Issue 631

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05/01/2017

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. Effects of snowfall April 29 – May 1, 2017 on Kansas wheat

The weekend of April 29 – May 1 was very challenging to the Kansas wheat crop, especially in the western portion of the state. Over that period, anywhere from 1 to more than 21 inches of snowfall covered the majority of western Kansas (Fig. 1), which corresponds to roughly 40% of the wheat acreage in Kansas.

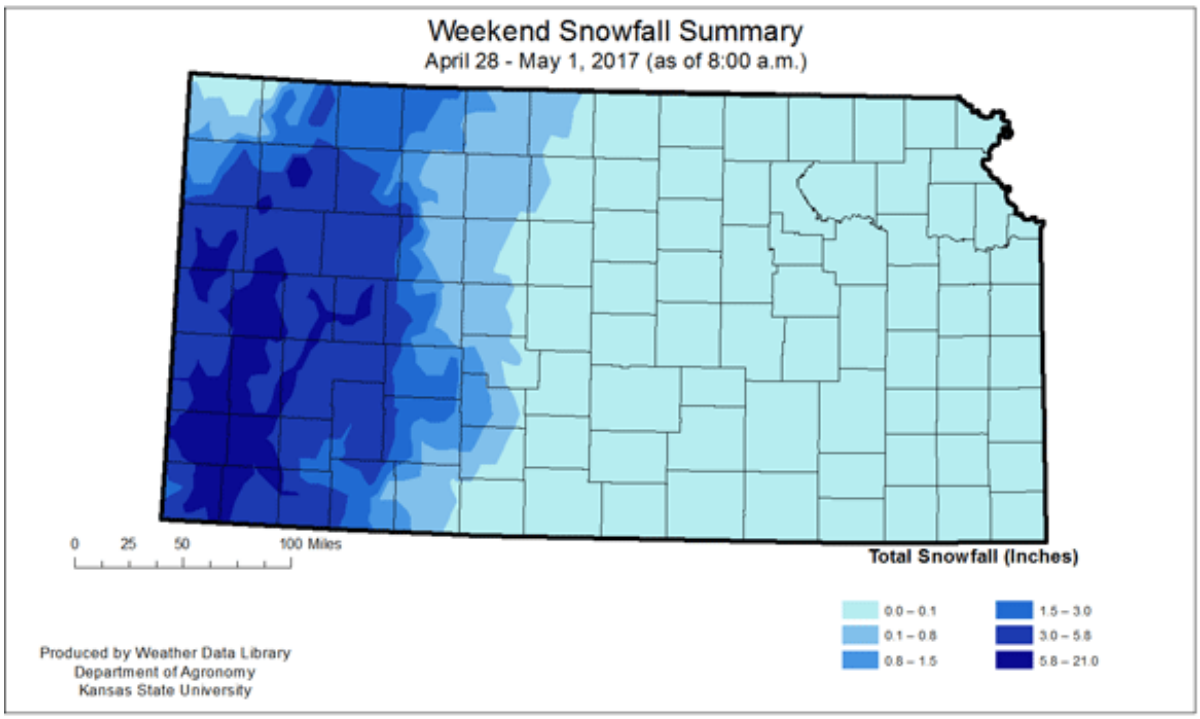


Figure 1. Snowfall accumulation during the period April 28 – May 1. Source: Weather Data Library (mesonet.ksu.edu/).

The snowfall was also accompanied by below-freezing temperatures during a long period of time. During the mornings of April 30 and May 1, minimum temperatures ranged from 27 to 31°F in the western third of the state (Fig. 2). While temperatures did not reach extreme low levels, they held below freezing for extended periods of time, ranging from zero hours in central Kansas to as many as 21 hours in Wallace County during the April 29 – 30 period, and 24 hours in Tribune during the April 29 to May 01 period (Fig. 3).

Wheat injury due to cold temperatures is more likely if it occurs repeatedly and if it is windy at night. Such conditions were experienced over the course of April 29 – May 1. During this period, we observed below-freezing temperatures three consecutive nights and wind speeds of more than 40 miles per hour for more than 6 consecutive hours, especially in southwest Kansas. The three consecutive nights with below-freezing temperature reduces the chances that wheat can escape freeze injury by having tillers that emerged at different times or wheat flowers within the same head pollinating at different times.

