Issue 629

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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 Curtis Thompson, Extension Agronomy State Leader and Weed Management Specialist 785-532-3444 cthompso@ksu.edu.

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1. Effect of freeze on April 27, 2017, on wheat in boot and early heading stages

Temperatures during the morning of April 27 dropped below freezing and into the lower 30's or upper 20's in most of the state. The lowest measured temperature was 24F in north central Kansas (Scandia, Republic Co.), where temperatures were below 32F for as long as 7.3 hours (Figure 1). Far southwest Kansas (Meade Co.) also reported 28F and was below 32F for more than 7 hours.

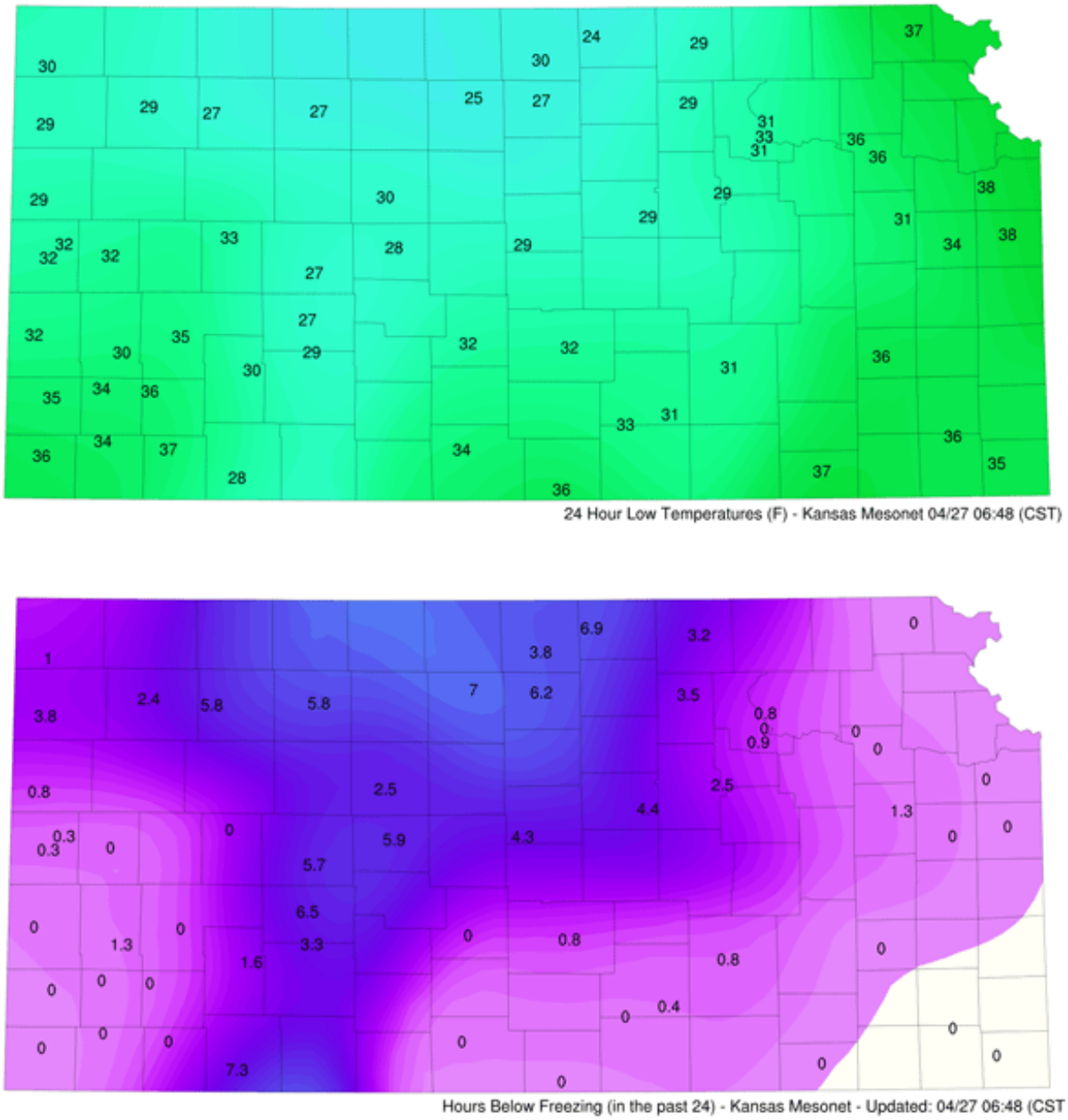

Figure 1. Minimum temperatures during the morning of April 27 (upper panel) and length of time below 32 degrees Fahrenheit during the 24-hour period encompassing the morning of April 27 (lower panel). Source: Weather Data Library (mesonet.ksu.edu/freeze).

