



Soybean Nutrient Profile

Manganese

This nutrient profile is the first in what will be 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

As do all 16 essential plant nutrients, manganese (Mn) plays a vital role in plant growth and development. One of the major functions of Mn in the plant is the oxidation of two water molecules into one molecule of oxygen and four hydrogen ions. This splitting of the water molecules helps power the photosynthesis process by supplying electrons that are needed throughout. This Mn requiring, photosynthetic complex is also the source of almost all of Earth's atmospheric oxygen and is the only known biochemical system to perform this reaction. Manganese also has a role in several metabolic reactions including respiration and the reduction of N-nitrate to a form of nitrogen readily utilized by the plant.

In the Soil

Manganese availability is tied to soil pH variations. As the pH increases by one unit, Mn availability in the soil solution decreases hundredfold. Reduced availability of solution Mn can occur at soil pHs as low as 6.5. With many of the soils in Louisiana having neutral or greater pH, it is not uncommon for Mn deficiency symptoms to appear based on a lack of available Mn even if total soil Mn is adequate or even high. As the soil pH decreases, Mn will become increasingly soluble leading to potentially toxic levels (pH < 5.5).

Manganese occurs in the soil as oxide and hydroxide minerals and as Mn^{2+} in the soil solution. As a result, dry soil conditions (increased oxygen levels) can also reduce Mn availability due to the formation of low-soluble Mn-O compounds. In some cases, Mn

deficiency symptoms can be corrected through proper irrigation or a measurable rainfall event. As counterintuitive as it may seem, this is the reason that some fields may not show symptoms beneath tire tracks because of the reduced pore space and subsequent reduced O₂ levels found in compacted areas.

Deficiency Symptoms

Manganese is an immobile nutrient in the plant. This means as Mn becomes deficient in the plant, what is present cannot be moved to new or developing tissues. Therefore, the first symptoms will appear on young or newly emerged leaves. The most prominent symptoms appear as interveinal chlorosis, or yellowing of the leaves between the leaf veins (figure 1). The veins will remain noticeably green as shown in figure 1.

Symptoms will often appear scattered as soil conditions will vary throughout the field (figure 2). Soil conditions including soil moisture, compaction, and pH can influence the availability of Mn.

Manganese deficiency symptoms can be difficult to distinguish from iron deficiencies and either deficiency can occur under some of the same environmental conditions. A knowledge of the local soils can help to narrow down the potential

culprit but a tissue sample is often necessary to distinguish between the two.



Figure 1. Soybean manganese deficiency symptoms appear as interveinal chlorosis with prominent green veins. (IPNI, R.J. Gehl, 2010)



Figure 2. Soybean manganese deficiency symptoms can appear scattered as soil conditions affecting Mn availability vary throughout the field. (IPNI, R.J. Gehl, 2010)

Deficiency Corrections

To correct Mn deficiencies during the season growers have few options. Growers should apply 1 lb A⁻¹ of actual Mn at the first appearance of symptoms and can apply an additional 0.5 to 1 lb A⁻¹ if deficiency symptoms reappear. Sources can include either manganese sulfate or a chelated manganese material. Many Mn products may recommend reduced rates, however these are often maintenance rates and a full rate as listed will be needed to correct deficiencies.

Manganese toxicity can occur when over applied or in soils with low pH. If there is any question as to whether the present symptoms are not Mn related, then a tissue sample is warranted.

Takeaways

- Manganese is essential to several functions in the plant, including photosynthesis and conversion of nitrates to plant usable forms.
- Manganese availability is affected by varying soil conditions and is greatly reduced in high pH soils.
- Manganese deficiency symptoms appear as stunted plants with interveinal chlorosis with prominent green veins. Symptoms will appear first on new, young leaves.
- Applications of 1 to 2 lb A⁻¹ of actual Mn are often required to correct deficiencies using either manganese sulfate or a chelated manganese product.

References

- Images:* IPNI, R.J. Gehl. 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.
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