Iron Deficiency Chlorosis in Soybean

- Iron deficiency has been a yield-limiting problem in some soybean production areas.
- The availability of a specific micronutrient such as iron is affected by many factors including soil chemical characteristics, field topography, and environmental conditions.
- Careful selection of soybean products with tolerance to IDC is one of the best and most recommended options to protect yield potential against IDC chlorosis in areas where this issue may be a concern.

Iron (Fe) is one of the necessary micronutrients for soybean plant growth and development and is important for:

- The development of chlorophyll, the green pigment in the plant which is critical for photosynthesis. If Fe is deficient, chlorosis (yellowing) occurs and growth and yield potential can be negatively affected.5,6
- Involved in energy transfer, plant respiration, and plant metabolism.
- A constituent of many enzymes and proteins in the plant.
- Necessary for soybean root nodule formation and has a role in nitrogen (N)-fixation; thus low Fe availability in the soil, and as a result lower uptake by the plant, can lead to a reduction in N-fixation.5

**Symptoms**

Soybean iron deficiency chlorosis (IDC) symptoms usually first appear on the youngest of the uppermost leaves.6 The distinctive symptom of Fe deficiency is the development of an interveinal chlorosis, while the veins remain dark green.6 Chlorosis is the result of low chlorophyll formation due to Fe deficiency. If the deficiency is not too severe and environmental conditions improve so that the root system is able to absorb sufficient Fe, plants may recover from IDC symptoms.

Under severe deficiency, leaf edges and even the growing points become necrotic (turn brown). Necrosis may progress and eventually leaves may die and fall off the plant and the growing point can be killed, reducing the amount of plant tissue available for photosynthesis.

Iron deficiency symptoms are similar to that of manganese (Mn) deficiency; therefore, only soil and tissue analysis can confirm the deficiency. Soybean IDC symptoms typically occur between the first and third trifoliate stage.

Reduced plant growth due to IDC can have a negative effect on yield potential. Substantial yield reductions from IDC have been reported throughout the north central United States. Iron deficiency does not affect an entire soybean field at one time, but the areas where IDC is present could show a 20 to 30% yield loss.1

**Factors Associated with IDC Development**

Iron deficiency chlorosis in soybean is the result of complex interactions between several factors including soil chemical characteristics and topography, soybean physiology, and environmental conditions:

**Soil Characteristics and Topography.** Soils usually have adequate amounts of Fe but may not be in the soluble form needed and ready to be absorbed by the soybean plant.

The most soluble form in oxidized or aerated soils is Fe(OH)3 where Fe is in the Fe(III) form.5 However, this form becomes less soluble and thus less available for plant uptake in higher soil pH with high levels of calcium carbonate.

Soil nitrate affects the development of IDC symptoms. When roots take up nitrate, they release bicarbonate. Over time free bicarbonate levels can increase in the soil, which may lead to Fe not being in the available form and therefore the development of IDC symptoms.

Iron deficiency chlorosis is often associated with shallow depressions in a field (Figure 1).
Iron Deficiency Chlorosis in Soybean

As water moves to low-lying areas, it carries solutes that collect over time. As the water evaporates, these solutes concentrate along the edge of the low-lying area. Symptoms of IDC may be more pronounced along these edges.

**Soybean Physiology.** Soybean plants prefer to take up the reduced Fe(II) form. The roots have mechanisms to excrete chemicals that can help reduce the pH slightly to improve Fe uptake. Because of these mechanisms, soybean plants can usually take up an adequate amount of Fe when the soil pH is less than 7.5. However, high levels of calcium carbonate in the soil can neutralize the acid excreted from soybean roots and increases IDC. Research has shown that IDC can be more severe at cool temperatures. In areas where IDC is more common, the amount of water lost to evapotranspiration (ET) tends to be greater than the amount of water that leaches through the soil profile. Thus, solutes do not leach through the soil, but instead collect on the soil surface. A shallow layer of carbonate or salts may be evident in soils where soybean IDC symptoms exist.

**Environmental Conditions.** Weather also plays a role in IDC symptoms. When soils are wet, carbon dioxide can build up in the soil. As the level of carbon dioxide increases, so does the level of bicarbonate, which neutralizes the acid excreted from soybean roots and increases IDC. Research has shown that IDC can be more severe at cool temperatures.

In areas where IDC is more common, the amount of water lost to evapotranspiration (ET) tends to be greater than the amount of water that leaches through the soil profile. Thus, solutes do not leach through the soil, but instead collect on the soil surface. A shallow layer of carbonate or salts may be evident in soils where soybean IDC symptoms exist.

**Management Considerations**

It is difficult to correct IDC, but there are several management options to consider. The most important management consideration is product selection. Other options include the use of Fe chelate products, planting cover crops, and adjusting planting rates.

**Product Selection.** Careful selection of soybean products with tolerance to IDC is the most important step to protect yield potential against IDC. Product selection is particularly important for fields with a history of IDC or soil with high levels of salts and carbonate.

Your local agronomist or seed brand representative can assist you in understanding the IDC scores of the soybean products available for your area and determining the appropriate product(s) for your fields.

**Minimize Plant Stress.** Reduce plant stress due to diseases, nematodes, and herbicides. Product selection can be an important factor in minimizing plant stress, particularly when dealing with disease or nematode issues. Minimize compaction and reduce operations that may damage soybean roots.

**Iron Chelate Products.** Use seed placement of Fe chelate product that is in the ortho-ortho form. University of Minnesota research has found yield benefits of ortho-ortho chelated Fe with seed; however, using other Fe chelate products and application methods have shown inconsistent yield benefits. Maximum return on investment has been found to occur when these products are used in areas moderately to severely affected by IDC. Always consult the product label for rates and application information.

**Additional Considerations.** Other management considerations include minimizing nitrate carryover from year to year and targeting soybean crops to low nitrate soils. Additionally, planting a companion crop, such as oats, can absorb excess nitrate-N and soil moisture, reducing bicarbonate build up to keep soil Fe available to the soybean crop. Adjusting planting rates may also be a management option in some situations. Research has found that higher seeding rates can result in less severe chlorosis and higher yield; however, this observation is limited to soybeans planted in wider rows, which suggests that spacing is the most influential factor.

**Summary**

- When Fe is limited in soybean, photosynthesis can be negatively affected, which can reduce yield potential.
- Iron in the soil should be available in the soluble form for plant uptake.
- Only soil and plant tissue analysis can confirm IDC in soybean.
- Soybean product selection is the most important management tool used to minimize IDC.

**Sources:**


For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology, Development, & Agronomy by Monsanto.

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. All other trademarks are the property of their respective owners. ©2015 Monsanto Company. 130712023035 060115SMK