1. Iron chlorosis of soybeans

Soybean is one of the most susceptible field crops to iron chlorosis, and this problem is not uncommon in Kansas. Iron is a catalyst in the production of chlorophyll, so a deficiency of iron (Fe) displays as a yellowish or pale color in the leaves. Iron is an immobile nutrient in the plant so symptoms first appear on the youngest leaves.

Iron chlorosis symptoms first show up on the youngest leaves.

Iron chlorosis is usually caused by a combination of stresses rather than a simple deficiency of available soil iron. Some of the soil chemical factors that play a role in iron chlorosis include high pH, high carbonate levels, high salinity (EC), low available iron (DTPA-Fe), and high soil nitrate levels. Other factors that play a role include variety susceptibility and the presence of soybean cyst nematodes.
and root rotting fungi. So iron chlorosis is a complex problem, and not one that can be determined solely on the basis of a soil Fe test.

**The role of soil nitrate levels in iron chlorosis**

One of the factors that can be involved in the development of iron chlorosis in soybeans is the high levels of soil nitrate. Iron is taken up in the ferric form (Fe$^{+3}$), then is immediately converted within the plant into the ferrous form (Fe$^{+2}$) (existing in the chlorophyll). High concentrations of nitrate-N seem to inhibit this conversion of Fe$^{+3}$ to Fe$^{+2}$ in the plant, creating Fe deficiencies. It is important to keep in mind that high soil nitrate levels alone will not cause iron chlorosis in soybeans, but is simply one additional factor that will magnify the problem.

Wheel tracks are noticeable with greener plants in this field of soybeans with iron chlorosis. Soil nitrate levels in these wheel tracks are much lower than the rest of the field due to some compaction and the consequent N loss by denitrification. Usually where soil nitrate levels are lower, plants are not as green. But in this case of iron chlorosis, it’s actually the reverse situation. That’s because higher nitrate levels make iron chlorosis symptoms worse.

**Fertilization strategies for iron chlorosis**

In 2009, we conducted tests at four locations in Kansas with seed coating treatments and foliar iron treatments to correct iron deficiency symptoms. We used two varieties, one with good iron chlorosis tolerance and one that was susceptible to iron chlorosis and locations were under irrigated conditions.

The seed coating treatment was approximately 0.3 lb/acre of actual Fe (chelated EDDHA Fe -6%). The foliar treatments were 0.1 lb/acre EDDHA Fe (6%) and 0.1 lb/acre HEDTA Fe (4.5%). There was an untreated check included. Soil pH at these locations varied from 7.9 to 8.4.
Soybean response to seed coating with chelated iron fertilizer. Photos by Dorivar Ruiz Diaz, K-State Research and Extension.

Greenness. The seed coating treatment had a significant effect in improving the greenness of the foliage, as shown by the chlorophyll meter reading. Overall, the greening response to the seed coating was greater than response to foliar iron applications. The variety most susceptible to iron chlorosis greened up in response to the seed coating much more than the variety more tolerant to iron chlorosis, even though there is also increase in greenness with the tolerant variety. This indicates that the tolerant variety stayed greener during the growing season but still showed additional benefit from the seed coating treatment. The seed treatment also increased plant height by an average of about 5 inches for both varieties (data not shown).
Chlorophyll meter reading after foliar Fe application. Higher values are correlated with greener plant leaves. Under these conditions favorable to iron chlorosis, an iron chelate seed coating improved greenness readings. 

**Yield.** Both the tolerant and susceptible variety also had a good yield response to the iron chelate seed coating, and no significant yield response to the foliar iron chelate treatments. Yield increase due to the seed coating treatment in the susceptible variety was approximately 10 bu/acre, while yield increase in the tolerant variety was approximately 20 bu/acre. Previous studies suggested that tolerant varieties tend to utilize Fe fertilizer sources more efficiently, which would explain these results in plant response observed in our study.

Average yield for the “tolerant” variety without seed coating treatment was 44 bu/acre, and with seed coating treatment was 63 bu/acre. Average yield for the “susceptible” variety without seed coating treatment was 47 bu/acre, and with seed coating treatment was 58 bu/acre.

