1. Leaf rust poses a serious threat again in 2008

The risk of significant yield losses from leaf rust and other foliar diseases have increased dramatically this past week. Leaf rust was discovered in commercial fields and variety demonstration plots in Sumner County on April 24th. The leaf rust was present on the F-1 and F-2 leaves (the two leaves just below the flag leaf), with an incidence of less than 10 percent and severity less than 2 percent, in both Jagger and Jagalene.

Leaf rust has also been observed on Jagalene and Jagger in commercial fields and variety evaluations in northern Oklahoma. The disease was slightly more advanced in Oklahoma. Leaf rust was observed at trace levels on Overley near Stillwater, but the disease has not yet been detected on Overley in Kansas. Do not be fooled by this slight delay in the arrival leaf rust races that can overcome the type of resistance in Overley. Overley is very susceptible to certain races of leaf rust, and this variety will likely become diseased soon. Resistance in Fuller, Santa Fe, and Postrock appears to be holding.

Powdery mildew has also increased significantly during this past week. Jagalene, Overley, Jagger, and Postrock are all susceptible to powdery mildew. The severity of powdery mildew was greater than 25 percent on the F-1 leaves in commercial fields of Jagalene and Overley in Sumner County. These levels of mildew can also result in significant yield losses.

The growth stages of wheat in the southern tier of counties ranges from jointing to early stages of heading, depending on the planting date last fall. The current presence of even low levels of leaf rust and severe powdery mildew suggests that potential for yield loss is significant. Yield losses of greater than 35 percent can be expected if the leaf rust and powdery mildew move onto the flag leaves of susceptible varieties prior to flowering. Varieties that are resistant to leaf rust will
not have this much yield loss from leaf rust, but may still be vulnerable to powdery mildew or other diseases.

Wheat fields in southcentral and southeast Kansas should be checked for symptoms of disease and to verify growth stage as soon as possible. Wheat in the central and northcentral districts of Kansas will be at critical growth stages within two weeks. The most effective timing for fungicide applications is between flag leaf emergence and heading. It is important not to apply the fungicide too early. Producers should wait until the wheat has reached the optimal window for application.

The yield response for foliar fungicides in Kansas will typically fall between 4 and 13 percent with the yield average response of 10 percent. Yield responses can be greater than 20 percent in fields were leaf rust arrives prior to flowering. The cost of a fungicide and application ranges between $20 and $27 per acre. The price of wheat is still very strong (above $8). Fields of Jagalene, Overley, and Jagger with a yield potential of greater than 30 bu/acre are excellent candidates for a fungicide application. I strongly recommend that seed production fields be sprayed.

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2. Importance of soybean inoculation: Field photos

It is sometimes easy to become complacent about the practice of soybean inoculation, but inoculation failures can and do occur. This article presents two examples of the effects of poor nodulation from central Kansas in 2007.

The photo below (Figure 1) was taken in a field of first-time soybeans in northwest Barton County in August of 2007. The plants were wilting from the heat and lack of moisture, but the color difference is obvious. The beans appeared normal early in the season, but the producer noticed light and dark strips developing as the season progressed. By August, the alternating light (left) and dark (right) green strips were very distinct and were consistent across the field. Further examination revealed that the strips corresponded to roughly half the drill width.
Figure 1. The light green strips (at left) are areas of poor nodulation. The dark green strips (at right) had good nodulation.

Plants dug from the light areas show essentially no nodulation (Figure 2). Plants from the dark areas were well nodulated (Figure 3).

Figure 2. Poor nodulation.
The producer had inoculated all the beans as he was filling the drill box at planting. It appears that one batch of inoculant must have had some problems, resulting in beans in half the width of the drill that were inoculated effectively and beans in the other half of the drill width having little or no nodulation. In this field that had not had soybeans previously, there was no resident population of *Bradyrhizobium japonicum* bacteria to fall back on. A planting time application of 10-15 pounds of nitrogen per acre, plus some additional nitrogen from mineralization, was enough to get the beans started well and to even produce some soybeans. However, the lack of nodulation and nitrogen fixation on part of the field eventually caused chlorosis, reduced plant growth, and reduced yield by about 10 bushels per acre according to the producer’s yield monitor averages.