The effects of a freeze event on the wheat crop will depend on whether the event matches critical sensitive stages of crop development and on several microclimate factors which are field-specific. According to the latest estimates of crop development across the state (Fig. 2), the areas where we are more likely to see cold damage include portions of southwest Kansas (Meade, Ford, Hodgeman, Ness, and Rush counties), and central and north central Kansas (the region between Saline and Ellsworth counties and north). These counties reported temperatures cold enough to harm the wheat at the average growth stages in those counties (Figure 3).

The risk of freeze damage is moderate in south central Kansas. Temperatures were not as cold in that region, but the crop is at anthesis or slightly past into early stages of grain development. The risk of freeze damage is also moderate in portions of northwest Kansas where the crop is not as far along but temperatures reached values as low as 25F (Fig. 1). The risk of freeze injury in the remainder of the state is lower, either because temperatures did not reach critical levels (south central and southeast Kansas), or cold temperatures did not match sensitive growth stages of the crop (northwest Kansas).

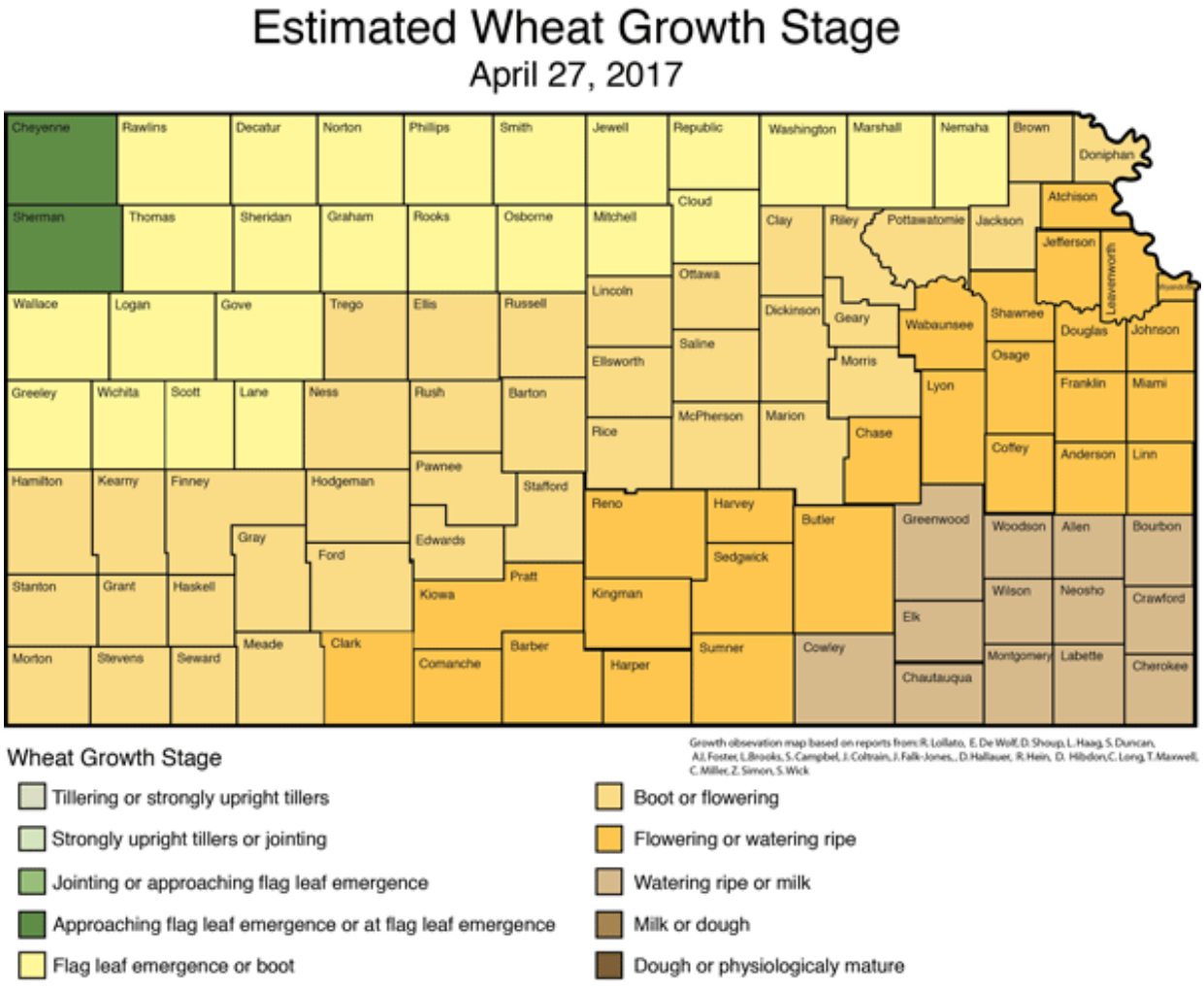

Figure 2. Estimated wheat growth stages across Kansas as of April 27, 2017.

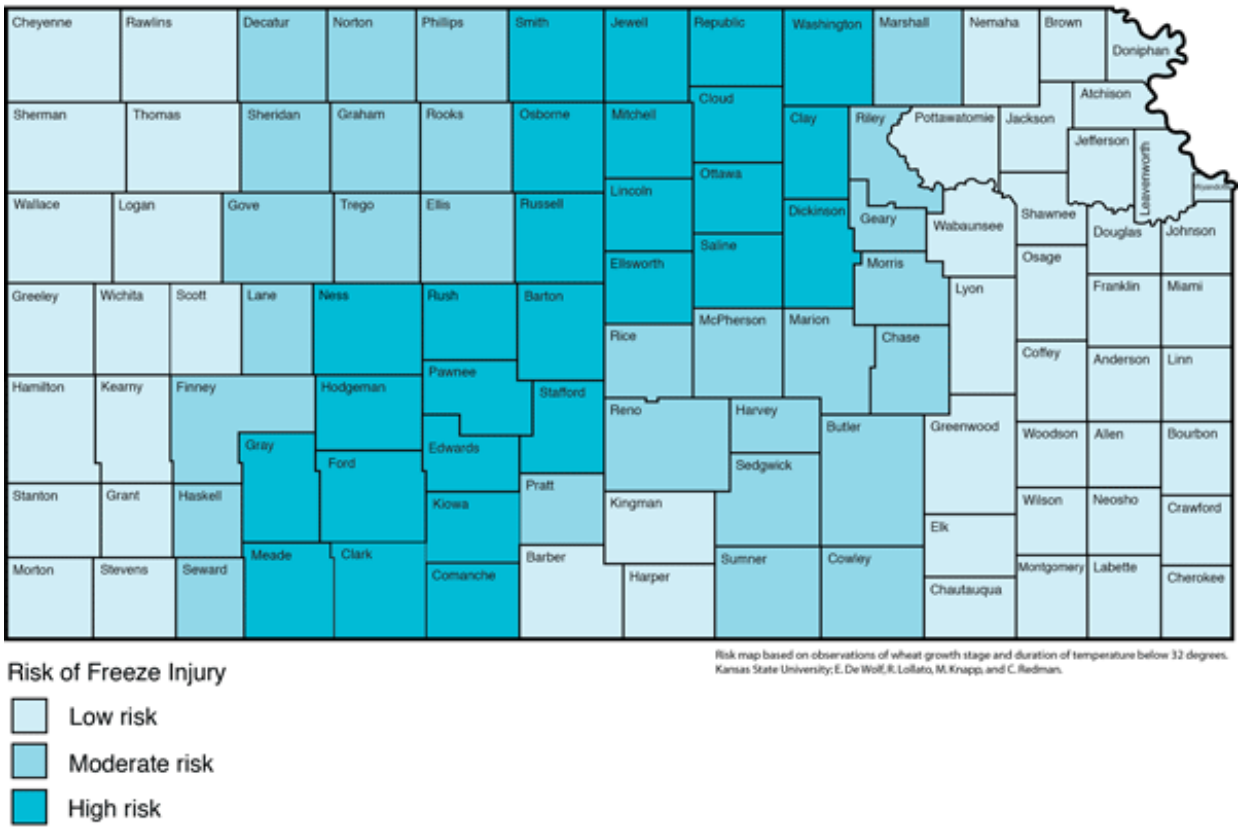

Figure 3. Estimated risk of freeze damage due to a combination of wheat growth stage sensitivity, lowest temperatures during the morning of April 27, 2017, and number of hours below 32F during the same period.

