EFFECTS OF SALT IN CROPLAND AND MITIGATION STRATEGIES

Authors: K. Mazer, E. Foster, K. Bright, M. Casey, and L. Bowling

HIGH SALINITY IN MAJES

Due to high levels of evaporation and low precipitation, agricultural areas in arid regions like Majes often have high levels of salts that accumulate in the soil when water is evaporated. The concentration of salt in water or soil is known as salinity. High soil salinity can reduce crop growth and yield, but there are several strategies to minimize or avoid these effects.

SALINITY BASICS

- Salinity is a measure of the concentration of salts, like those shown in the box to the right, in water or soil.
- Electrical conductivity (EC), which is a measure of how easily an electric current passes through water, is used to describe salinity because water with higher concentrations of salt conduct electricity more easily.
- Units of EC are measured in deciSiemens per meter (dS/m) or microSiemens per centimeter (1 dS/m is equal to 1,000 µS/cm).
- Some types of salts, like sodium, also have other affects on soil. High concentrations of sodium can deteriorate the soil structure, reduce drainage, and cause erosion.

Salts commonly dissolved in irrigation water:

Sodium chloride – NaCl

Magnesium sulfate – $MgSO_4$

Sodium bicarbonate – $NaHCO_3$

Calcium sulfate - $CaSO_4$

Fig. 1, A field with a salt pan in Arequipa

EFFECTS OF HIGH SALINITY

Figure 1 shows a salt pan that has formed on an agricultural field in Majes. A salt pan is formed when the evaporation rate is greater than the amount of water received (either as rain or irrigation), and evaporated water leaves salt on or within the soil. Due to the high temperatures, this often occurs in Arequipa. Salt pans can also create an impermeable layer, which prevents water from infiltrating into the soil.

Increased salinity can lead to a decrease in crop yield. Figure 2 shows the effect of increased soil salinity on tomato yields. For every 2 dS/m increase in salinity, yield decreases by approximately 20%.

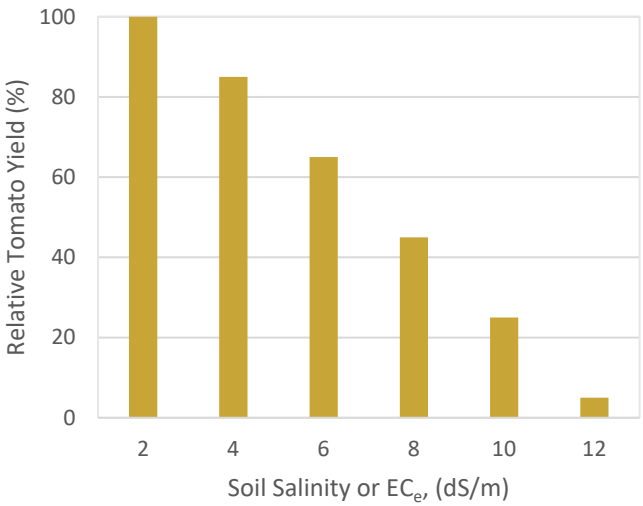

Fig. 2, Tomato yield is decreased by increasing soil salinity; University of California

Plants in high salt environments cannot absorb available soil water, which can result in "burning" of the edges of the leaves, also known as necrosis (Figure 3).

Plants in a salt-affected soil, like the barley in Figure 4, are smaller and produce less harvestable material than those in a low salinity soil.

Fig. 3, Salt-affected barley; Government of Western Australia

Fig. 4, Salt-affected barley; Government of Western Australia

HOW IS AGRICULTURAL SALINITY MANAGED?

KNOWING YOUR SALINITY LEVELS

Fig. 5, Tool used to measure electrical conductivity

Knowing the concentration of salts in your water and soil can help you make decisions on how to manage salinity. EC, which represents salinity, can be measured by sampling the irrigation water source (ECw) or from a saturated extract from the soil (ECe) with inexpensive equipment (Figure 5). Depending on the crop, yields may be affected when soil EC_e exceeds 1 dS/m. In Majes, measured levels of soil EC_e have ranged from 4 dS/m to 40 dS/m, which are levels that require management. Local water salinity measurements (EC_w) have ranged from 0.2 to 1.2 dS/m.

REMEDIATION STRATEGIES

REDUCE EVAPORATION

Reducing evaporation of water from the soil by covering it with plastic or mulch will reduce soil evaporation and salt accumulation. Leaving residual organic matter on the field after harvesting can also help reduce evaporation and salt accumulation.

RIP THE SOIL

To allow for infiltration, salt pans need to be removed. Deeply ripping the soil up to 35-50 cm will break up salt pan layers and help improve drainage. This can also improve irrigation efficiency and facilitate soil flushing.

ROTATE CROPS

Rotating crops and irrigation strategies can reduce salinity. For example, alfalfa is commonly irrigated using sprinklers, which can more effectively flush salts from the soil than drip irrigation. A crop rotation that includes alfalfa every 3 to 5 years can help reduce salt buildup. Alfalfa also fixes nitrogen, which promotes microbial activity and organic matter formation, which can reduce the effects of high salinity.

PLANT SALT-RESISTANT CROPS

Growing salt-resistant crops, such as barley, can reduce the impacts of high salinity in soils. Some of the most salt-resistant crops are shown on the right.

Barley: 8.0 dS/m

Cotton: 7.7 dS/m

Sorgum: 6.8 dS/m

Wheat: 6.0 dS/m

Beets: 4.0 dS/m

Peanuts: 3.2 dS/m

Alfalfa 2.2 dS/m

Salt tolerance (EC_e) without a decrease in yield

ENCOURAGE LEACHING

Leaching is the practice of applying excess water to the soil to move salts below the root area. When the irrigation water source has a high salinity, applying irrigation in excess of the crop water requirement can prevent continued salt accumulation in the soil.

It is not possible to maintain a soil ECe less than the salinity of the irrigation water source, but applying 10% extra water, on average, over a long time period, will lead to soil Ece values stabilizing at about 2.1 times the irrigation water salinity (Ecw). To maintain long-term ECe values equal to the ECw of irrigation water, one should apply 30% more water than is needed by the crops (Figure 6).

In areas with restricted vertical drainage, subsurface drains may be needed to help remove the high-saline leachate from the field, to avoid water table rise.

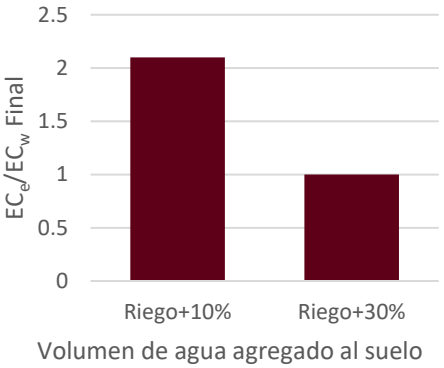

Fig 6. Overirrigating by 10% can reduce soil salinity to 2.1 times water salinity, and overirrigating by 30% can reduce soil salinity equal to water salinity.

CONTACT

For more information about the developers, this factsheet, and other tools developed by the Arequipa Nexus SWM team, contact us at nexus-swm@purdue.edu.