Another case of poor nodulation can be seen in the photo below (Figure 4). The following photos were taken in a no-till soybean field in Saline County in August of 2007. The field had been in sorghum in 2006. All the plants were suffering from the heat and needed some moisture, but there is an obvious break at the terrace. The beans were planted across the terraces, so the differential is not related to different passes of the drill. The same holds for glyphosate application, so the coloring was not due to glyphosate flashing.

The producer used a peat-based inoculant on all of his seed. Above the terrace (left), soybeans were planted for the first time in 2007. In this area the plants generally were lighter green and were about 14 inches tall. The area below the terrace (right) had been in soybeans within the last 5 years. Plants in this area were darker green and were 24 inches tall.
Figure 4. It is important to get adequate amounts of inoculant on the seed. In this case, not enough inoculant was applied, and nodulation was poor in the portion of the field (at left) that had no prior history of soybean production.

Plants from the area that had never had soybeans were poorly nodulated, or not nodulated at all (Figure 5). Although the seed was inoculated, it appears that there were not enough bacteria per plant for adequate nodulation. Plants from the part of the field that had been planted to soybeans in the past were well nodulated (Figure 6). Resident bacteria that had become established after previous soybean crops resulted in adequate nodulation. This was a tough upland soil. The shape and formation of the roots from both areas implies that there may have been a compaction problem as well.

Figure 5. Poor nodulation.
Yield monitor results from this field indicated that the well-nodulated area yielded about 28 to 30 bushels per acre and the poorly-nodulated area yielded about 16 to 20 bushels per acre. The poorly-nodulated beans were so short that it was often difficult or impossible to harvest the pods at the lowest node, which also influenced yield estimates.

These two situations from 2007 illustrate the importance of proper inoculation, especially for ground that has not had soybeans before. Even if it has been only two or three years since the last soybean crop on a given field, it is often a good idea to inoculate.

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3. Principles of successful soybean inoculation

When planting soybeans in Kansas, it is usually a good insurance policy to inoculate the seed. Soybeans are big users of nitrogen (N), removing about 3-4 lbs of N per bushel of seed. Soybeans that are poorly nodulated will have to take up most of the N they need from the soil. Since N fertilizer is generally not applied for soybeans, a crop that is poorly nodulated will quickly use up the available soil N in the soil and become chlorotic from N deficiency.

Soybean inoculant contains *Bradyrhizobium japonicum* bacteria. The *Bradyrhizobium* bacteria forms nodules on soybean roots, and these nodules fix nitrogen from the atmosphere and supply
it to the plants. Neither soybeans nor *Bradyrhizobium japonicum* are native to the United States, so there will be no *Bradyrhizobium japonicum* in the soil unless it was introduced at some time in the past on inoculated soybean seed.

The nodules can produce from 40-80 percent of the soybean plant’s N needs for the year. If soybeans have been grown on the field in previous years, there may be enough *Bradyrhizobium* bacteria in the soil to nodulate the soybeans adequately, in which case an inoculant will not benefit the crop. But if there is not enough *Bradyrhizobium* in the soil, the inoculant may increase yields by 2 bushels per acre or more on fields that have had soybeans in the recent past. On fields where soybeans have never been grown, the inoculant can increase yields by 10 bushels per acre or more.

Soybeans should be inoculated in the following circumstances:

* Where the field has not been planted to soybeans for the past four years or more. *Bradyrhizobium japonicum* do not compete especially well with other soil microbes over time, and their numbers often gradually decline unless a host plant (soybeans) is grown every few years or new populations of the bacteria are introduced regularly from inoculated seed.

* Where the soil pH is less than 5.5 or greater than 8.5. *Bradyrhizobium japonicum* does not survive well in the soil under these pH extremes, and good soybean nodulation is unlikely unless the seed is inoculated.

* Where soil erosion has occurred since the last time soybeans were grown. If some of the topsoil has been lost, the remaining topsoil will need to be replenished with *Bradyrhizobium japonicum* from the seed inoculant.

