



## Soybean Nutrient Profile

### Chloride

#### Deficiency and Toxicity

*This nutrient profile is a part of a weekly series dedicated to the function of the 16 essential nutrients in soybean. After excluding carbon, hydrogen, and oxygen, we are left with a thirteen part series in which we will explore how nutrients are used throughout the plant as well as how to identify deficiency symptoms and develop nutrient management decisions.*

#### **In the Plant**

Chlorine (Cl) is absorbed and utilized in plants strictly as the anion, chloride ( $\text{Cl}^-$ ). Chloride is often taken into the plant through other anion channels such as nitrate, sulfate, or phosphate. The main function of  $\text{Cl}^-$  throughout the plant is to maintain electroneutrality as cations are utilized in various plant processes. Of these processes, the two most important are the evolution of oxygen during photosynthesis and the maintenance of turgor pressure in stomatal guard cells to regulate water loss and gas exchange. In both cases,  $\text{Cl}^-$  is used by plants to balance the oxidation or transport of cations in plant cells. A reduction of  $\text{Cl}^-$  concentration in the plant will both reduce the rate of photosynthesis and increase water loss due to a reduction of stomatal regulation.

#### **In the Soil**

Chloride is very soluble in soils and nearly all of the  $\text{Cl}^-$  in soils will occur in soil solution. Excess  $\text{Cl}^-$  can accumulate in areas without sufficient water to leach excess  $\text{Cl}^-$ , soils with poor drainage characteristics, soils with a high water table, or soils with a layer of restricted drainage (i.e., tillage pan or hard pan). These can all lead to excess  $\text{Cl}^-$  availability in localized areas in which root growth is concentrated.

## **Deficiency and Toxicity Symptoms**

Although  $\text{Cl}^-$  deficiencies are rarely observed in soybean, two main symptoms include the chlorosis of younger leaves and wilting of the plant. These symptom descriptions make sense when we consider the role of  $\text{Cl}^-$  in both photosynthesis and stomatal regulation.

The more prevalent issue in Louisiana however, is  $\text{Cl}^-$  toxicity. Chloride toxicity is often observed in soybean under continuous irrigation with water high in  $\text{Cl}^-$ . Toxicity symptoms include interveinal chlorosis and progress to scorching, or necrosis, of the leaf margins. Leaves will thicken and eventually tissue will die and fall from the plant. Symptoms often appear shortly after irrigation water is applied.

## **Toxicity Prevention**

Producers should have irrigation water tested regularly to determine water quality. Seasonal environment will also play a large role in whether or not toxicity issues are seen. If rainfall is adequate, irrigation will be utilized less and symptoms will be less obvious. Rainfall, and soil water in general, will also effect the appearance of  $\text{Cl}^-$  toxicity due to its mobile nature in soils. Soil tests taken from the same point in a field can vary greatly even within 24 hours as  $\text{Cl}^-$  can move into or out of the root zone readily dependent on soil water.

Therefore, the best prevention practice for producers is variety selection. Many varieties will be labeled as either  $\text{Cl}^-$  excluders or includers. This information can often be found at manufacturer websites and on variety tech sheets. Although both excluders and includers take up similar amounts of  $\text{Cl}^-$ , excluder varieties can tolerate high  $\text{Cl}^-$  levels as excess  $\text{Cl}^-$  is held in the roots and not translocated to leaves and other tissues. Includer varieties will continually transport excess  $\text{Cl}^-$  to new growth even to toxic concentrations. Regardless of the ability of excluder varieties to tolerate excess  $\text{Cl}^-$ , the yield potential of both excluders and includers will be reduced in soils with high  $\text{Cl}^-$  levels.

## **Takeaways**

- Chloride is essential in small amounts to maintain electroneutrality in many processes in the plant including photosynthesis and plant water regulation.

- Chloride is very mobile in the soil and is easily leached through soils with adequate amounts of rainfall or irrigation. Chloride can accumulate in soils with continuous irrigation with water high in  $\text{Cl}^-$ .
- Chloride toxicity can occur under continuous irrigation with water high in  $\text{Cl}^-$ . Toxicity symptoms appear as light chlorosis progressing to scorching, or necrosis, of leaf margins.
- Irrigation water should be tested on a regular basis to prevent against the use of poor quality water for irrigation. The yield potential of every soybean variety will be reduced under high  $\text{Cl}^-$  concentrations and  $\text{Cl}^-$  excluder varieties should be selected to improve tolerance when necessary.

### **References**

- Havlin, J.J, Beaton, J.D., Tisdale, S.L., and Nelson, W.L. 2005. Soil Fertility and Fertilizers. Upper Saddle River, NJ: Pearson Prentice Hall.
- Taiz, L. & E. Zeiger. 2010. Plant Physiology. Sunderland, MA: Sinauer Assoc. Inc.