Benefits of Using Chloride Excluder Varieties in Irrigated Soybeans

What is a chloride excluder variety?

Chloride (Cl^-) excluder, or salt excluder, is a characteristic of a soybean variety that is helpful in areas with higher salt or Cl^- levels in the soil. In fields with saline soils, salt tolerance is improved when the soybean plant can regulate the absorbed Cl^- within the plant. All soybean products absorb Cl^- through roots at the same rate. However, soybean products can be differentiated into two genotype groups (excluder and includer) based on their ability to regulate the absorbed Cl^-. Excluder plants can tolerate high soil Cl^- levels by restricting higher concentrations of Cl^- to the roots. Includer plants accumulate Cl^- throughout the plant and are considered sensitive to high levels of soil Cl^-. Chloride excluder varieties have a dominant gene that enables them to segregate and exclude Cl^-, preventing the movement of Cl^- into the tops of the plant where injury can occur.

Why are chloride excluder soybean varieties potentially beneficial under irrigated conditions?

Soybeans under continuous irrigation may be subjected to high levels of salts or Cl^- from well or surface water. Irrigation water that contains salts can cause saline soil conditions when more salt is left behind after evaporation and transpiration of the irrigation water than is removed by runoff and deep percolation into the soil. This salt buildup is in addition to what is added to the soil by fertilizers and manure. Chloride toxicity can occur in regions where the water table or irrigation water is high in Cl^-. The problem is more common in southern geographies that 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. Chloride excluder soybean varieties are more commonly marketed in southern irrigated areas and less common in Northern areas, such as the Corn Belt where salty irrigation water and saline soils are less of a problem.

What causes chloride toxicity and what are the symptoms produced on soybeans?

Chloride does not adhere to soil particles, so it moves readily with soil water. It is taken up by the plant root system then translocated to the leaves where it accumulates. Toxicity symptoms develop if Cl^- concentrations in the leaves exceed the tolerance level of the plant. Soybeans with Cl^- toxicity will display symptoms that range from faint leaf chlorosis, to a scorched look, to total plant loss. Leaf symptoms usually occur shortly after irrigation water is applied. Leaves can appear scorched along the edges and the scorching will generally be worse on the lower leaves of large plants or relatively uniform on small soybeans (Figure 1). Severe injury can result in plant burning, stunting, and stand losses in field areas.

Figure 1. Salt damage to soybean from irrigation. Source: Dr. Gordon Johnson, University of Delaware.

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What is the effect of salt toxicity on soybean productivity?

It can be difficult to predict a soybean yield loss caused by salt toxicity. Both excluder and includer soybean varieties can suffer yield loss in salty soils. However, more yield loss can occur with includer soybean varieties. Salt toxicity may occur in localized field areas or be present across most of a field's acreage. Hot spots are likely to occur in plants located in potholes or low spots. Salt damage can also be worse on high spots and areas that dry out because of surface salt accumulation. Excessive levels of both Cl^- and sodium (Na) can be found in soil and irrigation water. It is important to note that Cl^- excluder soybean varieties will provide tolerance to Cl^- toxicity but not to Na toxicity. Chloride excluders will store Cl^- in the root while Na will still be translocated to the shoot tips and leaves where injury can occur.

What should a grower do to manage salt toxicity in soybeans under irrigation?

If soil salt conditions are too severe, actions can be taken to prevent damage to the crops grown. Saline soils are easy to reclaim if there is good soil drainage and an adequate supply of low salt irrigation water or precipitation. Extra irrigation water called the leaching fraction is applied to leach the salts out of the root zone. This can lower salt levels in the soil and salt stress to the crop. Universities and soil testing laboratories can provide information on how much water to use depending on the salt levels in the soil and the quality of the water being used for leaching.[1]

Proper diagnosis of salt toxicity to soybeans is important to successfully apply proper management practices. Soil testing is not much help in diagnosing Cl^- toxicity but could be helpful in the diagnosis of Na toxicity and other soil problems. Plant tissue testing can be used to confirm Cl^- toxicity. Sending a sample of the irrigation water for analysis is also recommended. A combination of plant tissue, irrigation water, and soil analyses increases the probability of a correct diagnosis.

The most practical way to reduce problems from Cl^- toxicity is to select a Cl^- excluder soybean variety. Bayer screens soybean lines for salt tolerance. They have a marker for the Cl^- excluder gene, and standard checks are used to confirm that there is a tolerance level to Cl^- toxicity in a specific line. Generally, soybean lines that are positive for the marker (Cl^- tolerant) will be scored between 1-3 on a 1-9 scale. Lines without the marker (Cl^- susceptible) can vary but typically score above 3. Chloride excluder characteristics are typically in the later maturing soybean varieties since the south is where salt problems occur. Many southern varieties have the excluder gene present, but it is relatively rare in northern soybean varieties. Refer to your seed guide or product characteristics sheet for the Cl^- sensitivity of your soybean product. Your Bayer seed representative can help you identify essential agronomic characteristics needed and match the right products to your fields.

Sources:

[1]Diaz, D. and Presley, D. 2017. Management of saline and sodic soils. Kansas State University Extension Publication MF1022. https://www.bookstore.ksre.ksu.edu.

[2]Dunn, J. and Widick, D. 2006. Effects of chloride irrigation water on soybean excluder and includer cultivars. Arkansas State University and University of Arkansas. ASA Southern Regional Branch Meeting. https://a-c-s.confex.com.

[3]Bennett, D. 2004. Putting an end to salty soybeans. Missouri Ruralist Farm Progress. https://www.farmprogress.com.

[4]Tacker, P. 2003. Salts can cause problems: Check quality of irrigation water. Missouri Ruralist Farm Progress. https://www.farmprogress.com.

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