* Where soil organic matter levels are less than 1 percent. Soils with low organic matter levels have less *Bradyrhizobium japonicum* and need to be replenished with new sources from the seed inoculant.

* Where there has been severe drought or flooding. Severe drought and flooding both reduce *Bradyrhizobium japonicum* populations in the soil.

There are several types of soybean inoculant on the market. Each one has certain advantages and disadvantages.
<table>
<thead>
<tr>
<th>Carrier System</th>
<th>Type of Inoculant</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen concentrate</td>
<td>No or low background contamination. High concentration of <em>rhizobia</em>. Excellent seed coverage. Can store for a long time.</td>
<td>Higher shipping costs. Special storage required. More handling by producer required (thawing, diluting, etc.)</td>
<td></td>
</tr>
<tr>
<td>Water. The newest advance in inoculants. Can be applied directly to the seed, in-furrow, or dealer-applied. Easy to use and effective.</td>
<td>Liquid ready-to-use</td>
<td>No background contamination. Excellent seed coverage. High level of <em>rhizobia</em>.</td>
<td>More volume to ship and store.</td>
</tr>
<tr>
<td>Peat. When applied in the seed furrow, granular inoculants apply higher populations of <em>rhizobia</em> than seed-applied inoculants, and are recommended on soils with no history of soybeans. Peat-based powders are the oldest form of inoculant. New sterile powder types increase <em>rhizobia</em> concentrations and extend product shelf life. High-stick formulations improve seed adhesion.</td>
<td>Granular in-furrow</td>
<td>No seed treatment required.</td>
<td>Requires more inoculant material.</td>
</tr>
<tr>
<td>Sterilized carrier</td>
<td>High level of <em>rhizobia</em>. No background contamination. High adhesion level.</td>
<td>More expensive than traditional seed applied material</td>
<td></td>
</tr>
<tr>
<td>“High stick” types</td>
<td>High adhesion to seed. Good bacterial survival.</td>
<td>Higher level of background contamination. Can affect seed flow in some planters.</td>
<td></td>
</tr>
<tr>
<td>Traditional seed-applied types</td>
<td>Good bacterial survival.</td>
<td>Higher level of background contamination. Moderate adhesion to seed without use of a separate sticker.</td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>Clay-based inoculant</td>
<td>Good adhesion to seed. Low level of background contamination.</td>
<td>Moderate bacterial survival for some rhizobial species.</td>
</tr>
</tbody>
</table>

Producers should be aware that inorganic soil N will reduce nodulation and N fixation by *Bradyrhizobium japonicum* bacteria. Where soil N levels are 40-60 lbs per acre or more, soybean plants may look fine, yet have reduced nodulation. At very high N levels, such as where the field was fertilized for corn but the producer decided to plant soybeans instead, there may be little or
no nodulation. In most cases, up to 20 lbs N per acre can be applied as a starter fertilizer to help get the soybeans started without having any detrimental effect on nodulation during the growing season (unless the upper layer of soil is already rich in inorganic N at planting time). However, it is not likely that this early season "greening" will result in increased yield.

If soybean plants are chlorotic and N deficient despite being inoculated, that probably indicates the inoculant has failed. There may be several causes of poor nodulation and inoculation failure that can reduce yields:

* Poor quality inoculant. The quality of commercial inoculant varies. It’s best to use a well-known brand, and one that producers have used before.

* Poor storage and handling. If the inoculant was subjected to heat or drying in storage, it may have lost some effectiveness. If a frozen inoculant was thawed too long before application (see product label), it may lose bacterial numbers.

* Fungicide seed treatments harmed the inoculant. Insecticide seed treatments tend to be the most toxic of all seed treatments to inoculants. Fungicide seed treatments can also cause problems, primarily due to the formulation or carriers used, which may inhibit bacterial growth and colonization. Using fungicides in combination with inoculants can be successful if some precautions are taken. Producers should treat the seed first and allow the seed treatment material to dry before applying the inoculant. Producers should also plant the seed as soon as possible after the inoculant is applied in order to minimize the time the inoculants are in contact with the seed treatment fungicides. Some seed treatment fungicides have specific label directions with regard to using them in conjunction with an inoculant. Users should always refer to the label and follow the directions for that product.

