MICRONUTRIENT FERTILITY FOR SOYBEANS

Micronutrients are essential elements that are used in small quantities [< 1 lb./acre] by plants to conduct critical metabolic processes. If a necessary micronutrient is limited or unavailable, plant abnormalities, reduced growth, and lower yield will result.

Micronutrients used by plants include boron [B], chlorine [Cl], copper [Cu], iron [Fe], manganese [Mn], molybdenum [Mo], and zinc [Zn]. The amount of these micronutrients is usually sufficient in most soils to meet crop needs.

Most micronutrients are weakly mobile or immobile in plants. Thus, deficiency symptoms will usually appear most severely in the newest plant tissues; e.g., the newest trifoliate in soybean.

Soil and plant analysis are both useful for determining levels of micronutrients in soil and plant tissue, respectively. However, soil tests for them are not as precise as those for pH, P, and K.

Plant tissue analysis can reliably determine the level of most micronutrients in the sampled plant part, and the results can aid in diagnosing a visual problem. Regrettably, once a micronutrient deficiency is detected, the plant has already suffered irreversible yield loss. Thus, results from these analyses can only be used to prevent such deficiencies in a future crop.

Deficiency of micronutrients in soybean production systems is an oft-discussed topic. However, this topic does not receive the attention accorded to deficiencies of the macronutrients Nitrogen [N], phosphorus [P], potassium [K], and sulfur [S], probably because there is not a wealth of evidence showing that micronutrient deficiencies are soybean yield limiters in the manner of the macronutrients. In fact, current dogma is that yield increases would not be expected from applying micronutrient fertilizers to the vast majority of soils or plants growing on them. Of course, if a rarely-seen deficiency of a particular micronutrient is documented, then that deficiency must be addressed by the addition of that micronutrient in a form used by plants.

In the May-June 2017 issue of Agronomy Journal [Vol. 109:1048-1059], authors Sutradhar, Kaiser, and Behnken present results from a four-year study conducted on 35 sites in Minnesota to evaluate soybean response to broadcast applications of B, Cl, Mn, and Zn. The objectives of the study were to determine how applications of these micronutrients affected soybean tissue nutrient concentration and grain yield, and the relationships between soil and plant tissue tests.

In the studies, soil samples were collected from the 0 to 6-in. depth and analyzed appropriately for P, K, B, Cl, Mn, and Zn. The newest fully developed soybean trifoliate leaf with petiole was sampled for tissue nutrient analysis when soybean was at the R1 growth stage. Concentrations of B, Cl, Mn, and Zn in the tissue samples were determined with appropriate analysis procedures.

Findings from this research follow.

- Plant tissue nutrient concentrations indicated that micronutrient levels in soils at the study sites were sufficient for maintaining soybean yield.
- Concentrations of micronutrients in sampled leaf tissue were all well above defined sufficiency levels, thus indicating that the soil reservoir of each micronutrient was sufficient without additional fertilization.
- Tissue micronutrient concentrations of B, Mn, and Zn were seldom increased by micronutrient fertilization compared to a non-fertilized control.
- There was no significant effect of micronutrient fertilization on soybean seed yield compared to non-fertilized controls.
- The results indicate that a yield response to direct application of micronutrients is unlikely for soybeans.

- Increasing soybean seed yield resulted in greater removal of the tested micronutrients from soil. Thus, a continuing period of above-average yields will result in the removal of micronutrients at a pace that exceeds the heretofore perceived normal rate.
- Trifoliate B, Mn, and Zn concentrations were not appreciably related to their respective soil test results or to seed yield. Thus, tissue micronutrient concentration should not be used to determine when micronutrient fertilizers should be applied.
- Soil-test B, Cl, and Zn levels were not related to soybean seed yield when each micronutrient was not applied. Thus, soil tests for these minerals will not be a good predictor of deficiency.
- The authors concluded that soybean seed yield may respond to Mn application if soil-test Mn is less than 20 ppm.

Click here for a 2017 article titled "Micronutrients for Soybean Production in the North Central Region" by Mallarino, Kaiser, Ruiz-Diaz, Laboski, Camberato, and Vyn (North Central Soybean Research Program) to access a summary of knowledge about specific micronutrients in soybeans. Key points about each micronutrient from that article follow.

Boron (B). Soil organic matter (OM) is the primary source and it becomes available to plants mainly through microbial activity. It can be leached from coarse-textured soils or soils that are irrigated; drought can decrease B availability because of its negative effect on OM decomposition. Yield increases from B fertilization are documented only in isolated cases; however, excess B can be detrimental to soybean. B fertilization is recommended only in documented cases of B deficiency.