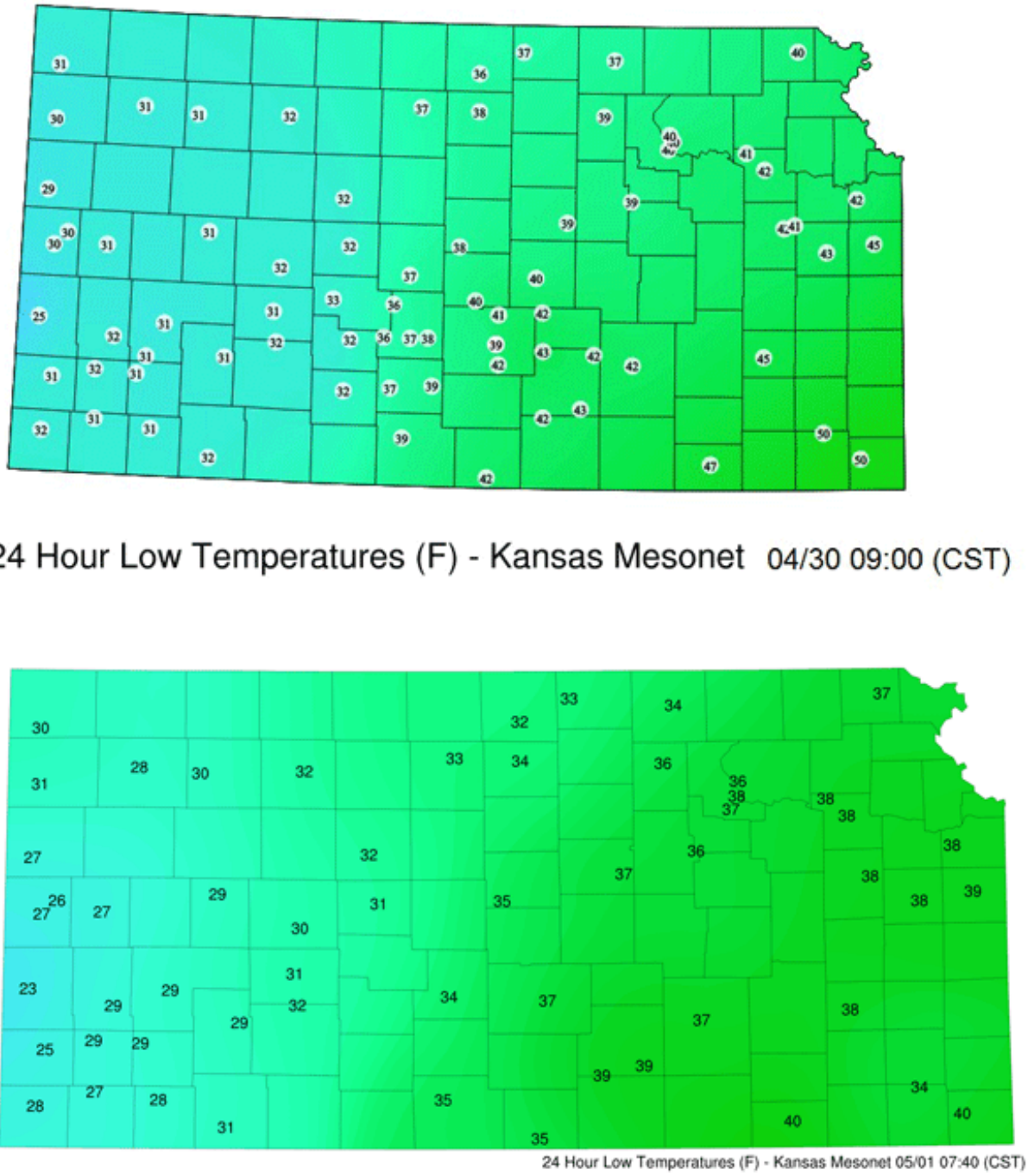
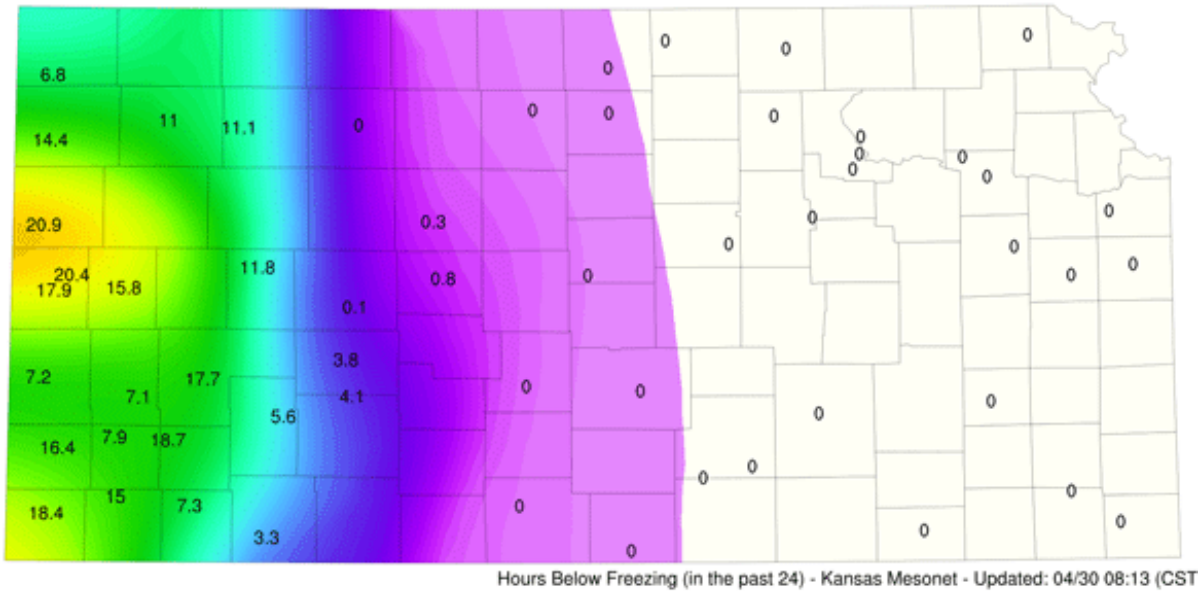


