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eUpdate

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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, Jim Shroyer, Crop Production Specialist 785-532-0397 jshroyer@ksu.edu, or Curtis Thompson, Extension Agronomy State Leader and Weed Management Specialist 785-532-3444 cthompso@ksu.edu.

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1. Special Edition. May freeze: Effect on wheat in boot and heading stages

Overnight temperatures dropped below freezing in parts of northwest, west central, and north central Kansas in the early morning hours of May 11 and 12. In low areas of the fields, temperatures will typically be lower than the officially recorded temperatures, and this will be where freeze damage will be most likely.

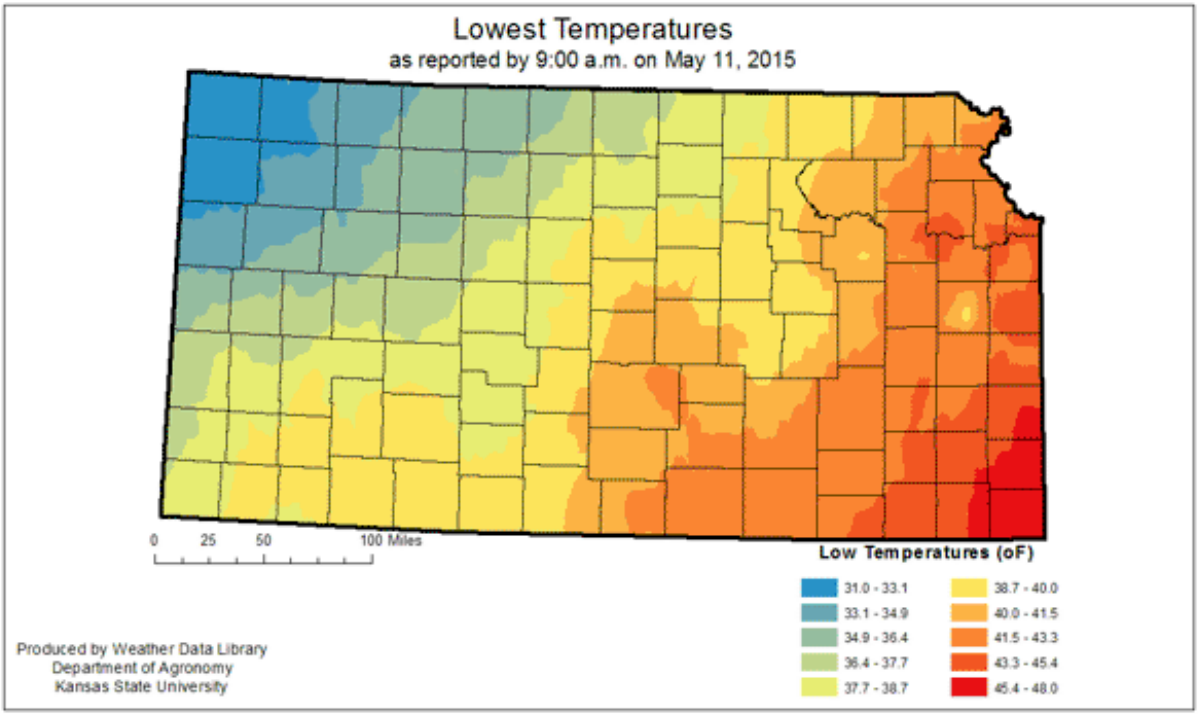

Figure 1. Lowest temperatures, early morning May 11, 2015. Source: Mary Knapp and Chip Redmond, Weather Data Library.