While the considerations above are general and for a large area, the actual freeze damage potential will be field specific and depend on several micro-climate factors. Low areas of the fields might experience colder temperatures than those reported at nearby weather stations. Similarly, increased wind speed might help warmer air make its way into the canopy, decreasing freeze injury potential. On the other hand, low wind speed might allow the canopy's microclimate temperatures to decrease more than those measured at nearby weather stations. Similarly, warm soils might help buffer some of the cold temperatures experienced in certain fields.

Soil temperature, which is affected by soil moisture status and by the presence of crop residue on the soil surface, can potentially help buffer cold temperatures. Moist soils will be able to hold warm temperatures better than dry soils. The majority of central Kansas has good soil moisture in the profile due to the recent rainfall events, which could help decrease the actual cold damage experienced.

Here are the possibilities for freeze injury by the most common stages of growth in the areas of the

latest freeze:

Jointing to pre-boot: Jointing wheat can usually tolerate temperatures in the mid to upper 20's with no significant injury. The only region of the state where the crop is still at these stages of development is far northwest Kansas. The lowest official temperature readings in that region were all in the upper 20's or above on April 27. Thus, the risk of freeze damage to that region is minimal. The exception would be if temperatures in some low-lying areas fell into the low 20's or even lower for several hours. Under these circumstances, the lower stems, leaves, or developing head may have sustained injury. If the tillers were in this stage or earlier at the time of the freeze and the tillers are green and growing actively now, then the heads should be fine. If the head had been killed, the tiller would not be green and actively growing. If the leaves coming out of the whorl are chlorotic, then the head on that tiller is dead.

Boot. 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. Temperatures at these levels were measured in parts of southwest Kansas and in north central Kansas (Fig. 1). Several early maturing varieties in southwest Kansas are past boot and could likely have sustained injury. In north central Kansas, the majority of the fields are at boot stage now and could sustain injury, as temperatures were as low as 24F. To detect 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.

It's possible for some of the spikelets to be alive and a healthy dark green while other spikelets on the same head are damaged. If a spikelet flowers normally and the kernels on that spikelet develop normally, then the head is at least partially viable and will produce grain (unless it freezes again, of course).

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. Field reports from north central Kansas indicate that more advanced fields were at this stage as of April 25; thus, the low temperatures measured during the morning of April 27 could most likely have caused damage to fields in this situation.

Flowering. Several fields in the central and south central portions of Kansas were flowering as of April 27. This is the stage when wheat is particularly vulnerable to damage from freezing weather.

Temperatures of 30-32 degrees or lower can damage anthers. The region encompassing Saline and Ellsworth counties in central Kansas, and Meade, Ford, Hodgeman, Ness, and Rush counties in southwest Kansas, had several fields already headed and reaching flowering during April 27. Also, measured temperatures were as low as 29F and temperatures were sustained below 32F for as much as 7.3 hours. The combination of low minimum temperatures, long exposure to temperatures below 32F, and wheat at flowering indicates that severe freeze damage may have been sustained in these regions. Several fields in south central Kansas (from Sedgwick to Sumner counties) are also largely characterized by wheat at flowering stages or beyond, and this area reported a freeze in the morning of April 27 (Fig. 4). While some injury may be sustained in this region, temperatures did not go much below 32F nor were low temperatures sustained below 32F for a long period of time (Fig. 1). Thus, the risk of freeze damage is moderate in south central Kansas.

Figure 4. Field of wheat past the flowering stage covered in frost during the morning of April 27 in Sumner County. Photo by Scott Van Allen, wheat producer.

If the wheat was in the flowering stage at the time of the freeze, you can determine if the anthers are damaged by examining them with a magnifying lens. Healthy anthers will first be lime green, then yellow (Figure 5). If they are damaged by a freeze, they will begin twisting within 2 to 3 days (Figure 6). Shortly afterward, they will begin to turn whitish or brown (Figure 7). 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 (Figure 8). 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.

In addition to this, be watching for any freeze damage to lower stems. If the damage is severe enough, the plants will eventually lodge.

