SeedSCOOP

LATE-SEASON SOYBEAN NUTRIENT DEFICIENCY IDENTIFICATION

In many operations, soybean fertility (except for nitrogen (N)), is provided by the residuals from corn fertilization programs. To sustain optimum growth and maximize genetic yield potential, soybean plants require adequate amounts of the essential, secondary, and micronutrients.

Nitrogen, phosphorus (P), and potassium (K) are considered essential nutrients for soybean growth. Each soybean bushel removes an estimated 4.2, 0.4, and 1.25 pounds of N, P, and K, respectively.[1]

Calcium (Ca), magnesium (Mg), and sulfur (S) are classified as secondary nutrients for most crops because of their importance for crop growth; however, the overall crop requirement for these nutrients are lower than that of the essential nutrients. Soybean use of the secondary nutrients is estimated at 0.2, 0.23, and 0.20 lb./bu. for Ca, Mg, and S, respectively.[1]

Micronutrients (boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn)) are nutrients that are needed in relatively small amounts. Of the micronutrients, Fe and Mn are the most important for soybean production.

Regardless of the crop, maintaining soil pH is a critical component for maximizing yield potential. Soil pH for a soybean crop should be maintained between 5.5 and 7.0 with lime to help ensure the availability of fertilizer nutrients. Should soil pH fall below 5.5, the ability to fix N can be reduced.

In general, noticeable fertility deficiencies in soybean are rare. Awareness of nutrient deficiency symptoms can help distinguish symptomology from foliar diseases, herbicide injury, sun scald, and other stresses.

DEFICIENCY SYMPTOMS OF ESSENTIAL NUTRIENTS

Nitrogen-deficient soybean plants appear pale-green to yellow with leaves maintaining dark-green veins (interveinal chlorosis) (Figure 1). Late-season deficiencies may be due to wet, compacted, saline, calcareous, drouthy, and less than 1.5% organic matter soil conditions or from root diseases that affect nodulation. Low soil pH reduces the number of rhizobia bacteria which restricts the amount of N produced. Rhizobia also will be limited if field has not been in a legume in past couple of years. The uptake of N is greatest from the onset of flowering to pod fill. Should a deficiency exist, and irrigation is possible, an application of 20 to 40 lb/acre of N at the R3 growth stage may be a consideration.[2] Plants under drought stress during seed set are unlikely to benefit from a foliar N application as leaves are likely starting to shut down and sending their stored N to developing pods and seeds.[3]

Figure 1. Nitrogen deficient soybean plants on right in contrast to nitrogen sufficient plants on left where previous soybean crop was planted. Picture courtesy of Dr. Stewart Duncan, Kansas State University.

Phosphorus-deficient plants may appear stunted, have small leaves, and may have interveinal reddening on lower leaves (Figure 2). Because P is mobile within the plant, symptoms are generally more severe on lower leaves. Plants may be deficient in P if a leaf tissue analysis of the newest leaves at the R2 growth stage reveal a P concentration of less than 0.25%.[4] Concentrations of 0.25 to 0.30% should be considered as low.[4] There is limited information to support the use of additional P during pod set to offset deficiencies.

Figure 2. Soybean fertility plot with phosphorus applied (left) and none (right). Deficient plants are smaller and have smaller leaflets. Picture is provided courtesy of the International Plant Nutrition Institute (IPNI) and its IPNI Crop Nutrient Deficiency Image Collection, Luiz Antonia Zanao Junior.

Potassium deficiency appears first on the oldest leaves as a yellowing of outer leaf margins (Figure 3). Since K is mobile within the plant, symptoms can appear throughout the plant. A leaf tissue test for K concentration of less than 1.5% at R1 to R2 growth stages is indicative of deficiency, 1.5 to 1.8% should be considered as low, and greater than 1.8% is sufficient to help maximize yield.[4] If K deficiencies are notable before the R5 growth stage, K fertilizer may be applied and watered in with irrigation or rainfall.[4]

Figure 3. Potassium deficiency. Picture courtesy of Dr. Bobby Golden, Mississippi State University.

LATE-SEASON SOYBEAN NUTRIENT DEFICIENCY IDENTIFICATION

DEFICIENCY SYMPTOMS OF SECONDARY NUTRIENTS

Calcium is important for cell wall development, transport of other nutrients, strength within the plant, and potentially counteracts the effect of alkali salts and organic acids in the plant. A balance of Ca, Mg, and K needs to be maintained within the plant or one or two of them may become deficient. The newest soybean leaves appear necrotic if a deficiency occurs (Figure 4).

Magnesium is a much-needed nutrient in soybean as it plays an important role in photosynthesis, starch production, leaf and root growth, carbon fixation, maturation uniformity, and uptake of P.5. Magnesium deficiency is mostly observed on very acid (below pH 5.5) soils which usually have textures of sandy loam, loamy sand, or sand. High levels of K, ammonium (NH_4), or Ca can cause a Mg deficiency. Deficiency symptoms (pale-green leaves with interveinal yellowing) appear first on older leaves (Figure 5).

