1. Skip-row corn and grain sorghum research

Planting corn in a skip-row pattern has the potential to provide higher yields than corn planted every row in adverse environments with low yield potential. In 2009, the Risk Management Agency approved coverage for skip-row corn in far western Kansas when the number of plants per acre is at least 75% of that in a field with every row planted.

Planting grain sorghum in a skip-row pattern is much less common than with corn, primarily because there are few effective postemergence herbicide options for controlling weeds in the unplanted rows. However, two new types of herbicide-tolerant sorghum (ALS-tolerant and ACCase-tolerant) have been released by K-State and should be available on the market within the next few years. These resistant hybrids would allow the use of more effective postemergence herbicides such as Steadfast on ALS-resistant sorghum and Assure II on ACCase-resistant sorghum. This will make weed control in skip-row grain sorghum potentially more viable.

To test the difference in yields between skip-row and conventionally planted dryland corn and grain sorghum in western Kansas, K-State initiated a research project in 2007 at three locations: Tribune, Garden City, and Colby. The skip-row consisted of planting two 30-inch rows and skipping two 30-inch rows. The conventional plots were planted in 30-inch rows.

The same seeding rate was used for all treatments. A preemergence application of a grass herbicide plus atrazine was made on all treatments. Glyphosate was applied postemergence to the corn plots. Late-emerging weeds in the grain sorghum plots were controlled with directed applications of 2,4-D or hand hoeing.
## Agronomic Information

<table>
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<th>Crop</th>
<th>Tribune</th>
<th>Garden City</th>
<th>Colby</th>
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<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
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<tr>
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<td>June 7</td>
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<tr>
<td>Planting date</td>
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<td>(seeds/acre)</td>
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## Rainfall Information

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<td>2009</td>
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<tr>
<td>April 1 to Sept. 30</td>
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<tr>
<td>30-year average</td>
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<td>11.1</td>
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<td>14.2</td>
</tr>
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<td>14.2</td>
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## Effect of Row Pattern on Corn and Grain Sorghum Yields

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<tbody>
<tr>
<td>Corn</td>
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<td>66</td>
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<tr>
<td>Skip row</td>
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<tr>
<td>Grain sorghum</td>
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<td>69</td>
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<tr>
<td>Skip row</td>
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<td>64</td>
<td>83</td>
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<td>LSD (0.05)</td>
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<td>6.1</td>
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### Results and Conclusions:

* Unlike previous research conducted in western Kansas, there was no benefit to planting skip-row corn when yields were less than 80 bu/acre at any site. The previous research results can be found at:
http://www.plantmanagementnetwork.org/sub/cm/research/2009/skip/

* There was no benefit to planting skip-row grain sorghum at any site. Instead, yield loss was significant when growing conditions were good for grain sorghum, as was the case at Colby in 2007-2008.

* For Colby in 2009, growing conditions were optimum for corn. Corn yielded 161 bu/acre and grain sorghum yielded 114 bu/acre. Skip-row yielded 45 bu/acre less than conventional row spacing, averaged over both crops.
* Planting grain sorghum in a skip-row pattern did not provide any additional yield benefit over planting every row in these tests, regardless of growing conditions.

The complete report can be found in the 2010 Field Research report: www.ksre.ksu.edu/library/crpsl2/srp1030.pdf

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2. Wheat grain fill development stages

Wheat is currently in a wide range of maturities across Kansas. Some has not yet flowered, while wheat in far south central Kansas is well into grain fill.

Grain begins growing immediately after flowering and reaches its maximum size (not weight) within about 2 weeks. The maximum weight occurs about 4 weeks after flowering in Kansas. The extent of the grain fill period is determined largely by temperature.

After flowering, the kernels will begin to fill, unless there was a problem during the flowering period. In this example, there are four kernels per spikelet. That’s not normally the case. Usually, there are either two or three kernels per spikelet. The awns are green for most of the grain filling period. Photos by Jim Shroyer, K-State Research and Extension.
Grain development stages are determined by the hardness or consistency of the endosperm of the new kernel. As the kernels begin to form, they will first consist of a clear, water liquid inside. This is the watery ripe stage. Shortly after that, the endosperm will develop the color and consistency of milk.

These two kernels are about 15-17 days old, well formed, and plump. When the kernels are smashed, the liquid inside has a milky appearance. This is the milk stage of kernel development. The milky substance is sucrose that was produced by the leaves and it is being transported into the cells of the endosperm. It will be converted to glucose and stored as starch in the endosperm cells. The milk stage in a single kernel will last for about 5 days, but it will last for more than a week for the whole head.

In the late milk stage, the kernels are plump and they no longer have a silverish-green color. Now they look more lime green. The lemma and palea stick to the kernel. These kernels are about 20 days old. The milky substance is now thicker and there’s more solid material inside the kernel.
Soft dough stage. These kernels are about 22-24 days old. They still have a slight green color, especially along the crease on the underside of the kernel. The kernel on the right is more tan, but has a hint of green at both ends and it is green along the crease.

Inside the kernel in the soft dough stage is a soft, wet, mealy substance. It has a doughy texture. The doughy substance is the starch that is in the kernel’s endosperm.

