# 55. Salinity Damage

*Thomas D. Landis*

## Hosts

All woody plant seedlings can be injured by high concentrations of soluble salts. Because they are adapted to well-leached, acidic soils, most forest tree species are affected by high salinity. Seedlings of some tree species, such as Russian olive and Aleppo pine, are relatively more tolerant. Germinants and young seedlings are particularly susceptible to damage, compared to older seedlings and transplants, which are more resistant. Small-seeded or slow-growing species, like the spruces and true firs, are more susceptible because they take longer to grow out of the young, succulent stage.

## Distribution

Saline soils can be formed by either of the two processes: (1) by deposition of salts that were carried by water, or (2) from soils derived from marine sediments. Salinity damage is most common in arid climates with less than 15 inches of annual precipitation, where soluble salts accumulate in the soil. Calcium salinity problems are also found on calcareous soil types or may be induced by over-liming acid soils. Salt injury can develop in container seedlings if the growing medium is not leached regularly.

## Damage

Salinity injury can consist of either outright mortality of young germinants or growth losses to older stock. Mortality of young germinants is often mistakenly attributed to other diseases, such as damping-off. Growth losses are difficult to determine because significant losses may occur before symptoms become evident. Stunted seedlings may suffer outplanting losses because of low vigor or poorly developed root systems.

## Diagnosis

Diagnosis of salinity injury requires a comprehensive examination of the entire disease complex, but foliar symptoms and certain soil characteristics offer valuable clues. Chlorosis of young needles (fig. 55-1), "burning" of needle tips or leaf margins (fig. 55-2), stunting (fig. 55-3), and patchy growth patterns (fig. 55-4) are symptomatic of salinity damage. Calcareous soils often develop white soil crusts (fig. 55-5), which effervesce when tested with a drop of dilute acid (fig. 55-6). Sodium salts, on the other hand, produce blackish soil with a slick feel.

***Figure 55-3***—One characteristic symptom of saline soil is stunting, which can occur in a variable pattern.

Chemical analysis of the soil, the irrigation water, and the seedling foliage can help diagnose a salinity problem. Soil samples should be taken in the surface horizons, where salts accumulate. High pH is often an indication of excessive salt levels. Salinity can be described in terms of total salinity, or concentrations of specific salt ions. An electrical conductivity measurement of the irrigation water or a saturated paste of the soil is the best way to measure total salt load. Concentration of individual salts can be measured by a laboratory test of a water extract of the soil.

***Figure 55-1***—Chlorosis of young needles is symptomatic of iron deficiency, one nutritional disorder associated with high soil salinity.

***Figure 55-2***—High soluble salt levels cause a physiological drought, resulting in a "burn" of needle tips or leaf margins.

*Figure 55-4*—Often the stunted, chlorotic seedlings occur in irregular patches throughout the seedbed.

*Figure 55-5*—Visible salt crusts often form on the surface of saline soils.

*Figure 55-6*—One simple test for calcareous soils is to apply a drop of dilute acid to the soil surface, which will produce a "fizzing" reaction.

## Biology

High levels of soluble salts cause an "osmotic effect;" which reduces the water available for plant growth. Salts accumulate in surface soils, including raised seedbeds, where they are "wicked-up" during evapotranspiration. Damage becomes more severe as the soil dries. Because of their succulence and limited root systems, germinating seeds and young seedlings are the most severely affected.

Different salt ions cause different problems. Sodium salts destroy soil structure, resulting in poor water infiltration and drainage. Sodium chloride and boron are directly toxic to plants. High calcium levels can cause nutrient availability problems, such as an iron deficiency disorder called "lime-induced chlorosis."

Because salts are carried in water, the quality of the irrigation water and irrigation practices affect soil salinity levels. Sprinkler irrigation during hot weather promotes salt accumulation. Soil type is also important because salts often accumulate in fine-textured soils with poor internal drainage. Soil compaction layers, called plow pans, can inhibit proper leaching of soluble salts.

## Control

**Cultural**—Prevention is the only true control for salinity problems. Both irrigation water and soils should be tested during nursery site selection. In existing nurseries, soil mapping can be used to identify problem areas and ensure that sensitive species are planted on the best soils. Leaching to flush harmful salts from the root zone is the only long-term solution for salinity problems. Deep ripping can break up impermeable soil layers, and adding organic matter will make the soil more porous. Irrigation should not exceed the infiltration rate and is most effective during periods of low evapotranspiration. Use surface mulches to improve water infiltration and prevent the formation of a salt crust.

**Chemical**—Treatment depends on the predominant type of salt. To improve soil structure and promote internal drainage in soils dominated by sodium salts, apply gypsum at a rate of 10 tons per acre. To lower the pH of high calcium soils, add sulfur at a rate of 250-750 lb per acre, which also converts the relatively insoluble calcium carbonate to the more soluble calcium sulfate. Fertilizers with a low salt index should be applied in a series of small applications and carefully irrigated into the soil. Specially formulated chelate fertilizers can be used to treat iron chlorosis and other micronutrient deficiencies.