**Summary**

* Fe deficiency potential can not be explained well by any single soil parameter.
* Development of a “soil index” may be the best alternative. A soil index would combine two or more soil parameters that in combination can explain more of the potential plant response.
* Foliar Fe treatments to soybeans with iron chlorosis seem to increase the “greenness” effectively but preliminary results suggest that yield increase may be inconsistent.
* An iron chelate seed coating provides significant yield increases to soybeans under conditions favorable to iron chlorosis. Another alternative to seed coating may be in-furrow application of chelated Fe fertilizer. Seed contact with the fertilizer source seems to be particularly important for reducing iron chlorosis symptoms.
* If iron chlorosis has been a common problem in the past, producers should select a soybean variety that is tolerant to Fe chlorosis. It may also pay to also use a chelated iron foliar treatment, in-furrow application of Fe chelate, or an iron chelate seed coating.
* Producers should avoid excessive application of nitrogen fertilizer to the crop that precedes soybeans in the rotation. In fields with some risk of iron chlorosis, the high levels of soil nitrate may be a complicating factor.

This study, which will continue in 2010, is funded by the Kansas Soybean Commission.

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2. Soybean planting dates

In recent years, there has been renewed interest in early soybean planting dates. Much of that interest is based on relatively recent work done in Nebraska, Iowa, and Indiana. In Kansas, planting dates and variety maturity combinations are often chosen to avoid having soybeans flower or fill seed during the most stressful times of year. Does early planting achieve this under Kansas conditions? First, we should review the research results.

**Recent research in other states**

In the Nebraska research, yields of irrigated soybean decreased somewhat when planting was delayed past May 1. This research was done at one location, for two years. The early planted beans had more pod-bearing nodes. It should be noted that with irrigated soybeans, the potential for adverse environmental conditions during bloom and grain fill is greatly reduced. In these trials, a fungicide and insecticide seed treatment was used to minimize the effects of planting early into cool, wet soils.

In Iowa, the research was done under dryland conditions – but dryland in Iowa is not quite the same as dryland in Kansas, except possibly northeast Kansas. The research done in Iowa, consisting of 24 tests in all so far, found that yields were higher 79% of the time when soybeans were planted in late-April or early May than when planted about May 20. The greatest response to early planting was in high-yield environments.

In Indiana, research at one location in 2006 and 2007 also found that soybean yields were higher when planted in late April or early May than at later dates. Earlier planting was associated with more pods per unit area.
Kansas research

The last major round of research studies in Kansas looking at planting dates was in the early 2000’s, which was a period of generally very low yields. The basic conclusions varied by region of the state:

North Central/Northeast: Producers might consider planting a bit earlier than normal in high-yield environments. At Topeka, with yields up to 55 bu/acre, yields increased with planting dates in late April compared to May for Group III and IV varieties. In Belleville, with yields up to 50 bu/acre, yields were generally unaffected by planting dates up to mid-May, but had a fairly sizable yield drop when planting in June. In Powhattan, with yields less than 30 bu/acre, there was no advantage to planting any earlier than early May.

* East Central: There is no evidence to support earlier planting.

* Southeast: There were no tests conducted in southeast Kansas during this round of studies.

* South Central: It is probably a good idea to plant as early as possible. At Hutchinson and Wellington, yields were low but generally maximized by planting in late April.

* Western Kansas: Yields were very poor during the years of these studies. Planting dates had no effect on yields.

Conclusions and recommendations

* In northeast Kansas, on deep bottom soils in southeast Kansas, and for irrigated beans statewide, planting dates should be as early as practical. Late-April planting would be advisable if soil conditions allow. When planting early, seed should be treated with a fungicide and insecticide. Varieties with resistance to soybean cyst nematode and sudden death syndrome should be used if possible. Do not plant into soils that are too wet, however. Also, do not plant until soil temperatures are at least 50 degrees. If planted into soils cooler than that, seedlings may eventually emerge but will have poor vigor.

* In drier areas of Kansas and on shallow soils, yields have been most consistent when planting soybeans in late May to early June. By planting in that timeframe, soybeans will bloom and fill seed in August and early September, when nights are cooler and the worst of heat and drought stress is usually over.

* Ultimately, weather patterns dictate soybean yields, especially under dryland conditions. There is no guarantee that any certain planting date will always work out the best when it comes to soybean yields in Kansas.

