Soybean Nutrient Profile

Molybdenum

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

Molybdenum (Mo) is essential to all plants due to its role associated with nitrogen metabolism in the plants. As a component of nitrogen reductase in the chloroplasts of plants, it helps in the conversion of nitrates to nitrite as it is assimilated into the plant cell. Even more so to soybean, and various other legumes, Mo is an essential structural component to nitrogenase. Nitrogenase is the enzyme responsible for converting nitrogen gas to ammonia during nitrogen fixation. Molybdenum also plays a role in iron uptake and translocation.

In the Soil

Molybdenum is taken into the plant as molybdate which typically occurs through mass flow, the movement of nutrients through the soil towards the plant with the transpirational movement of water. Unlike most micronutrients, Mo availability in soils increases with increasing pH. Optimum availability of Mo will occur in the pH range of 6.5 to 7.

Other nutrients such as phosphorus and magnesium have been shown to increase Mo uptake in plants. Nitrogen has also been shown to play a role in some plant uptake of Mo dependent on the source. Nitrates have been shown to increase Mo uptake while ammonium can reduce uptake. This is most likely due to the slight increase in alkalinity in the rhizosphere commonly associated with the uptake of nitrates.

Deficiency Symptoms

Because Mo is required in small amounts that are typically provided by native soil concentrations, Mo deficiencies are rare. Symptoms of a Mo deficiency in most plants will appear as interveinal chlorosis similar to that of iron. This is most likely due to the role Mo plays in iron uptake and translocation.

However, because of the essential role of Mo in nitrogen fixation, symptoms of Mo deficiency in soybean often appear as a nitrogen deficiency due to the lack of nitrogen fixation in the roots. Nodulation is often reduced and chlorosis will appear on older leaves. Most often, this occurs in low pH soils. This is often a function of both reduced availability of Mo and a reduction in *Rhizobium japonicum* (the bacteria responsible for nodule formation and nitrogen fixation in soybean) activity due to the low pH.

Deficiency Corrections

LSU AgCenter recommendations for Mo have been based on soil pH. The recommendations state that seed should be treated with a Mo seed treatment at pH below 6.2 and should be both inoculated with *Rhizobia* and treated with Mo at pH below 6.0. However, our recommendations going forward are being refined to account for the affect that the Mo salt seed treatments have on the viability of the *Rhizobia*. *Rhizobia* are living organisms that can die if not kept in a proper environment. Commercial products can often remain viable even after seed treatment for up to 90 days, depending on the individual product. When mixed with a Mo seed treatment however, the salt has been shown to desiccate the *Rhizobia*, reducing the amount of viable bacteria on the seed. An example of this was seen at the Sugar

Figure 1. *Molybdenum seed treatments (B) reduced the viability of Rhizobium japonicum in commercial inoculants when compared to seed treated only with commercial inoculants (A) (LSU AgCenter, A. Orgeron)*

Research Station in St. Gabriel, LA this spring. A reduction in nodulation was observed after planting soybean seed that was both inoculated and treated with a Mo seed treatment compared to those inoculated seed without the Mo treatment (figure 1).

Research from surrounding states have shown that seed treated with both inoculant and a Mo seed treatment more than a few hours before planting have reduced viable *Rhizobia* compared to those not treated with a Mo seed treatment or those planted immediately after the Mo seed treatment was applied. Therefore, until additional research is conducted in Louisiana, producers should be cautious in applying Mo seed treatments to inoculated seed unless seed will be planted immediately. In soils with a pH below 6.0, producers should always treat seed with a commercial inoculum.

Takeaways

- Molybdenum is essential to several functions in the plant, including both the assimilation of nitrogen in plant cells and the fixation of nitrogen in soybean.
- Molybdenum availability is affected by varying soil conditions and is greatly reduced in low pH soils.
- Molybdenum deficiency symptoms in soybean typically appear as a nitrogen deficiency due to the reduction of nitrogen fixation.
- Producers should avoid applying both a commercial inoculant and a molybdenum seed treatment due to the potential reduction in viable *Rhizobia* unless intentions are to plant immediately.

References

Burton, J.J. and R.L. Curley. 1966. Compatibility of *Rhizobium japonicum* and sodium molybdate when combined in a peat carrier medium. Agron. J. 58:327-330.

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.

Philipp, D. and J. Jennings. Forage Legume Inoculation. UACES. Pub. no. FSA2035. UACES. Fayetteville, AR.

Taiz, L. & E. Zeiger. 2010. Plant Physiology. Sunderland, MA: Sinauer Assoc. Inc.