Sulfur is an essential element for the formation of proteins. When S is deficient, growth is reduced, maturity is delayed, protein formation is reduced, and foliage becomes pale-green to yellow with non-prominent veins (Figure 6). Sustained deficiencies can result in leaves becoming pale-brown to bronze.

DEFICIENCY SYMPTOMS OF MICRONUTRIENTS

Boron is necessary for nodulation as it accelerates atmospheric N fixation. Deficiency appears as yellowed leaves with curled leaf tips, interveinal chlorosis, tip dieback, and stunted roots (Figure 7). Flowering can stop under severe deficiency conditions.

Copper is necessary for plant enzymatic activities, chlorophyll production, and seed development. The element is generally immobile in plants; therefore, deficiency symptoms appear first in younger plant tissues. Most Midwest soils supply adequate amounts of Cu for crop production. However, deficiencies can occur on organic soils, sandy-textured soils, soils with increased amounts of oxides and carbonates, and soils with a pH of 7.5 or greater. A deficiency of Cu can lead to increased susceptibility to diseases. Deficiency symptoms include reduced nodulation and N fixation, delayed flowering and maturation, pollen sterility, necrosis of leaf tips and stems, and yellowing of leaves.

Iron is needed for chlorophyll synthesis (in all crops) and nodule formation in soybean. High levels of Mn can induce Fe deficiencies and vice versa. Iron deficiency is common in soils with pH above 7.0 and soils with high sodium (Na) and Ca content (common in western states). Deficiency symptoms include yellowing between the veins of the newest leaves and reduced nodulation and nitrogen fixation (Figure 8). The symptoms are generally referred to as iron deficiency chlorosis (IDC).

Figure 4. Calcium deficiency. Photo is provided courtesy of the International Plant Nutrition Institute (IPNI) and its IPNI Crop Nutrient Deficiency Image Collection, T.L. Roberts, 2018

Figure 5. Magnesium deficiency. Picture courtesy of Dr. Bobby Golden, Mississippi State University.

Figure 6. Sulfur deficiency comparison, sulfur applied (left) and omission (right). Picture is provided courtesy of the International Plant Nutrition Institute (IPNI) and its IPNI Crop Nutrient Deficiency Image Collection, T. L. Roberts.

Figure 7. Boron deficiency. Picture courtesy of Nathan Slaton, University of Arkansas.

Figure 8. Iron deficiency. Picture courtesy of Dr. Bobby Golden, Mississippi State University.

LATE-SEASON SOYBEAN NUTRIENT DEFICIENCY IDENTIFICATION

Manganese plays a vital role in photosynthesis through chloroplast formation, which is important for chlorophyll development, helps in the development of carbohydrates, and influences enzyme activity. Deficiency symptoms include interveinal yellowing with veins remaining dark. Symptoms resemble Fe deficiency; however, Mn deficiency appears across the whole plant (Figure 9).

Molybdenum is vital for N fixation and nitrate reduction processes. Deficiencies in soybean are very rare. If a deficiency occurs, plants have the same light-green appearance associated with N deficiency because the plants have few or no N producing nodules.[4]

Zinc is necessary for the development of carbohydrates, proteins, and chlorophyll. Soils lacking Zn can reduce plant growth and yield potential. Symptoms are more apparent when soil temperatures are cool and in soils that are fine-textured, sandy, of low organic matter content, eroded, and under fallow syndrome situations. Soils with high phosphate applications may exhibit Zn deficiencies. Deficiency symptoms include interveinal mottling or chlorosis (Figure 10). Symptoms can be confused with IDC.

Figure 9. Manganese deficiency.

Figure 10. Zinc deficiency. Picture courtesy of Dr. Bobby Golden, Mississippi State University.

Sources

1 Soybean nutrition requirements. Integrated Crop Management. Iowa State University. https://crops.extension.iastate.edu/.

2 Wortmann, C.S., Krienke, B.T., Ferguson, R.B., and Maharjan, B. 2018. Fertilizer recommendations for soybean. G859. NebGuide. http://extension.unl.edu/publications.

3 Nafziger, E. 2014. Do soybeans need N fertilizer? The Bulletin. University of Illinois. http://bulletin.ipm.illinois.edu/.

4 Slaton, N., Roberts, T., and Ross, J. 2013. Fertilization and liming practices. Arkansas Soybean Production Handbook. Chapter 5. University of Arkansas.

5 Smith, D. 2016. Magnesium magic. Problems can be avoided, or easily fixed, once you understand this secondary nutrient. Nutrient Navigator. AGWEB. https://www.agweb.com/.

Sources verified 7/1/19.