As the kernels continue to develop beyond soft dough, an important change is occurring now is with kernel development. The wheat plants are losing their green color, and so are the kernels. During the soft dough stage, the kernels still have considerable green in them, especially along the crease on the underside of the kernel. Once the kernels have lost their green color along the crease, they are in the hard dough stage and it won’t be long until harvest time.
These kernels are about 25-27 days old, and are in the hard dough stage. The kernel on the right has been sliced open (it was too hard to smash). There is starchy, grainy material inside. That is the starch in the endosperm.

At the hard dough stage, the grain moisture is still too high to begin harvest. The grain would spoil in storage if harvested too early. Also, the plants are still too green and wet, especially in the head, so the grain and the chaff would not separate well during threshing.

The appearance of the kernels as they progress from soft dough (far left) to hard dough.

The photo above shows the progression of kernel development. On the left is a kernel in the soft dough stage. The second kernel is early in the hard dough stage. While the third kernel is also in the hard dough stage, it is a little darker or further along in its development. The fourth kernel is about 30 days old and it is physiologically mature. That means there are no more carbohydrates or proteins moving into the kernel, so it won’t get any bigger. The moisture content of this kernel is about 35 percent. This is still too wet to harvest, but it is mature.

Ripening includes the changes that occur after the grain reaches physiological maturity. The most important change is the loss of moisture from 30 to 35 percent in mature grain to 12 to 13 percent in combine-ripe grain. Grain must be harvested promptly after ripening to save the yield. Hail, lodging, and preharvest sprouting are ever-present threats to ripe grain. High temperatures, especially when accompanied by winds, and foliar diseases such as leaf rust cause shriveled kernels, low test weights, and low yields.
Protein and starch are the most important constituents of the wheat kernel. Most of the protein comes from nitrogen previously accumulated in the leaves, and most of the starch is from sugars made by photosynthesis during the grain-filling period. The nitrogen moves into the filling kernels to form protein during early grain development. This is why, if yields are low because the kernels do not fill properly, the grain is high in protein. Drought and high temperatures are usually responsible for this condition.

If the grain fills normally and yields and test weights are high, grain protein is frequently lower because it is diluted by other materials. Of course, under good growing conditions, grain protein can be increased with nitrogen fertilizer. Most of the leaves senesce, or die, soon after flowering, but the flag leaf, glumes, and awns remain active during most of the grain-filling period. Photosynthesis in the awns, or beard, provides 10 to 20 percent of the grain weight. This is why nearly all the wheat varieties grown in Kansas have awns. In cooler areas with higher rainfall, wheat leaves remain active longer, and awns are less important. Yields are high when favorable filling conditions, mild temperatures, and active leaves promote growth of large, plump kernels.

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3. Barley yellow dwarf symptoms, yield losses, and control

There are many fields of wheat in Kansas with yellowish leaves this year. Many factors can cause yellowish leaves, but two of the most common causes this year are stripe rust and barley
yellow dwarf. Stripe rust is relatively easy to diagnose, with stripes of yellow pustules on the leaves. Barley yellow dwarf can be a bit more difficult to diagnose in the field.

**Symptoms**

The primary symptoms of barley yellow dwarf are stunting and yellow or red discoloration of the leaf tips. The disease can be uniformly distributed in fields, but it is most commonly found in patches that are 1 to 5 feet in diameter. Stunting is typically most severe near the center of a patch. The color of the symptoms depends on the variety. In most cases, the discoloration of the leaf tips increases over time until eventually the entire leaf is discolored. The midrib of the leaf often remains green longer than the edges of the leaf.

![Yellow or purple leaf tips caused by barley yellow dwarf. Photos courtesy of Erick DeWolf, K-State Research and Extension.](image1)

Barley yellow dwarf often occurs in 1- to 5-foot diameter patches.

Typically, there is no mosaic pattern on the leaf, but sometimes there is some striping at the border between the discolored leaf tip and the green leaf base. In addition, leaves affected with barley yellow dwarf often have small black spots or streaks randomly spaced over the discolored portion of the leaf tip. These are presumably opportunistic infections by bacteria.
Infection by barley yellow dwarf is often associated with the occurrence of dark heads with shriveled grain. These occur in small patches similar to barley yellow dwarf patches. It has not been conclusively proven, but it is suspected that barley yellow dwarf causes the dark heads.

Barley yellow dwarf can be confused with other production problems such as wheat streak mosaic or nutrient deficiency. Accurate serological tests for barley yellow dwarf virus are available from the Plant Diagnostic Lab at Kansas State University.

**Losses**

The amount of yield loss depends on the percentage of plants showing symptoms. Casual observation often overestimates the percentage of infected plants. Collecting random samples while moving through a field in a systematic way will give a more accurate estimate of the incidence of infected plants.

The timing of the infection relative to crop development also influences the potential yield loss associated with barley yellow dwarf. When infection takes place in the fall, the virus has more time to disrupt plant growth and losses can exceed 35 percent. If plants are infected after heading; however, the losses are usually minimal.