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

Romulo Lollato, Wheat and Forages Specialist
lollato@ksu.edu

Erick DeWolf, Extension Plant Pathologist
dewolf1@ksu.edu

Mary Knapp, Weather Data Library
mknapp@ksu.edu

Chip Redmond, Kansas Mesonet
christopherredmond@ksu.edu

2. Susceptibility of newly planted corn to April 27 freeze

Kansas corn planting progress reached 21% at the state-level as of April 23 (Fig. 1). In many areas of the state farmers are currently making good additional progress planting corn where soils are dry enough. The low temperatures experienced the early morning hours of April 27 have the potential to cause damage on the recently planted corn.

Cold temperatures can result in injury to the germinating seed as it is absorbing moisture. When soil temperatures remain at or below 50 degrees F after planting, the damage to germinating seed can be particularly severe.

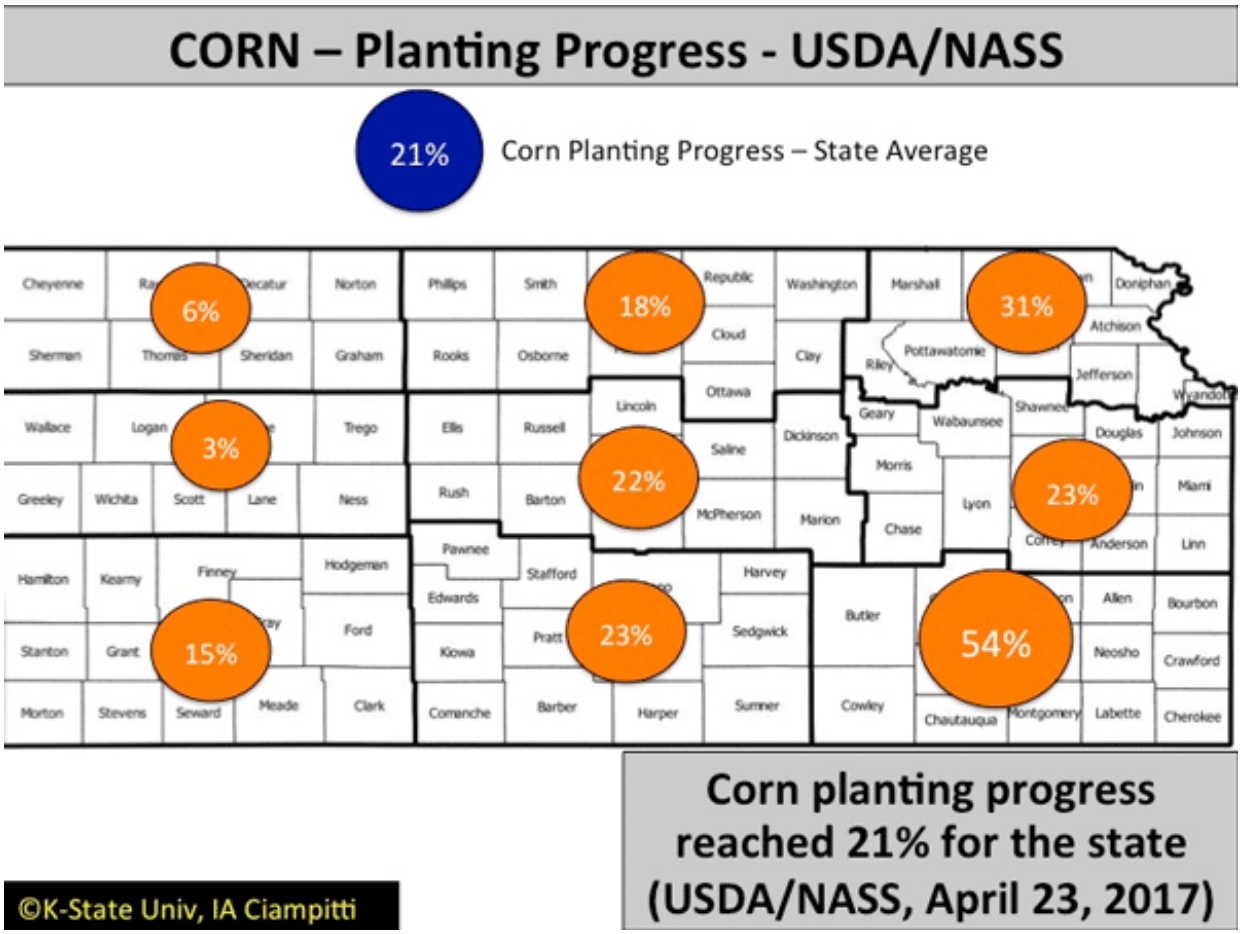

Fig. 1. Corn planting progress, April 23, 2017. USDA/NASS information.