Figure 2. Minimum temperatures during the mornings of April 30 (upper panel) and May 1 (lower panel), 2017. Source: Weather Data Library (mesonet.ksu.edu/freeze).



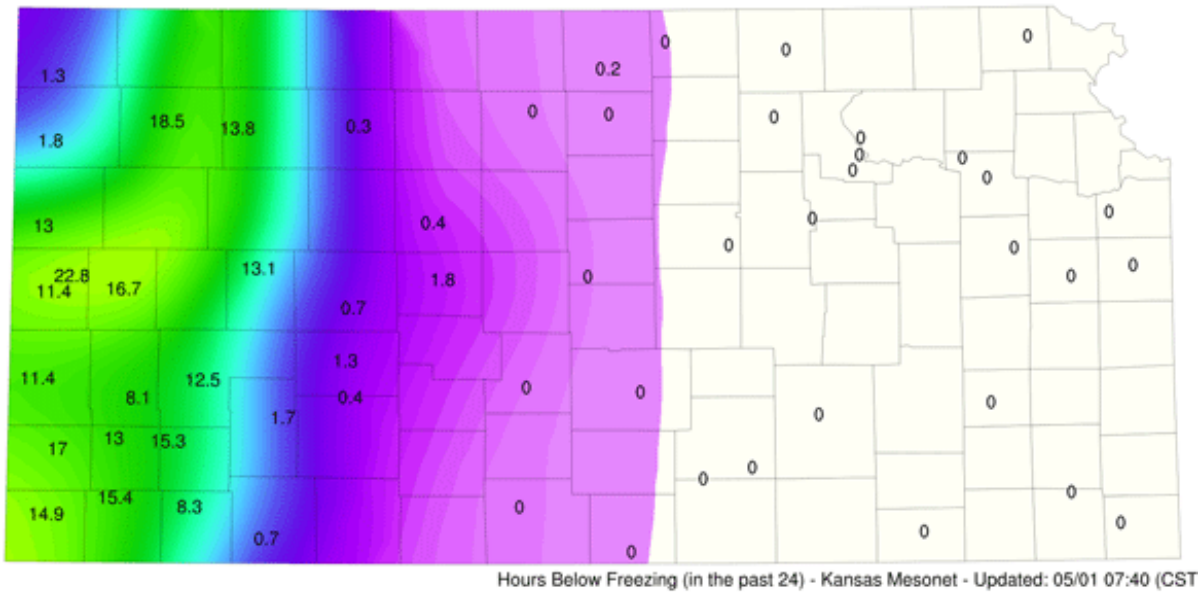


Figure 3. Length of time below 32 degrees Fahrenheit during the 24-hour period encompassing the morning of April 30 (upper panel) and May 1 (lower panel), 2017. Source: Weather Data Library (mesonet.ksu.edu/freeze).