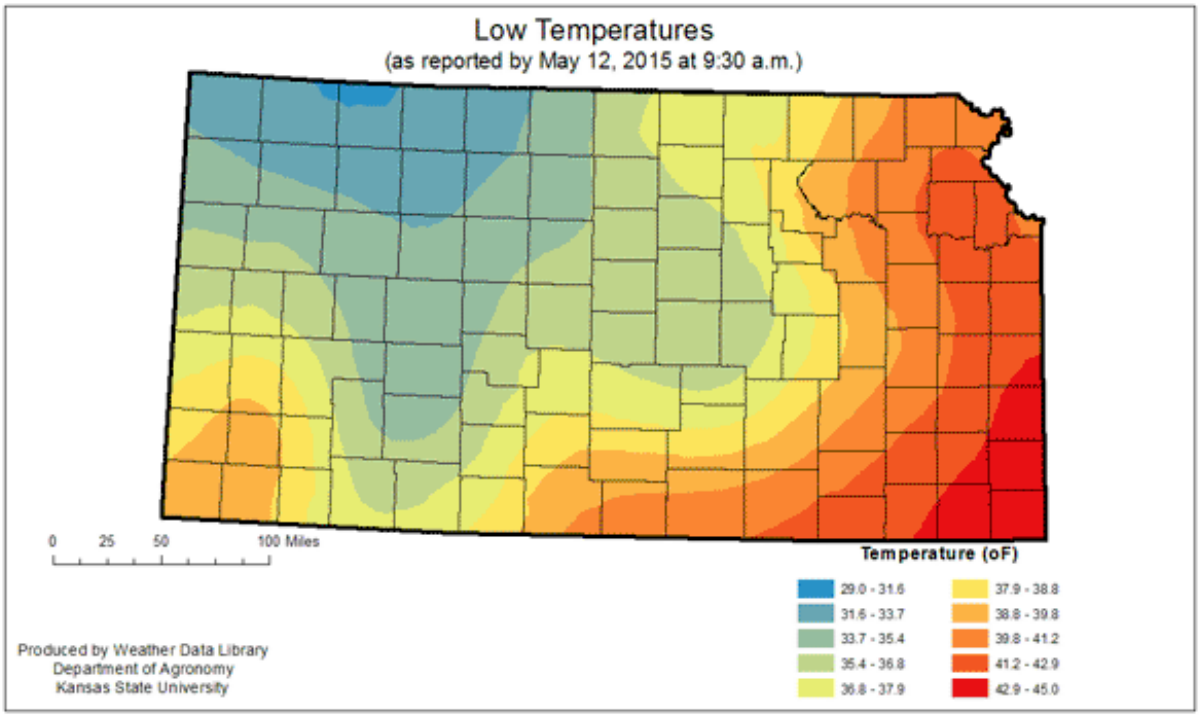

Figure 2. Lowest temperatures, early morning May 12, 2015. Source: Mary Knapp and Chip Redmond, Weather Data Library.

The biggest effect will be on wheat that was in the flowering stage. It doesn't take very cold temperatures to cause injury to anthers. At other stages of development, it takes more than just a light frost to cause injury.

Here are the possibilities for freeze injury by the most common stages of growth in the areas of the May 11-12 freeze:

Boot. Some of the wheat in the affected areas, especially later-planted wheat, may still be in the boot stage. In this stage, wheat can be injured if temperatures drop down into the mid to upper 20's for several hours. Injury is more likely if this occurs repeatedly and if it is windy at night. It's unlikely temperatures got cold enough in most places on May 11-12 to injure wheat in the boot stage, but not impossible.

The more worrisome problem for wheat in the boot stage is the effect of low, but non-freezing, temperatures on pollen viability. When wheat is in the boot stage and pollen is forming, temperatures in the 30's and 40's can lead to pollen sterilization.

To detect actual freeze injury, producers should wait several days then split open some stems and look at the developing head. If the head is green or light greenish in color and seems firm, it is most likely going to be fine. If the head is yellowish and mushy, that's a sign of freeze injury.

Freeze injury at the boot stage causes a number of symptoms when the heads are enclosed in the sheaths of the flag leaves. Freezing may trap the spikes inside the boots so that they cannot emerge

normally. When this happens, the spikes will remain in the boots, split out the sides of the boots, or emerge base-first from the boots.

Sometimes heads emerge normally from the boots after freezing, but remain yellow or even white instead of their usual green color. When this happens, all or part of the heads have been killed. Frequently, only the male parts (anthers) of the flowers die because they are more sensitive to low temperatures than the female parts. Since wheat is self-pollinated, sterility caused by freeze injury results in poor kernel set and low grain yield.

