

Diagnosing Saline and Sodic Soil Problems

Fact Sheet No. 0.521

Crop Series | Soil



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Symptoms and causes of salinity, high pH, specific ion toxicity, and sodicity are frequently confused. Each of these conditions can have adverse effects on plant growth, but they differ significantly in their cause and relative impact. Effective management of these problems vary and require proper diagnosis. Proper diagnosis is critical to successful problem correction.

Definitions

- Basic - High pH. Problems usually start at > 7.8 (alkaline).
- Saline - High salt content.
- Sodic - High sodium content.
- Saline/sodic - High salt and high sodium content.

In-field Diagnosis

Visual symptoms can be used to identify these problems, but ultimately a soil test is the best way for an accurate diagnosis. When salinity is suspected from a high water table, you may be able to measure groundwater depth by boring holes with an auger. If free water collects in holes less than 4 to 5 feet deep, a drainage problem is indicated.

Normally, high pH or basic soil doesn't look different than soil with neutral pH, although sometimes the soil may have a powdery substance on the surface. Plants growing in these soils sometimes give clues about the problem. High pH reduces the availability of some nutrients (zinc, iron, phosphorus). Signs of high soil pH include yellow stripes on middle to upper leaves (signs of zinc and iron deficiency); or dark green or purple coloring of the lower leaves and stems (signs of phosphorus deficiency).

Looking for symptoms is useful when growing high pH sensitive plants such as dry beans, sorghum, or silver maples. Corn and wheat are moderately susceptible to high pH and may also suffer from nutrient deficiencies on these soils.

Plants growing in saline soils may appear water stressed. This is because the high salt content of the soil hampers the ability of plants to take up water from the soil. Water naturally moves from areas of low salt content to high salt content. Sometimes a white crust is visible on a saline soil surface. Plants that are sprinkler irrigated with saline water often show symptoms of leaf burn, particularly on young foliage.

If a soil is sodic, a brownish-black crust sometimes forms on the surface due to dispersion of soil organic matter. Dispersion of soil particles also results in crusting and impaired drainage. Often you will first notice reduced seedling emergence and viability. By the time darkened crusts are visible on the soil surface, the problem is severe and plant growth and soil quality are significantly impacted. Laboratory analysis of soil is the best way to diagnose these problems before plant growth is severely damaged.



Figure 1: Salt impacted field.

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Quick Facts

- High pH, salinity or sodicity can hamper plant growth.
- High pH, salinity or sodicity have different causes and must be treated differently.
- Correctly diagnosing soil problems is the key to determining effective management strategies.

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Table 1: General classification of salt-affected soils.

Classification	Electrical conductivity (dS/m) ¹	Soil pH	Sodium adsorption ratio (SAR) ²	Soil physical condition
Slightly Saline	2 - 4	<8.5	<13	normal
Saline	>4.0	<8.5	<13	normal
Sodic	<4.0	>8.5	>13	poor
Saline-Sodic	>4.0	<8.5	>13	varies
High pH	<4.0	>7.8	<13	varies

¹dS/m = mmho/cm
²If reported as exchangeable sodium percentage (ESP) use 15% as threshold value.

Table 2: Diagnosing high pH, salinity or sodicity problems.

Problem	Potential symptoms
High pH	Nutrient deficiencies manifesting as: stunted, yellow plants. Dark green to purplish plants.
Saline soil	White crust on soil surface. Water stressed plants. Leaf tip burn.
Saline irrigation water	Leaf burn. Poor growth. Moisture stress.
Sodic soil	Poor drainage. Black powdery residue on soil surface.
Saline-sodic soil	Generally, same symptoms as saline soil.

Laboratory Diagnosis

Soil testing labs typically evaluate pH and EC (electrical conductivity) as part of a routine analysis. If the pH is high (>8.5), sodium adsorption ratio (SAR) should also be calculated. See Table 1 to evaluate the lab results.

If you suspect salinity or sodicity problems, collect a soil sample from the top 6 to 12 inches of soil, concentrating on the areas that appear most impacted. High pH, salt or sodium levels are rarely uniformly distributed across fields. Areas of the field suspected of these problems should be mapped and sampled separately to fully understand the severity of the problem. Be sure to tell the laboratory that you suspect a problem and ask that they analyze for SAR or exchangeable sodium percentage (ESP) and perform a gypsum test, if necessary.

If you are irrigating the site in question, collect a water sample for analysis as well. High levels of salts and sodium may come from irrigation, a high water table,

manure or fertilizer inputs, or from the soil parent material. To effectively manage the problem, you need to know the source of the salts. Although 4.0 dS/m is used as a general threshold EC to define saline soils, many sensitive crops such as some vegetables and ornamentals will show symptoms and reduced yields at ECs of 2 - 4 dS/m. Likewise, many soils will begin to have reduced infiltration and increased crusting at SAR levels well below 13.

What can be done after diagnosis?

There are several management options available once the extent of the problem and its source are properly identified. See Colorado State University Extension fact sheets 0.503, *Managing Saline Soils*; 0.504, *Managing Sodic Soils*; 0.506, *Irrigation Water Quality*; and 0.520, *Selecting an Analytical Lab* for more information.