Soybean Iron Deficiency Chlorosis

Iron deficiency chlorosis, otherwise known as IDC, is a common yield-limiting condition in a soybean crop. It is most common in poorly drained calcareous soils in parts of Minnesota, the Dakotas, Nebraska, and Iowa. Iron deficiency occurs due to various stresses and not simply due to a low iron level in the soil. Selecting soybean products with tolerance to IDC is one of the best options to protect yield potential.

What to Watch For

Iron (Fe) is an essential micronutrient for soybean plant growth and development. If soybean plants cannot absorb enough Fe, yellowing (chlorosis) can develop, which may lead to a reduction in potential yield. Iron is needed for the development of chlorophyll, which is the green pigment in the plant and is critical for photosynthesis. Iron is also involved in energy transfer, plant respiration, plant metabolism, and is a constituent of certain enzymes and proteins in the plant. Additionally, because Fe is necessary for soybean root nodule formation and has a role in nitrogen (N)-fixation, low Fe availability in the soil can lead to a reduction in N-fixation.

Impact on Your Crop

The distinctive symptom of Fe deficiency is the development of interveinal chlorosis on the leaves while the leaf veins remain dark green (Figure 1). Symptoms typically appear on the youngest upper leaves between the first and third trifoliate growth stages. The 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.

If Fe deficiency is severe, leaf edges and the growing point may become necrotic (tissue death). 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.

Substantial yield reductions from IDC have been reported throughout the north central United States. However, Fe deficiency generally does not affect an entire soybean field in a season, but the areas where IDC is present may result in a 20 to 30% potential yield loss (Figure 2).

Interactions between the following factors can contribute to increased incidence of IDC.

Soil Characteristics and Topography. Soils usually have adequate amounts of Fe, but it may not be in the required soluble form 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. However, in high pH soils which have high levels of calcium carbonate, this form is less soluble, and thus less available for plant uptake.

Also, the presence of soil nitrates can indirectly contribute to the development of IDC symptoms. Even though soybean plants...
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have the ability to fix N through root nodules, they will take up nitrate directly from the soil when it is available. When roots take up nitrate, they release bicarbonate. Over time, free bicarbonate levels can increase in the soil, which increases the soil pH surrounding the roots and may lead to the development of IDC symptoms.

Iron deficiency chlorosis is often associated with shallow depressions in a field (Figure 2). 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 soil pH slightly to improve Fe uptake. Due to these mechanisms, soybean plants can usually take up adequate amounts of Fe when soil pH is less than 7.5. However, high levels of calcium carbonate in the soil can neutralize the excreted chemicals and may decrease the plant’s ability to take up adequate Fe.

**Environmental Conditions.** Weather can affect the potential for the occurrence of 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 the potential for IDC. Also, research has shown that IDC is 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.

**Tips to Manage**

It is difficult to correct IDC, but there are several management options to consider.

**Soybean Product Selection.** The most important practice to protect yield potential against IDC in subsequent years, is selecting of soybean products with tolerance to IDC. Product selection is particularly important for fields with a history of IDC or soils with high levels of salts and calcium carbonate. Your Channel® Seedsman or agronomist can assist you in understanding the IDC ratings 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. An important factor contributing to potentially reducing plant stress is product selection, especially in fields with a history of disease or nematode issues. Minimizing compaction and reducing operations that may damage soybean roots potentially can lessen plant stress.

**Fe Chelate Products.** Consider using a seed placement method 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 has 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, targeting soybean crops to low nitrate soils, and planting a companion crop, such as oats. The companion crop may absorb excess nitrate-N and soil moisture to reduce bicarbonate build-up, possibly keeping soil Fe available for the soybean crop.

In some situations, adjusting planting rates may also be a management option. Research has found that a higher seeding rate may result in less severe chlorosis and higher yield potential; however, this observation is limited to soybeans planted in wider rows, which suggests that row spacing is the most influential factor.

**Sources**