The photos below show partial white heads caused by freeze injury to wheat in the boot stage.

Figure 3. Freeze damage to tips of heads. Photos by Jim Shroyer, K-State Research and Extension.

Figure 4. Closeup of freeze damage to tips of heads.

Awns beginning to appear. If the awns have begun to appear, there can be significant injury to the heads if temperatures reach about 30 degrees or lower for several hours. The heads may fully exert from the boot, but few, if any, of the spikelets may pollinate normally and fill grain. Damaged heads from a freeze at this stage of growth may seem green and firm at first glance, but the floral parts will be yellowish and mushy.

Flowering. Wheat is particularly vulnerable to damage from freezing weather as the head starts to emerge through the flowering stage. Temperatures of 30 degrees or lower can damage anthers.

If the wheat was in the flowering stage at the time of the freeze in the early morning hours of May 11 or 12, you can determine if the anthers are damaged by examining them with a magnifying lens. Healthy anthers will first be lime green, then yellow. If they are damaged by a freeze, they will begin twisting within 2 to 3 days. Shortly afterward, they will begin to turn whitish or brown. The stigma in the florets may or may not also be damaged by a freeze. If the anthers are damaged by freeze, the flowers may fail to develop a kernel.

Fortunately, wheat doesn't flower all at the same time on the head. Flowering proceeds from florets near the center of wheat spikes to florets at the top and bottom of the spikes over a 3- to 5-day period. This small difference in flowering stage when freezing occurs can produce some odd-looking heads. The center or one or both ends of the spikes might be void of grain because those florets were

at a sensitive stage when they were frozen. Grain might develop in other parts of the spikes, however, because flowering had not started or was already completed in those florets when the freeze occurred.

Figure 5. Healthy wheat anthers are trilobed, light green and turgid before pollen is shed. Each wheat floret contains three anthers. Healthy stigmas are white and have a feathery appearance. Photos from Spring Freeze Injury to Kansas Wheat**, K-State Research and Extension publication C646.**

Figure 6. Anthers become twisted and shriveled, yet they are still their normal color within 24 to 48 hours after a freeze. A hand lens is necessary to detect these symptoms.

Figure 7. If damaged, anthers become white after 3 to 5 days and eventually turn whitish-

brown. The anthers will not shed pollen or extrude from the florets.

Figure 8. Damage may occur in different areas of the spike because flowering, which is the most sensitive stage to freeze, does not occur at the same time in all florets.

If you are unsure whether there has been freeze damage to the anthers, wait several days and determine whether kernels are developing normally. A week after flowering, kernels should be well-formed up and down the head under normal conditions.

Kernel development. If kernels were already forming at the time of the freeze, there still could be damage, although it is not likely with this freeze event since temperatures did not get cold enough in most cases. Generally, it takes colder temperatures (about 28 degrees) to cause damage to kernel development than to floral structures.

Healthy, developing kernels shortly after flowering are greenish-white and as they grow, they turn more greenish. But if they are damaged, they will turn grayish-white, shriveled and rough and will not continue to enlarge. Producers might need to check heads several times to determine the amount of damage. If the kernels were only slightly injured by freeze while in the milk stage, they may continue to grow to full size but produce light, shriveled grain at maturity. If the rachis is injured by freeze at this stage, it will weaken and turn dark. If that occurs, the spikelets can be easily stripped from the head increasing the potential for shattering.

Figure 9. Kernel development stops immediately after freeze damage. Damaged kernels are grayish-white, rough and shriveled.

More information

The comments above are general guidelines. Actual damage, if any, will not become apparent until temperatures have warmed back up for several days and growth has resumed.

For more information on freeze damage to wheat, see *Spring Freeze Injury to Kansas Wheat*, K-State Research and Extension publication C646, at:
http://www.ksre.ksu.edu/bookstore/pubs/c646.pdf

Jim Shroyer, Crop Production Specialist Emeritus
jshroyer@ksu.edu

Mary Knapp, Weather Data Library
mknapp@ksu.edu