape species, and even varieties of the same species, have different salinity tolerances. Including salt-tolerant plants in the landscape design process for areas with salt-affected soils or areas targeted for irrigation with saline (including recycled) water now or in the future is highly recommended. Using this strategy will increase the initial and long-term success of landscape plantings because these species are inherently more capable of surviving the adverse effects of high salinity in the root zone and on leaves. Generally, plants that can withstand salinity levels greater than 6 dS/m are considered "highly tolerant." "Tolerant" plants withstand a level of 4-6 dS/m, while "moderate" species tolerate a level of 2-4 dS/m, and only "sensitive" plants are affected by a salt level of less than 2 dS/m.

INCLUDING SALT-TOLERANT SPECIES IN LANDSCAPE DESIGN IS HIGHLY RECOMMENDED FOR AREAS SUSCEPTIBLE TO SALINITY ISSUES.

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FOR MORE INFORMATION

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Amir Haghverdi *is an Assistant CE Specialist for the Department of Environmental Sciences, University of California, Riverside. Reach him at amirh@ucr.edu.*

Laosheng Wu *is a Professor of Soil and Water Science and Chair for the Department of Environmental Sciences, University of California, Riverside. Reach him at laowu@ucr.edu.*

Janet Hartin *is an Environmental Horticulture Advisor for the UCANR Cooperative Extension, San Bernardino, Riverside, and Los Angeles Counties, and County Co-director, San Bernardino County. Reach her at Jshartin@ucanr.edu.*

Laurent Ahiablame *is a Hydrologist/Water Quality & Management Advisor and County Director for the University of California Agriculture & Natural Resources. Reach him at lmahiablame@ucanr.edu.*

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