**Control**

The control of barley yellow dwarf is closely linked to control of the aphids that introduce the virus into the plants. One of the primary means of controlling barley yellow dwarf is to avoid early planting, which often increases the likelihood that aphids will infest a field in the fall. Planting after the Hessian fly-free date reduces the risk of aphid infestation and minimizes the risk of barley yellow dwarf infection. The Hessian fly-free date works well against barley yellow dwarf unless there is a mild fall that allows aphids to survive longer than usual. The aphids that survive these mild conditions can spread the disease and increase the potential for severe yield losses.

Ratings of wheat varieties can be found in *Wheat Variety Disease and Insect Ratings*, MF-991. No wheat varieties have high levels of resistance to barley yellow dwarf, but some are more tolerant than others. Under severe barley yellow dwarf pressure, a tolerant variety (rating 4 or 5) might have a loss around 15 percent while a susceptible variety (rating 8 or 9) could have more than a 30 percent loss.

Chemical control of the aphid vectors can suppress barley yellow dwarf. Unfortunately, spraying insecticides for aphid control has not proved practical. First, multiple applications would be required to achieve satisfactory control. Second, it is not possible to wait for obvious aphid populations before spraying because by the time they are detected, significant virus transmission would already have occurred. Therefore, applications would have to be made on a preventive schedule. Given the unpredictable nature of barley yellow dwarf epidemics, it is not economical to make several preventive sprays in the fall and early spring.

Seed treatments containing the systemic insecticides (e.g., Gaucho XT, CruiserMax Cereals) are labeled for aphid control. These products have shown fair to good suppression of barley yellow dwarf in university trials. The variability in effectiveness is probably due to the timing of aphid infestation. If aphids arrive after the 6- to 8-week period of protection provided by the chemical,
then the insecticide will have minimal effect. These seed treatments are more expensive than other seed treatments, so their use has been limited in Kansas.

Note: This article is based on K-State Plant Pathology’s Fact Sheet “Barley Yellow Dwarf,” at: http://www.ksre.ksu.edu/library/plant2/ep165.pdf

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4. Loose smut on wheat: Causes and treatments

As we head into wheat harvest time, there are often reports of loose smut in wheat. It is not uncommon to find low levels of loose smut in wheat fields throughout Kansas.

It is easy to pick out plants with loose smut in a field. The spikelets of infected heads are completely black and sooty instead of the normal, healthy color. There is no grain. Instead, infected heads consist entirely of a mass of fungal spores.

Loose smut in wheat. Photo from May 29, 2009 CropWatch, University of Nebraska-Lincoln: http://cropwatch.unl.edu/archives/2009/crop14/wheat_loose_smut.htm

Loose smut is a seedborne disease that is caused by the fungus *Ustilago tritici*. The fungus that causes loose smut survives as dormant mycelia within the embryo of an infected wheat seed. When the seed germinates, the fungus becomes active again. The fungus develops within the growing point and moves into the developing grain tissue as the wheat plants grow.

When the head emerges, there are masses of black spores on the spikelets instead of flowering parts. By harvest only an erect bare rachis remains. The spores are released into the air and can be blown onto healthy wheat heads were infection takes place at flowering or the early stages of kernel development. If the infection is successful, the fungus begins to grow within the developing wheat seed embryo.
Newly infected grain appears healthy in every way, but when it germinates the following season, the plant that grows from the infected seed will produce nothing but a dark mass of spores instead of healthy grain. The yield loss on infected heads is total. On a field-wide basis, the amount of yield loss is proportional to the percentage of infected heads.

Cool (60-70 degrees), humid weather accompanied by light showers or heavy dews is most favorable for infection. Under favorable weather conditions, the wheat produced from a field with only one percent of the heads infected, can have seed with 10 percent or more infection of loose smut.

Once loose smut becomes evident in the field, it is far too late to control the disease. The best option at that point is seed treatment. If producers have a field that is infected with loose smut and plan to keep some of the grain back for seed, they should be sure to have the seed commercially treated with a systemic fungicide seed treatment such as Charter (triticonazole), a Dividend (difenoconazole) product, a Raxil (tebuconazole) product, or RTU-Vitavax (carboxin)-Thiram. These fungicides provide excellent control of loose smut, but good coverage of the seed is very important to ensure that the maximum benefit of the treatment is realized.

Another option is to sell all the wheat from the infected field as grain and buy certified seed to plant in the fall. Certified seed in Kansas is allowed to have as much as 10 heads in 1,000 (or 1 percent) that are infected with loose smut. There is no requirement that this seed be treated in order to qualify as certified seed by the Kansas Crop Improvement Association, but it would be a good idea to buy treated seed. The cost of having seed treated with a standard low-rate fungicide seed treatment for loose smut is relatively low. Costs are higher if the seed treatment also includes an insecticide, such as Cruiser or Gaucho.

There are no varieties are highly resistant to all races of loose smut.

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5. Note on this week’s Vegetation Condition Report maps

We chose not to include the latest Vegetation Condition Report in this week’s e-Update. This is due to poor quality data that was caused by unusually high cloud cover throughout the image composite creation period. When this occurs, few if any images are cloud-free enough to be georegistered. The maps will resume with next week’s e-Update.

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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