Copper (Cu). Soybean is considered one of the least susceptible crops to Cu deficiency. Thus, documented Cu deficiencies in soybean are rare to non-existent.

Chlorine (Cl). Soybean is considered one of the least susceptible crops to Cl deficiency. Thus, documented Cl deficiencies in soybean are rare to non-existent, as are positive responses to Cl fertilization. Certain potash fertilizers supply large amounts of Cl to soil.

Iron (Fe). Soybeans are one of the most sensitive crops to Fe deficiency. Fe deficiency symptoms are referred to as Iron Deficiency Chlorosis (IDC), which is a condition that is related to Fe in the soil being unavailable to plants rather than Fe deficiency in the soil. Past knowledge of IDC symptoms in a field and measurements of affecting soil properties are typically used to identify fields or areas of fields that are prone to IDC in soybeans. Click here for a complete treatment of IDC.

Manganese (Mn). Mn deficiency symptoms in soybeans may look similar to Fe or Zn deficiencies because the deficiency is usually related to a soil property or properties that render Mn in the soil unavailable to the plant. Broadcast applications of Mn to the soil rapidly become unavailable. Thus, foliar-applied Mn will likely be the most effective method to alleviate a deficiency. Since Mn is immobile in the plant, multiple foliar applications may be necessary. Fertilization with Mn will not be economical if visual deficiency symptoms are not obvious. Click here for a White Paper that provides indepth information about Mn fertility for soybeans.

Molybdenum (Mo). Mo deficiency can show as an N deficiency in soybeans since it is required for N fixation. Mo deficiencies can usually be corrected by liming soils to the proper pH level since its availability decreases in acid soils with a low pH. The most common Mo fertilization practice is to treat seed with an Mo product.

Zinc (Zn). Soybeans have low to moderate susceptibility to Zn deficiency; thus Zn deficiency in the crop is not common. Since Zn is moved to the plant roots primarily via diffusion in soil water, Zn deficiency in soybeans is more likely to occur on sandy soils that dry quickly (i.e., have limited available water most of the time). Because Zn has low mobility in the plant, deficiency symptoms that do occur will show in the upper plant in the newest leaves.

Take Home Message

These results referenced in the above-linked articles may not be totally applicable to Midsouth soils and the Midsouth soybean production environment. However, they do paint a consistent picture of soybean response, or rather lack of response, to micronutrient fertilization when soil levels of these nutrients are determined to be adequate according to accepted soil tests.

Most soils have inherently adequate levels of most micronutrients needed for optimum soybean production. However, with increasing yields from irrigated soybean in the Midsouth, producers likely should become more aware of micronutrient levels in their soils, and be vigilant for micronutrient deficiency symptoms.

- Click here for a White Paper on this website that provides detailed discussion about nutrient management for soybean production.
- Click here for a White Paper on this website that provides a detailed discussion about tissue testing and how it can be used in conjunction with soil test results to determine proper fertilization for high soybean yields.
- Click here for a Pioneer.com article titled "Micronutrients for Crop Production" that provides details about availability of micronutrients by soil pH level, their estimated uptake by high-yielding soybeans, and a narrative description of general micronutrient deficiency symptoms.

Excess Micronutrients

There are circumstances that can result in an excess of a particular micronutrient. This can lead to a toxic condition that may reduce soybean performance. A case in point is chlorine.

Research studies have been conducted to explore the potential soybean yield reduction that might result from excessive Cl in the soil. This condition can occur where large amounts of potassium fertilizer in the form of potassium chloride (KCl) have been applied.to address soil K deficiency.

- Potassium chloride is the cheapest source of fertilizer K. However, high soil Cl concentrations can result when high rates of KCl are applied.
- Research has shown that the amount of KCl applied ahead of a soybean crop should be limited to no more than about 100 lb/acre. However, this can vary from field to field.
- If soil test K is very low, higher rates should be considered since the yield reduction due to insufficient K is greater than yield reductions that might result from higher rates of KCl.
- When chloride toxicity is a concern, consider applying potassium sulfate as the K fertilizer.
- The effect of too much Cl will be worse on poorly drained soils in years with low rainfall since Cl will not move out of the root zone.
- Two important points should be considered when managing this issue. 1) Apply K fertilizer only where it is needed. 2) Apply K fertilizer annually when needed so the rate that is applied will be relatively low each year.

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