

AGRONOMIC Spotlight



Soybean Fertility: Functions, Deficiency, Management

Nutrients are required for water transport and photosynthesis processes, and protein and oil production in the plant. Nutrient deficiencies are one of the causes of leaf discoloration and/or chlorosis that might be observed in a soybean field and can decrease plant growth and reduce yield potential. It is beneficial to understand the function of a nutrient and identify deficiency symptoms to know when to apply corrective steps. Diagnoses from visible symptoms should be confirmed with results from soil tests and plant tissue analysis in some cases.

Soybeans require at least 13 elements derived from the soil and three (carbon, hydrogen, oxygen) are supplied primarily by air and water. Nitrogen, phosphorus, and potassium are the three major soil supplied nutrients that are needed in greater amounts. The secondary nutrients, calcium, magnesium, iron, boron, manganese, zinc, copper, molybdenum, chlorine, and sulfur are needed in small amounts and deficiencies may appear on soybean plants only under certain conditions.

MACRONUTRIENTS

Nitrogen (N) is very mobile within the plant and moves from older leaves to the new leaves. About 50 to 80% of the plant's N need can be met by biological N-fixation. The absorbed N is converted into amino groups, which are the fundamental building blocks of proteins and enzymes.

Deficiency and Management

Deficiency is characterized by a yellowing or chlorosis of the lower leaves, as N is remobilized to the new growth. One of the causes of chlorotic leaves under cooler and wet soil conditions is inefficient N-fixation.

Inoculation is required to supply the nodule-forming bacteria in fields that have not been previously planted to soybean, Nitrate-N fertilizer can have an antagonistic effect on symbiotic N-fixation. Nitrate-N prevents the development of the new nodules and can also interfere with existing N-fixation nodules.

Phosphorus (P) is involved in storing and transferring energy produced by photosynthesis to be used by the plant for growth and development. When P levels are inadequate, soybean plants cannot develop properly or tolerate stresses as they should. The demand for P in soybeans is greatest during pod and seed development as more than 60% of P ends up in the pods and seeds.

Deficiency and Management

Symptoms of P deficiency in soybeans includes stunted plants and dark green coloration with necrotic spots, and cupping of the older leaves. Additionally, P deficiency can delay blooming and maturity. Application of P fertilizer should be based on soil testing.

Potassium (K) is important to maximize soybean yield potential. Peak absorption of K occurs from flowering through early pod development. A shortage of K during this period can result in yield loss without obvious foliar symptoms. Potassium is also important for nodule formation and, therefore, N-fixation.

Deficiency and Management

Plants have green stems and retain their leaves at maturity. Deficiency symptoms occur first on older leaves, although under severe deficiency all but the very young, newly developed leaves may show symptoms. Leaf margins and between the veins show yellowing and brown coloration.

Apply the required K rate based on soil analysis and plant soybean in warmer conditions.

General Nutrient Information

Mobile Nutrients

Nutrients transfer from older tissues to youngest tissues, thus symptoms first appear on lower, oldest leaves.

**Nitrogen, Phosphorus,
Potassium, Magnesium**

Immobile Nutrients

Nutrients are not transferred within plant tissues, thus symptoms first appear on upper, youngest leaves.

**Boron, Calcium, Copper, Iron,
Manganese, Molybdenum,
Sulfur, Zinc**



Potassium deficiency symptoms in soybean.

to pg. 2

from previous page Soybean Fertility: Functions, Deficiency, Management

MICRONUTRIENTS

Boron (B) is involved in carbohydrate translocation within the plant and assists in metabolic regulation. Boron is essential for protein synthesis, seed and cell wall formation, germination of pollen grains, and growth of pollen tubes.

Deficiency and Management

Deficiency symptoms include yellowing of leaves, chlorotic tissue between the veins, downward curling of leaf tips, crinkling of leaves, dieback of tips, delayed flowering, and reduced number and size of pods and seed quality.

Boron fertilizer is added based on soil and tissue analysis. Several methods of application can be used. Boron may be mixed with N-P-K fertilizer, applied separately on the soil, sprayed on the plant, or side-dressed.

Iron (Fe) is necessary for the development of chlorophyll. It is involved in energy transfer, plant respiration, and plant metabolism. Iron is a constituent of certain enzymes and proteins in the plant. In addition, Fe has a role in N-fixation.