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3. Plant analysis for wheat

Many farmers are asking questions about secondary and micronutrient nutritional status of their wheat crop. Unfortunately, soil testing is not as accurate for many nutrients as we would like. Nutrients such as iron, or manganese for example are always present in large quantities in the soil, but they are not
always available. Factors such as soil pH, organic matter content, and soil oxygen content have huge effects on their availability. Other mobile nutrients such as nitrogen, sulfur, and chloride tend to accumulate in the subsoil, and require the use of a 24-inch profile sample to best estimate availability.

Plant analysis is an excellent alternative. Plant analysis is also an excellent “quality control” tool for wheat growers interested in high yield wheat management to use to look for “hidden hunger” issues. This spring we have already used plant analysis to help diagnose problems with sulfur deficiency on sandy soils in south central Kansas.

There are two primary ways plant analysis can be used: as a routine monitoring tool to ensure nutrient levels are adequate, and as a diagnostic tool to help explain some of the variability in wheat growth we see in fields this time of year. Keep in mind however that any plant stress (drought, heat, frost, etc.) can have a serious impact on nutrient uptake and plant tissue nutrient concentrations. Sampling under stress conditions for monitoring purposes can give misleading results, and is not advisable.

We have good calibrations to use for monitoring purposes: at the late tillering to joint stage, and at boot and early heading stages. At late tillering to joint, collect whole plant samples by cutting off 20-30 plants at the ground level from various locations around the field. At boot to early heading collect 40-50 flag leaves at random from the field. In both cases the plant material should be allowed to wilt over night to remove excess moisture, placed in a paper bag or mailing envelope, and shipped to a lab for analysis. Do not place the leaves in a plastic bag or other tightly sealed container, as they will begin to rot and decompose during transport, and the sample won’t be usable.

Once the samples arrive in the lab they will be oven dried for 12-36 hours, ground, digested so all the nutrients are brought into solution, and then analyzed. Generally the results will be sent out within 4-7 working days after the sample arrives in our lab, depending on the complexity of the analysis requested.

The data returned from the lab will be reported as the concentration of nutrient elements, or potentially toxic elements, in the plants. Most labs/agronomists compare plant nutrient concentrations to published sufficiency ranges. A sufficiency range is simply the range of concentrations normally found in healthy, productive plants during surveys. It can be thought of as the range of values optimum for plant growth. The medical profession uses a similar range of normal values to evaluate blood work.

The sufficiency ranges change with plant age (generally being higher in young plants), vary between plant parts, and can differ between varieties or hybrids. So a value slightly below the sufficiency range does not always mean the plant is deficient in that nutrient, but it is just an indication that the nutrient is relatively low. However, if that nutrient is significantly below the sufficiency range, then one should ask some serious questions about the availability and supply of that nutrient.

Levels above sufficiency can also indicate problems. High values might indicate over fertilization and luxury consumption. Plants will also sometimes try to compensate for a shortage of one nutrient by loading up on another. This occurs at times with nutrients such as iron, zinc, and manganese. In some situations very high levels of a required nutrient can lead to toxicity. Manganese is an example of an essential nutrient which can be toxic when present in excess.

Plant analysis is also an excellent diagnostic tool to help understand some of the variation seen in the field. When using plant analysis to diagnose field problems, producers should take comparison samples from both good/normal areas of the field, and problem spots. Collect soil samples from the same good and bad areas. Don’t wait for boot to take diagnostic samples. Early in the season (prior to
stem elongation) collect whole plants from 20-30 different places in your sampling area. Later in the season take the uppermost, fully developed leaves (those with leaf collars visible). Handle the samples the same as those for monitoring.

The following table gives broad sufficiency ranges for wheat early in the season, prior to jointing, and later in the season at boot to early heading. Keep in mind that these are the ranges normally found in healthy, productive wheat.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Whole plant at tillering-jointing</th>
<th>Flag leaf at boot to heading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>%</td>
<td>3.5-4.5</td>
<td>3.5-4.5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>%</td>
<td>0.3-0.5</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>Potassium</td>
<td>%</td>
<td>2.5-4.0</td>
<td>2.0-3.0</td>
</tr>
<tr>
<td>Calcium</td>
<td>%</td>
<td>0.2-0.5</td>
<td>0.3-0.5</td>
</tr>
<tr>
<td>Magnesium</td>
<td>%</td>
<td>0.15-0.5</td>
<td>0.2-0.6</td>
</tr>
<tr>
<td>Sulfur</td>
<td>%</td>
<td>0.19-0.55</td>
<td>0.15-0.55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Nutrient</th>
<th>Unit</th>
<th>Tillering-jointing</th>
<th>Boot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>ppm</td>
<td>30-200</td>
<td>30-200</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>ppm</td>
<td>20-150</td>
<td>20-150</td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>ppm</td>
<td>15-70</td>
<td>15-70</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>ppm</td>
<td>5-25</td>
<td>5-25</td>
<td></td>
</tr>
<tr>
<td>Boron</td>
<td>ppm</td>
<td>1.5-4.0</td>
<td>1.5-4.0</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>ppm</td>
<td>&lt;200</td>
<td>&lt;200</td>
<td></td>
</tr>
</tbody>
</table>