* Poor seed coverage with inoculant. Liquid inoculants, or “high-stick” powder inoculants, have the best adhesion to seed. Proper application methods are critical.

If the inoculation has failed, producers may need to apply N to their soybean crop. Producers may need to apply as much as 80-100 lbs N/acre in that case.

Soybean inoculation is basically “cheap insurance” against an N deficiency. Even if soybeans have been planted in the field recently, it doesn’t cost much to inoculate the seed.

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4. *Corn Watch*: Software for predicting corn development

As we move into the planting season most planting decisions (hybrid selection, planting date, irrigation, plant population, fertility, etc.) have probably already been made. However, we were reminded last year that the best plans may be changed dramatically by a late freeze or heavy rains and flooding. Already this year, planting has been delayed significantly in some areas.

How much will delayed planting delay corn silking and harvest? If a fuller-season hybrid than normal is being planted, how much later will it silk or mature? Will a full-season hybrid planted a month later than normal mature before a season-ending frost at my location? Should planting date or hybrid maturity be changed if less irrigation water is available than in the past?

*Corn Watch* is a computer-based program designed to answer these kinds of questions. The program uses the normal accumulation of thermal growth units to predict when a given hybrid will reach various stages of growth based on the thermal growth unit requirements for that hybrid and date of planting. Once the program has predicted the date on which the crop will reach the different stages of growth, it can then provide additional information about the expected climatic conditions on those dates for a location chosen by the user.

For example, *Corn Watch* will determine the chance that a late-spring freeze will occur after crop emergence or an early-fall freeze will occur before the crop reaches maturity based on average weather conditions. It also will provide the probability of receiving a selected amount of rain in a two-week period around each of the growth stages. Finally, it calculates the average evapotranspiration (ET) that will occur during a growing season and lists the seasonal accumulation of ET and rainfall that occurs at each crop stage. By changing hybrids (with different thermal growth unit requirements) and date of planting, growers can evaluate several options and select the one best suited for their operation.

If the crop is already growing, producers can enter the actual date on which one of the developmental stages occurred, rather than the planting date. The program then predicts the rest of the season based on that information.

The program and an instruction file can be downloaded at [http://av.vet.ksu.edu/webwx/apps/cornw2.exe](http://av.vet.ksu.edu/webwx/apps/cornw2.exe).

Once you download the program, click on CORNW2.EXE to uncompress the files. The default directory for installation is C:\CORN, but you can change this directory if desired. After the files are ready, type WATCH in a DOS window that points to the folder where you have the program installed to run the *Corn Watch* Program. You can read more detailed instructions in the READMEFIRST document that will appear in the same folder as the program files.

Keep in mind that *Corn Watch* was developed nearly 20 years ago and must be run in the DOS Execution window on computers using the MS Windows operating system. An effort is beginning to update the program so that it will be available to run online, with all the familiar user interface features. If you download *Corn Watch* and use it, please provide feedback to Mknapp@ksu.edu so we can incorporate useful suggestions as we develop the upgrade.
5. The importance of good soil aggregation

Any given soil is more or less fixed in terms of its soil texture – the proportion of clay, silt, and sand – and its mineralogy. Those factors were set long ago by geological and environmental forces. For example, all Richfield silt loam soils will have very similar proportions of clay, silt, and sand, and will have very similar types of clay minerals.

But there may be a wide variation among different fields of any given soil series in terms of topsoil depth, nutrient levels, soil pH, organic matter levels, and soil aggregation. Many producers are familiar with factors such as topsoil depth and nutrient levels, and these are important factors in a soil’s productivity. Soil aggregation is probably less familiar, but can be equally important.

Soil aggregation is important in crop production due to the effects it has on soil structural stability, water holding capacity, and the movement of air and water in soil. Native forest and grassland soils tend to have a high degree of aggregation. Soils under crop production have a wide range of aggregation, depending on their use and management.
What is soil aggregation?