Deficiency and Management

The two most common micronutrients deficiency are Fe and Mn. Iron deficiency chlorosis (IDC) occurs on calcareous soils (pH > 7.4). Deficiency symptoms include interveinal chlorosis of young, upper leaves and plant stunting, which are similar to Mn deficiency. IDC deficiency is difficult to correct but can be managed by improving soil drainage in heavier soils, however, variety selection is the best method to manage Fe deficiency. Other management options include the combination of selecting the right variety, improving soil drainage, maintaining high level of P, and Fe foliar application.

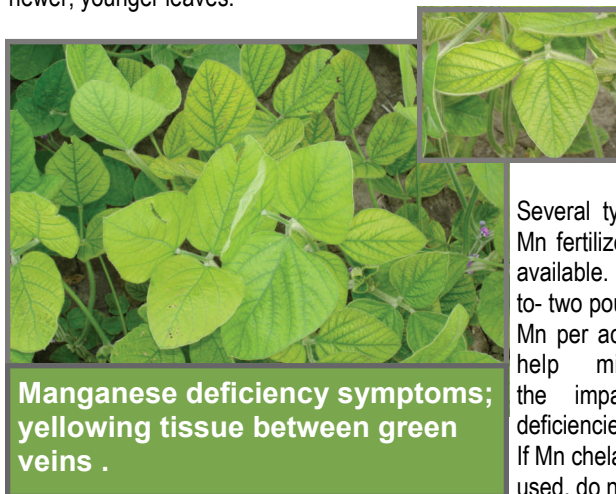


Iron deficiency symptoms in a soybean field.

Manganese (Mn) is important to activate enzyme systems required for the photosynthesis process and is involved in chlorophyll formation.

Deficiency and Management

A field might not show deficiency symptoms but it does not mean that there is no problem. It is highly recommended to conduct soil testing every two to three years to monitor Mn availability. Although, annual soil and tissue analysis is important especially in a field with a history of Mn deficiency. Manganese deficiency symptoms are similar to Fe chlorosis. Symptoms include a yellowing tissue between green veins (Figure 1). When more severe, the yellowing becomes almost white and possibly necrotic. Manganese deficiency symptoms occur on newer, younger leaves.



Several types of Mn fertilizers are available. One - to - two pounds of Mn per acre can help minimize the impact of deficiencies. If Mn chelates is used, do not

exceed the labeled rate as higher rates may cause foliar injury.

Molybdenum (Mo) is essential for the symbiotic N-fixation process. It is involved in the enzyme systems of N-fixation and nitrate reduction.

Deficiency and Management

Deficiency only occurs on very acidic and highly weathered soils. Deficient plants are stunted and yellowish to greenish in color due to the lack of N-fixation. Deficiency may be corrected by liming acidic soils or applying Mo fertilizer.

Sources: Brouder, S. et al. 2003. *Manganese Deficiencies in Indiana Soils*. Purdue Univ. www.agry.purdue.edu. (Viewed 4/4/10).

Corn & Soybean Field Guide. 2007 Edition. *Purdue Pest Management Program*. Purdue Univ., (Viewed 4/4/10).

McKenzie, R. & A. Middleton. 1997. *Phosphorus fertilizer application in crop production*. Agriculture Information Services, Alberta, Canada. <http://www1.agric.gov>, (Viewed 4/1/10).

Diaz, D. 2008. *Nutrient deficiency symptoms*. Agronomy e-Updates, K-State Ext. Common nutrient deficiency symptoms, soybeans. 2007. <http://plantsci.sdstate.edu>

Sawyer, J. 2007. *Integrated Pest Management Nutrient Deficiencies and Application Injuries in Field Crops*. Department of Agronomy <http://extension.agron.iastate.edu>, (Viewed 4/4/10).

Advance agronomic guide 2009-2010, growing knowledge, Monsanto CO.

Pedersen, P. 2007. *Soybean Nutrient Requirements*. Iowa State University Extension. <http://extension.agron.iastate.edu>, (Viewed 4/4/10).

Soybean production handbook. 1997. Kansas State Univ., C-449.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. **ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS.** Technology Development by Monsanto and Design(SM) is a service-mark of Monsanto Technology LLC. ©2010 Monsanto Company. 06072010SMK