Plant analysis is an excellent tool to monitor the effectiveness of your fertilizer and lime program, and a very effective diagnostic tool. Producers should consider adding this to their toolbox.

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4. Winter Canola Field Days Planned April 23 and 28

For producers and others interested in learning about growing canola in Kansas and about K-State’s canola variety performance trials, K-State Research and Extension will host two Winter Canola Field Days, April 23 and April 28.

Sixteen varieties and hybrids were planted by K-State last fall and should be in full bloom for the tours. Vic Martin, alternative crops and forages specialist, and Mike Stamm, canola breeder for K-State and Oklahoma State University, will be presenters. Topics include winter canola production practices, managing winter canola in Kansas and currently available varieties and hybrids for Kansas. Presentations will last about an hour with time to tour the variety trial and for questions.

* April 23, 2010 - 10 a.m. - McPherson County near Marquette. Coming from east or south, the site is
located one mile west of the Marquette exit on Highway 4. Turn north at the intersection of Highway 4 and Fourth Avenue. Proceed one mile north to Wells Fargo Road then turn west onto Wells Fargo Road. Travel approximately ¾ mile and turn north into the second farmstead. Further information is available by contacting Dale Ladd, McPherson County Extension agent at 620-241-1523.

* April 28, 2010 - 7:30 a.m. - Sedgwick County at Clearwater. The plots are located on the north edge of Clearwater at the Farmer’s Co-op Elevator and located on the southeast corner of West 95th Street South and South 135th Street West. Further information is available by contacting Gary Cramer, Sedgwick County Extension agent at 316-722-1432.

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5. Comparative Vegetation Condition Report: March 30-April 12

K-State’s Ecology and Agriculture Spatial Analysis Laboratory (EASAL) produces weekly Vegetation Condition Report maps. Detailed information on how the maps are produced is in e-Update No. 239, April 9, 2010, available at: http://www.agronomy.ksu.edu/extension/DesktopDefault.aspx?tabid=58

The most recent VCR maps from EASAL are below:

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Figure 1. The Vegetation Condition Report for March 30-April 12, from K-State’s Ecology and Agriculture Spatial Analysis Laboratory, shows that early April vegetation growth is ahead of the 21-year average across much of Kansas. The exception is in south central Kansas, particularly in Sumner, Cowley, and southern Sedgwick counties. These counties also show as abnormally dry in the U.S. Drought Monitor. The grassland areas appear to be greening at a normal to ahead-of-normal pace throughout much of the state. Earlier-than-normal green-up in Kansas is often associated with better-than-normal winter wheat yields (based on 15 years of observations by Dr. Kevin Price in producing these maps), although there are many factors that can confound this outcome, such as late heavy frost and drought.

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Figure 2. The U.S. Corn Belt comparison to the 21-year average shows greater-than-normal vegetation production in all but small areas of south central Kansas, the Nebraska Sand Hills, and western South Dakota. Mild temperatures and favorable moisture have favored rapid plant development.

Figure 3. This map shows that the vegetation for much of the U.S. is greener than normal, which might be interpreted as greater amounts of photosynthetically active vegetation than normal. The exceptions are parts of the northwestern U.S. where the brown patterns (except the splice line in California) are typical of snow. In the general area of Nebraska and Iowa, the greenness levels are mostly normal.
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These e-Updates are a regular weekly item from K-State Extension Agronomy and Steve Watson, Agronomy e-Update Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Steve Watson, 785-532-7105 swatson@ksu.edu, or Jim Shroyer, Research and Extension Crop Production Specialist and State Extension Agronomy Leader 785-532-0397 jshroyer@ksu.edu