Salinity Problems in Soybean

- Soybean productivity can be significantly hampered by toxic elements.
- Excessive levels of chloride (Cl) and sodium (Na), which make up salt, can be found in the irrigation water and are considered toxic ions with the ability to damage soybean plants.
- Plant toxicity normally occurs when certain ions in irrigation water are absorbed and accumulated at high concentrations in the leaves.

Salinity Problems

Almost all water contains dissolved salts (Cl and Na) and other trace elements which can impact water quality. For most irrigation situations the main water quality concern is salinity levels, as high levels can harm plants and reduce yield potential. Salt begins to accumulate as water evaporates from the surface and the crops remove water from the soil.

Symptoms of salt injury are similar to drought as plants will wilt and the leaf area can decrease when low-quality water is available to the plant. Symptoms will first appear on older leaves, turning them light green to yellow followed by necrosis (Figure 1). The under canopy of the soybean crop must be evaluated to catch salt injury early on. Leaves may also appear scorched shortly after irrigation is applied. If salinity levels are high enough, a plant may die prematurely.

In fields with furrow irrigation, salt injury may be worse for soybean plants that receive higher rates of low-quality water. These areas may be the first third of the field nearest the water source or any low-lying areas where irrigation water may be stagnant.

Testing Chloride Toxicity

Soil testing may not be of much help in working with chloride, as chloride ions move rapidly in the soil when water is added or removed. If excessive salt is suspected in an irrigated field, a water sample should be sent in for analysis. From the analysis, two types of salt problems can be diagnosed, a problem with total salinity (too much Cl) or a problem associated with the combination of total salinity and sodium (Cl and Na), sodicity.

Irrigation, a high water table, manure, fertilizer applications, or the soil parent material may be sources for high Cl or Na levels. Knowing the source of the salt is important to apply an effective management practice(s). When submitting water samples, remember that water from the same source can vary in quality with time. It is good to always test during potential irrigation periods.

Chloride Toxicity (Saline Soils)

Soils with high Cl levels are called saline soils and can reduce plant water uptake. Saline soils normally have a pH value below 8.5 and are low in sodium (Table 1). Additional facts about saline soils:

- Chloride does not adhere to soil particles, so it moves readily with soil water.
- Water salinity can be measured by electric conductivity (EC) (Table 1).
- Symptoms occur initially at the soybean leaf tip. Chemical analysis of plant tissue can be used to confirm Cl toxicity.
- In irrigated areas, Cl uptake depends not only on the water quality, but also on soil Cl levels from leaching and the ability of the soybean product to exclude Cl.
- Chloride toxicity can occur in regions where the water table or irrigation water is high in Cl. Excessive fertilizer use can also increase Cl toxicity.

Table 1. Classification of salt-affected soils.

<table>
<thead>
<tr>
<th>Classification</th>
<th>EC (dS/m)</th>
<th>Soil pH</th>
<th>SAR</th>
<th>Soil physical condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slightly Saline</td>
<td>2 - 4</td>
<td>&lt;8.5</td>
<td>&lt;13</td>
<td>normal</td>
</tr>
<tr>
<td>Saline</td>
<td>&gt;4.0</td>
<td>&lt;8.5</td>
<td>&lt;13</td>
<td>normal</td>
</tr>
<tr>
<td>Sodic</td>
<td>&lt;4.0</td>
<td>&gt;8.5</td>
<td>&gt;13</td>
<td>poor</td>
</tr>
<tr>
<td>Saline-Sodic</td>
<td>&gt;4.0</td>
<td>&gt;8.5</td>
<td>&gt;13</td>
<td>varies</td>
</tr>
<tr>
<td>High pH</td>
<td>&lt;4.0</td>
<td>&gt;7.8</td>
<td>&lt;13</td>
<td>varies</td>
</tr>
</tbody>
</table>

1 Electrical conductivity dS/m = mmho/cm.; 2 Na adsorption ratio, if reported as exchangeable sodium percentage (ESP) use 15% as threshold value. Source: Colorado State University Extension.
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- Geographies include the coastal/tidal region and hard clay pan soils with poor drainage in areas of Kansas, Southern Missouri, Southern Illinois, and parts of Arkansas and the Mississippi Delta.

Sodium Toxicity (Sodic Soils)

Water that contains high amounts of Na are called sodic soils. High Na levels can lead to the breakdown of soil structure causing the soil to become hard to compact when dry and impervious to water penetration. Sodic soils can appear to be dark and smooth.

- High Na concentration can cause ion imbalance of potassium (K), calcium (Ca), and magnesium (Mg) in the plant.
- Na toxicity is not as easily diagnosed as Cl toxicity, but damage to plant tissues has been correlated to high Na concentrations in irrigated water.
- Soils with high Na levels are expressed by the Sodium Adsorption Ratio (SAR). This number is calculated from the ratio of Na to Ca and Mg (Table 1).1
- To determine if a soil is sodic or just has high pH the SAR should be determined (Table 1).
- Symptoms are leaf burn, scorch, and dead tissue along the outside edges of leaves. A combination of plant tissue, irrigation water, and soil analyses increases the probability of a correct diagnosis.
- Na toxicity can occur in regions where soils have high levels of exchangeable Na, irrigation water is high in Na, and rainfall is limited.

Management

Leaching is a basic management tool for controlling salinity in soil. To leach the soluble salts, water is applied in excess and then is lost to evaporation. This technique is used to keep the salts in solution until they leach below the plant root zone. This technique may be accomplished during any irrigation and as much as needed. In some areas normal amounts of rainfall may provide enough additional water to allow for salt leaching. Preplant irrigation can also help reduce salt levels as salts can accumulate near the soil surface when fields are fallow.

In fields with saline soils, salt tolerance can be improved when the soybean plant has the ability to regulate the absorbed CI ion within the plant. Soybean products absorb CI from the soil at the same rate, but are differentiated into two genotype groups based on their ability to regulate the absorbed Cl (Table 2). The two genotype groups are:

- **Excluder** plants that store CI in the root while Na will still be translocated to the shoot tips and leaves.
- **Includer** plants take in the chloride and move it to the top of the plant where toxic levels can accumulate and kill the plant.

<table>
<thead>
<tr>
<th>Table 2. Soybean chloride sensitivity product rating.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Includer (I)</td>
</tr>
<tr>
<td>Excluder (E)</td>
</tr>
<tr>
<td>Segregating (SEG)</td>
</tr>
</tbody>
</table>

It is important to note that soybean excluder products planted in areas where both Na and Cl are at the toxic levels will not provide tolerance due to the Na toxicity effect on the plant. Soybean excluders are more common in soybean products planted in the Southern regions and less common in Northern regions. Both includer and excluder soybean products are affected by high salt levels, but includers may experience more damage.

How to Select Soybean Products?

Salt tolerance may be a key agronomic characteristic to consider in fields where high levels of Cl or Na limit yield potential. Symptoms and causes of Cl and Na toxicity are frequently confused. Effective management of these problems varies and requires proper diagnosis. Excluder soybean products can be an effective management tool to minimize the impact of Cl toxicity.

Your Asgrow® seed representative can help you identify essential agronomic characteristics needed and match the right products to your fields. Refer to agSeedSelect® for the chloride sensitivity of your Asgrow soybean products. The abbreviations Inc. = Includer and Exc.= Excluder.

Sources:


For additional agronomic information, please contact your local seed representative.