Soil temperatures at 7 a.m. on April 27 are presented in Figure 2. The main concern for recently planted corn is for the north central part of the state, where soil temperatures dropped below 40F – reaching a minimum of 37 F at the 2-inch and 45 F at the 4-inch soil depth.

Soil temperatures at the 4-inch depth during the first 24-72 hours after seeding, when the kernels

imbibe water and begin the germination process, are critical. Kernels naturally swell when hydrating. If the cell tissues of the kernel are too cold, they become less elastic and may rupture during the swelling process, resulting in "leaky" cells. Injury symptoms may include swollen kernels that fail to germinate or aborted growth of the radicle and/or coleoptile after germination has begun.

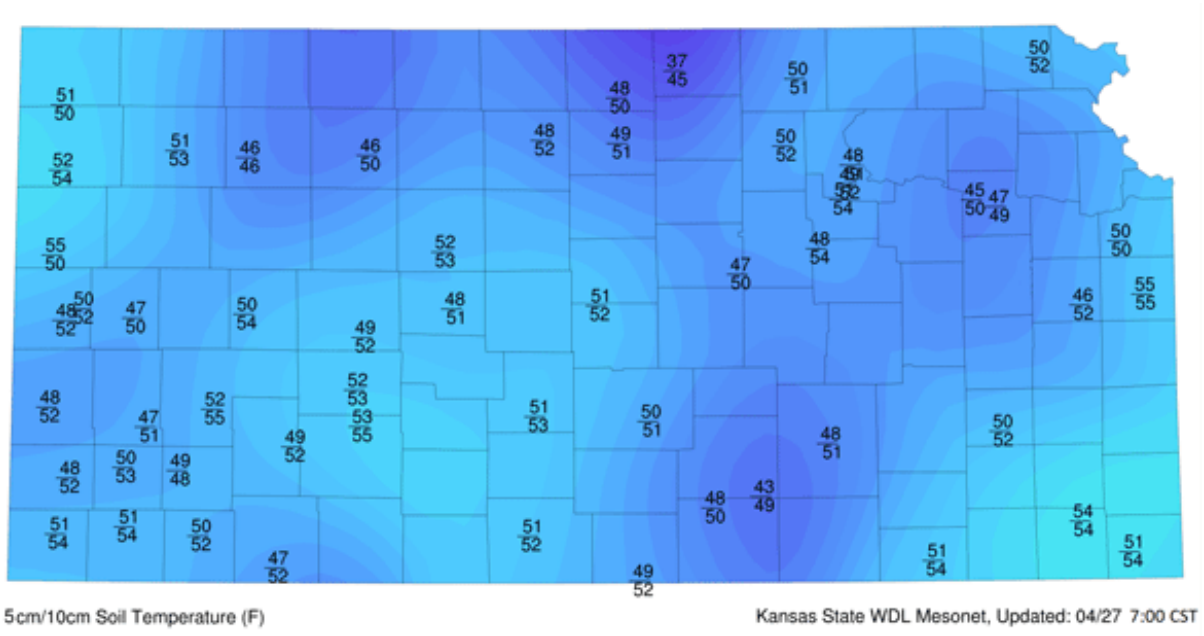

Fig. 2. Soil temperatures at 2-inch (upper value) and 4-inch (lower value) recorded at 7 am CT on April 27 at different locations for the state of Kansas.

Chilling injury can also occur following germination as the seedlings enter the emergence process, reducing plant metabolism and vigor (Fig. 3).

Fig. 3. Leaf burn from freeze damage early after corn emergence. Photo by Ignacio Ciampitti, K-State Research and Extension.

More information on the effects of freeze injury in corn will be discussed in the next issue of the eUpdate. Stay tuned!

Ignacio Ciampitti, Crop Production and Cropping Systems Specialist
ciampitti@ksu.edu

Mary Knapp, Weather Data Library
mknapp@ksu.edu