Possible consequences to the wheat crop

A cold spell during the spring often reduces wheat yield potential due to the direct damage from cold air temperatures. At earlier stages of wheat development, when a minimum of 2-3 inches of snowfall is present and entirely covers the wheat crop, it is often positive as it buffers cold damaged from temperatures lower than 32°F due to insulation. This is particularly true during the winter months, when the wheat stem has not started to elongate.

However, the snowfall events observed during the April 29 – May 1 period were heavy due to a high moisture content, and in many cases had the wheat lying flat on the ground (Fig. 4). In some cases, the entire plants might have simply lodged without actually breaking the stems, case in which the crop might stand back up again in the near future after the snow melts. In other cases, however -- and what seem to be the majority of the cases in the region -- the sheer weight exerted on top of the wheat crop might have caused the stems the break in many fields (Fig. 5), causing another source of yield loss in addition to the cold temperatures.

Figure 4. Wheat field in western Kansas almost completely covered by snow during the morning of April 29, 2017. Photo by Justin Gilpin, Kansas Wheat.

While yield loss from this snowfall event might occur in most of the fields affected, the magnitude of the yield loss at this point is uncertain. At least one week to 10 days will be needed to properly assess the situation, after the snow melts away. The yield loss will depend on stage of crop development, severity of stem breaking, and number of hours of below-freezing temperatures observed.

Yield losses due to stem breaking are generally lower if the crop is at boot stage (when it still has time to compensate with late tillers) as compared to a crop at anthesis or early stages of grain development. Similarly, the crop at boot stage is also more protected from cold temperatures than a crop at or near anthesis. Thus, larger yield losses from the heavy snow and below-freezing temperatures might be expected in parts of the state wheat where the crop is near anthesis as than where the crop was still at boot stage.

According to our latest estimates of crop development across the state (Fig. 6), we expect larger yield losses in the southwest corner of the state due to a combination of floret sterility and stem breaking in fields that were near or at anthesis. Possibly, fields in the northwest corner of the state where the crop was mostly at boot stage might still produce a decent crop, depending on the severity of stem

breakage. In this situation, the majority of the yield loss should come from stem breaking due to the heavy snow, but the long period of time at below-freezing temperatures might also contribute to any possible yield loss. These speculations are based on our understanding of wheat response to different stresses, and the actual damage will need to be assessed on a field-by-field situation after the snow melts away.

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Figure 5. Stem bending due to the weight of the snow on top of the wheat crop near Leoti. Photo by Rick Horton, wheat producer in Wichita and Finney counties.