Soil aggregation refers to the process in which soil particles (sand, silt, and clay) are bound together into larger structures of varying size, usually by natural forces and soil organic matter.

Aggregate stability measurements are performed to determine how well the aggregates resist degradation when subjected to forces such as being shaken in water, as shown below in Figure 2. This kind of test simulates how well the aggregates will hold together in a rainfall event.

There are many physical, chemical and biological factors that affect the stability of aggregates.

Chemical. In most Kansas soils, clay particles will clump or flocculate together in the presence of calcium and magnesium cations, and will disperse in the presence of sodium cations. As a result, soils that are high in sodium have poor aggregation, so water often ponds on the soil surface.

Physical. Most Kansas soils contain the type of clay that shrinks when dry and swells when wet. This shrink-swell action helps form aggregates over the long term by physically forcing soil particles together. Freeze-thaw cycles work in the same way.
Biological. Biological factors affect both the stability and size of aggregates. Organic matter is one of the best stabilizing agents for soil. Soil organic matter comes from the decomposition of plant roots and residues and from soil microorganisms. Fungal mycelial growth can also play a role in aggregation. The more organic matter in the soil, the larger the aggregates, and the more stable the structure.

The importance of soil aggregation

Well-aggregated soils contain lots of large pores, called macropores, which allow water to infiltrate quickly, preventing water from standing on the soil surface or running off of sloping surfaces. In this way, good aggregation helps reduce the potential for water erosion.

Well-aggregated soils also will be more resistant to breakdown during rainfall, which will reduce the chance of crust formation. Crusting occurs when raindrops hit the soil surface and detach soil particles from aggregates, which then fill in the soil pores. Crusts are not easily penetrated by water, and increase the risk of water runoff, soil erosion, and poor seedling emergence. A soil with good aggregation will rarely crust, even after a hard rain.

In addition, good aggregation helps reduce the potential for wind erosion. Larger aggregates will require a stronger wind to move them.

Measuring and managing soil aggregation

The level of aggregation in a soil is not fixed. It can be measured, and improved. The following are some basic questions in this regard:

* How do I know whether my soil has good, or adequate, aggregation? What defines this? A very simple test is to take natural soil aggregates, immerse them in water, and watch how long it takes for the aggregate to “explode,” or fall apart. The following set of pictures shows aggregates from the same soil type under different management schemes (conventional till, no-till, and native soil) before immersion, two seconds after immersion, and 15 seconds after immersion. There are no standards for minimum or adequate aggregation, but a well-aggregated soil is desirable for optimum water infiltration and gas exchange.
Figure 2. Samples were taken from an identical soil under three different management practices: conventional tillage, no-till, and native sod. Each sample was placed in water. The top photo is time 0; the middle photo is after two seconds; the bottom photo is after 15 seconds. This clearly shows the strong stability of soil aggregates in no-till and native sod, and the poor stability of aggregates in conventional tillage. (Photos by DeAnn Presley)

* Why do some soils have good aggregation and some soils have poor aggregation? Soils that are naturally low in organic matter and high in sodium will usually have poor aggregation. Soils that are naturally high in calcium or iron tend to be well-aggregated. Soils with high organic matter levels and microbial activity are naturally well-aggregated. Intensive tillage often results in lower levels of soil aggregation in the tillage zone.

* What can I do to improve soil aggregation? Any practice that increases soil organic matter levels will improve soil aggregation. Tillage mixes more oxygen into the soil, stimulating the soil microbes to decompose organic matter. This process is called oxidation. Oxidation reduces soil organic matter levels, and therefore reduces the ability of the soil to form large and stable aggregates.

One management practice that can be used to improve soil aggregation is reduced-till or no-till production. Tillage not only increases oxidation of soil organic matter, it also physically breaks down aggregates.

Production practices that reduce compaction and the number of trips over the field can also help improve soil aggregation.

Another practice that can help increase aggregation is more intensive cropping systems, including the use of cover crops. Having more plants and soil cover for longer periods of the year
provides more organic plant material for the soil, more root growth in the soil, and better protection from weather.

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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