Soybean Nutrient Profile

Calcium

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

Calcium (Ca) is essential in the formation of new cell walls, specifically the middle lamella that separates plant cells. It is required for normal plant membrane functions and permeability. Low Ca results in increased permeability of cell membranes, reduction of nutrient-uptake, potential loss of cellular contents, and the reduction of cell division. Because of its function in the makeup of cell walls, Ca is also essential for the translocation of many photosynthetic products and nutrients in the plant. As the carbohydrates build up in leaves under a Ca deficiency due to a lack of adequate translocation, root function will decline and nutrient uptake is severely reduced.

Calcium is immobile in the plant. When Ca is taken into the plant through the roots it is moved through the xylem with transpirational water. Once in the leaves, minimal amounts of Ca are ever moved through the phloem to other parts of the plant. Because of this, it is important that plants have a continuous supply of calcium for adequate root and shoot development. Conditions that will limit root growth will hinder access to Ca and can potentially induce a calcium deficiency.

In the Soil

Calcium, a cation in the soil (Ca^{+2}), occupies the negatively charged sites found on the surface of clay particles that makeup a soil's cation exchange capacity (CEC). In many Louisiana soils with a neutral or alkaline pH, Ca often dominates these exchangeable sites. As with any cations that occupy these sites, soil Ca will exist in equilibrium between solution and

exchangeable Ca. As Ca is removed from the solution due to plant uptake or leaching, exchangeable Ca will desorb from these sites into the soil solution to maintain this equilibrium. Plant roots often encounter Ca through the mass flow of solution Ca or through root interception, in which growing roots come into contact with solution Ca.

Deficiency Symptoms

Because of the immobile nature of Ca in plants and the function of Ca with newly developing cells, deficiency symptoms are primarily found in meristematic regions, or regions of rapid cell division such as terminals and apical growing points of roots. Newly developing leaves and root tips will become necrotic as cells attempting to divide die. Because cell walls do not form, the contents of dividing cells are lost and often cause the developing leaflets to stick together as the trifoliates unfold (figure 1).

Figure 1. *Soybean calcium deficiency cause a dieback of meristematic regions and unfurling leaf tissues will often stick together as newly dividing cells lack adequate cell wall formation. (IPNI, T.L. Roberts, 2018)*

In the soil, Ca deficiencies can lead to poor nodulation while the nodules that do form are white to green when sliced open instead of the characteristic pink color of active nodules. Root development will be reduced and root tips will also have a dark color as the roots also begin to die back.

Deficiency Corrections

Calcium deficiencies in Louisiana are very uncommon as many of our soils contain large amounts of plant available Ca. Soils with the potential for low plant available calcium levels will often have a low pH. To correct both low soil pH levels and the potential for Ca deficiencies in soybean, soils should be limed with either $CaCO_3$ (calcitic lime or ag-lime) or $CaMg(CO_3)_2$ (dolomitic lime). If calcium is needed to correct low soil Ca without the need to increase soil pH, then $CaSO_4 \cdot 2H_2O$ (gypsum) should be applied.

Takeaways

- Calcium (Ca) is a secondary plant nutrient essential in the development and function of plant cell walls, including the translocation of many carbohydrates and nutrients found in plant tissues.
- Calcium occurs as a cation in the soil (Ca^{+2}) both in solution and adsorbed to the negatively charged exchangeable sites on clay particles that makeup the majority of a soils CEC. Low pH soils typically have reduced plant available Ca and require greater concentrations of Ca to maintain root growth than do soils with a higher pH.
- Calcium deficiency symptoms include the dieback of terminal meristems in shoots and apical meristems in roots. Leaflets of a soybean trifoliate will often remain stuck together as they unfurl do to the lack of cell wall separation in newly dividing cells.
- To correct both low soil pH levels and the potential for Ca deficiencies in soybean, soils should be limed with either $CaCO_3$ (calcitic lime or ag-lime) or $CaMg(CO_3)_2$ (dolomitic lime). If producers need to correct low soil Ca without the need to increase soil pH, then $CaSO_4 \cdot 2H_2O$ (gypsum) should be applied.

References

Images: IPNI, T.L. Roberts. 2018. IPNI Crop Nutrient Deficiency Image Collection. Version 2018-05-07.

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.