SERVICE IN ACTION
COLORADO STATE UNIVERSITY COOPERATIVE EXTENSION

Management of salt- and sodium-affected soils

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Quick Facts

- Poor soil drainage is either the cause of or a contributing factor to excessive soil salinity.
- Drainage is the key to reclamation of salt-affected soils.
- A source of soluble calcium is necessary to reclaim sodium-affected soils.
- Prevention and control of salt- and sodium-affected soils can be accomplished through land leveling, subsoil tillage, planting salt and sodium tolerant crops, specialized bedding and seed placement, maintaining a leaching fraction, mulching, and incorporation of organic matter.
- The method selected to control salinity problems depends upon the type of problem and the economic resources available.

Excessive soluble salt or exchangeable sodium (Na^+) accumulation within the soil root zone may be caused by one or more factors. These factors are all related to or enhanced by poor soil drainage.

The most frequent cause of excessive soluble salt or exchangeable Na^+ is a shallow groundwater table. This condition impedes drainage and enhances the movement of salts upward through capillary (wick-like) action into the plant root zone.

Irrigation with water containing large amounts of salts and/or a high proportion of Na^+ is another cause.

Poorly leveled land is a frequent cause of excess accumulation of salts in high spots because irrigation water does not penetrate into the soil uniformly.

Improper irrigation management also is a factor. Overirrigation can contribute to raising the groundwater level which may lead to soil salinization. Underirrigation will allow the salts from irrigation to accumulate and concentrate in the plant root zone.

Under some conditions, continuous row cropping also may lead to salinization in the furrow ridges.

Problem Diagnosis

Generally a salt problem will be indicated by the appearance of a white crust (salt) on the soil surface. However, harmful salt and Na^+ concentrations can occur anywhere within the plant root zone with no visible indication of their presence.

Excessive, exchangeable Na^+ may be suspected if water infiltration becomes increasingly slower. Spotty plant germination and poor growth also may be indicative of a problem.

If a problem is suspected, it can be confirmed and its severity determined by a soil analysis. Soil samples for salinity analysis should be taken by increment depths throughout the plant rooting zone. This is necessary to determine the distribution of salt and Na^+.

If their concentration decreases with depth, it may be possible to correct the problem by irrigating before or after planting. This tends to redistribute the salts within the soil profile.

Ground-water depth can be measured by boring holes with a soil auger. If free water collects in a hole that is less than four feet (1.2 meters) deep, a drainage problem is indicated.

In this case, it may be necessary to install drains to lower the water table to a five- to six-foot (1.5 to 1.8 m) depth in medium- to fine-textured soil. A water table depth of four to five feet (1.2 to 1.5 m) may be acceptable for coarse-textured soils.

If the water table fluctuates naturally during the cropping season, installation of drains may not be necessary. A temporary water table rise within the plant root zone may not be serious if other management practices for salinity control are followed.

Drainage specialists should be consulted if the installation of drains is contemplated.

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Irrigation water should be analyzed if it is suspected that the water is a significant source of salt and Na^+. To accurately assess the water quality, it may be necessary to take samples at various times during the cropping season. The CSU Soil Testing Laboratory can perform the required analyses.

Reclamation Treatments

The key to reclamation is drainage. Until this is established, the salt and Na^+ cannot be leached from the plant root zone.

When excess salt is the problem and not Na^+, leaching is the only means of correcting the difficulty. Chemical amendments, conditioners or fertilizers will not correct a salt problem.

It is desirable to apply sufficient water to reduce the soil salt level below four millimhos per centimeter. One acre-foot (1233 cubic meters) of good quality irrigation water passing through one foot (.3 m) of soil will reduce the salt concentration by about 80 percent.

On a severely Na^+-affected soil, a source of soluble calcium (Ca^{++}) is necessary to reduce the exchangeable Na^+ to about 10 percent throughout a 12- to 18-inch (30.5 to 45.7 centimeters) soil depth before planting a crop.

The soil or irrigation water may contain enough native gypsum so that commercial gypsum or other amendments are not required.

Enough leaching water should be applied on the field to dissolve the applied or native soil gypsum. One acre-foot (1233 cu m) of irrigation water will dissolve about one ton per acre (1 metric ton per hectare) of gypsum.

Prevention and Control

Level land is essential for good water management. Uniform distribution and penetration of water is necessary for prevention of salt and Na^+ accumulation. Land should be touched up frequently with a land plane.

Subsoil tillage operations—such as chiseling, or moldboard or disc plowing on land with compact layers, hardpans, or cemented layers—frequently will permanently improve infiltration and uniformity of water and root penetration. This will aid in salt and Na^+ removal as well as in preventing their accumulation. When no such restrictive layers are present, subsoil operations are not recommended.

In some cases, it may not be economically feasible to improve drainage or undertake other practices to reduce salt and sodium levels in the soil. The alternative will be to plant crops that are less sensitive to such conditions. A discussion of crop tolerances to saline soils is presented in Service in Action sheet .505.

Generally, crop seeds should be planted in such a way as to avoid a salt build-up in the immediate zone of seed placement. Planting on the shoulder of the double bed for furrow irrigation will accomplish this (see Figure 1).

Water in excess of that used by the crop must be applied to prevent salts from accumulating in the root zone. All irrigation water contains some salt which becomes more concentrated in the soil solution as plants selectively absorb more water than salt. Flushing accumulating salts to below the root zone in drainage water is necessary to maintain or reduce the present soil salt level.

However, overirrigation—to the extent that it raises the water table to within the plant rooting zone—is undesirable.

In cases where water for irrigation or leaching is in short supply, mulching with straw or other crop residues will reduce evaporation from the soil surface. Rain or leaching water will remove salts more effectively in conjunction with mulching.

Incorporation of crop residues or plowing under green manure in soils adversely affected by Na^+ will improve the tilth, tend to rebuild structure and result in better water infiltration.

Proper plant nutrition will aid in minimizing yield depressions due to salt and Na^+. However, when yield depressions are large because of severely affected soils, fertilization will be of small consequence and likely will be uneconomical.

Figure 1: Planting position on the double bed to minimize salt effect.