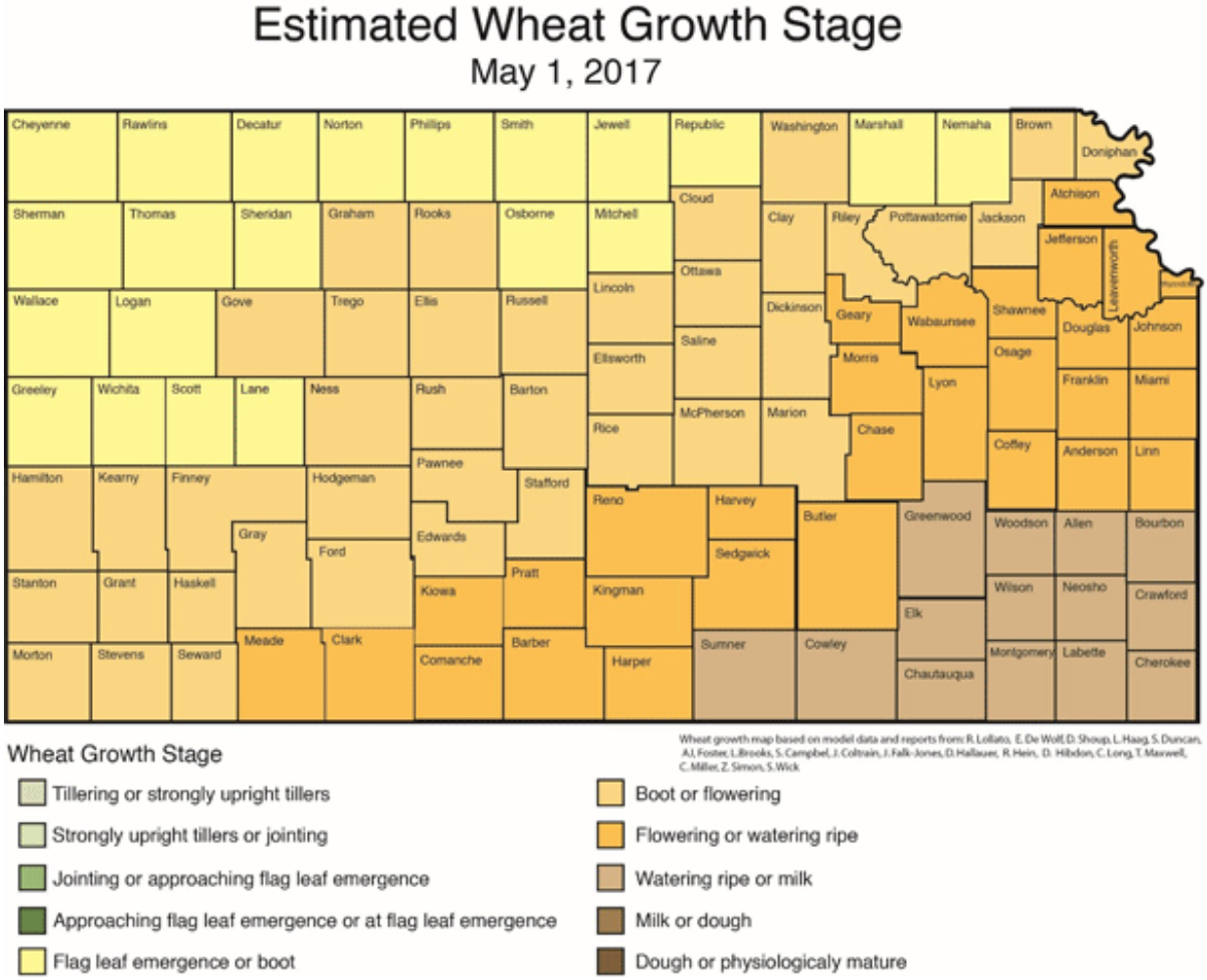

Figure 6. Estimated wheat growth stages across Kansas as of May 1, 2017.

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2. Diagnosing damage to wheat from the snowfall and freezes of April 29 – May 1, 2017

Damage potential from the snowfall during April 29 – May 1 will be field specific and depend on the stage of crop development, amount of snowfall and consequent severity of stem damage, and the number of hours the crop was exposed to below freezing temperatures. While it is still early to try to estimate yield loss resulting from the snowfall, producers can start to look for the first signs of damage once the snow melts away by looking for broken stems. In two or three days, producers will be able to look for damage anthers by the cold temperatures in fields that were near or at anthesis. Other symptoms, such as white heads, might take another week or ten days to appear.

Here are more details for freeze injury by the most common stages of growth in the areas of the latest freeze:

Boot

In this stage, wheat can be injured if cold 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 -- conditions experienced over the course of April 29 – May 1 when below-freezing temperatures were experienced during three consecutive nights for the western third of Kansas (please see accompanying article in this issue of the Agronomy eUpdate). In addition to the cold temperatures experienced, the heavy and wet snow fall also caused stem bending in wheat at boot stage (Fig. 1), which might further exacerbate yield loss. While yield loss from stem bending alone is not as severe during boot stage as in more advanced stages of development, the extent of yield loss would be worsened by the long period of time under below-freezing temperatures.

To detect injury to wheat at boot stage, 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.

Usually, it is possible for some of the spikelets to be alive and a healthy dark green while other spikelets on the same head are damaged due to the difference in pollination timing within the wheat head. This is especially true following one single freezing event. 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). However, the three consecutive nights with below-freezing temperatures during the April 29 – May 1 period might decrease the chances that earlier of later pollinating spikelets survive.

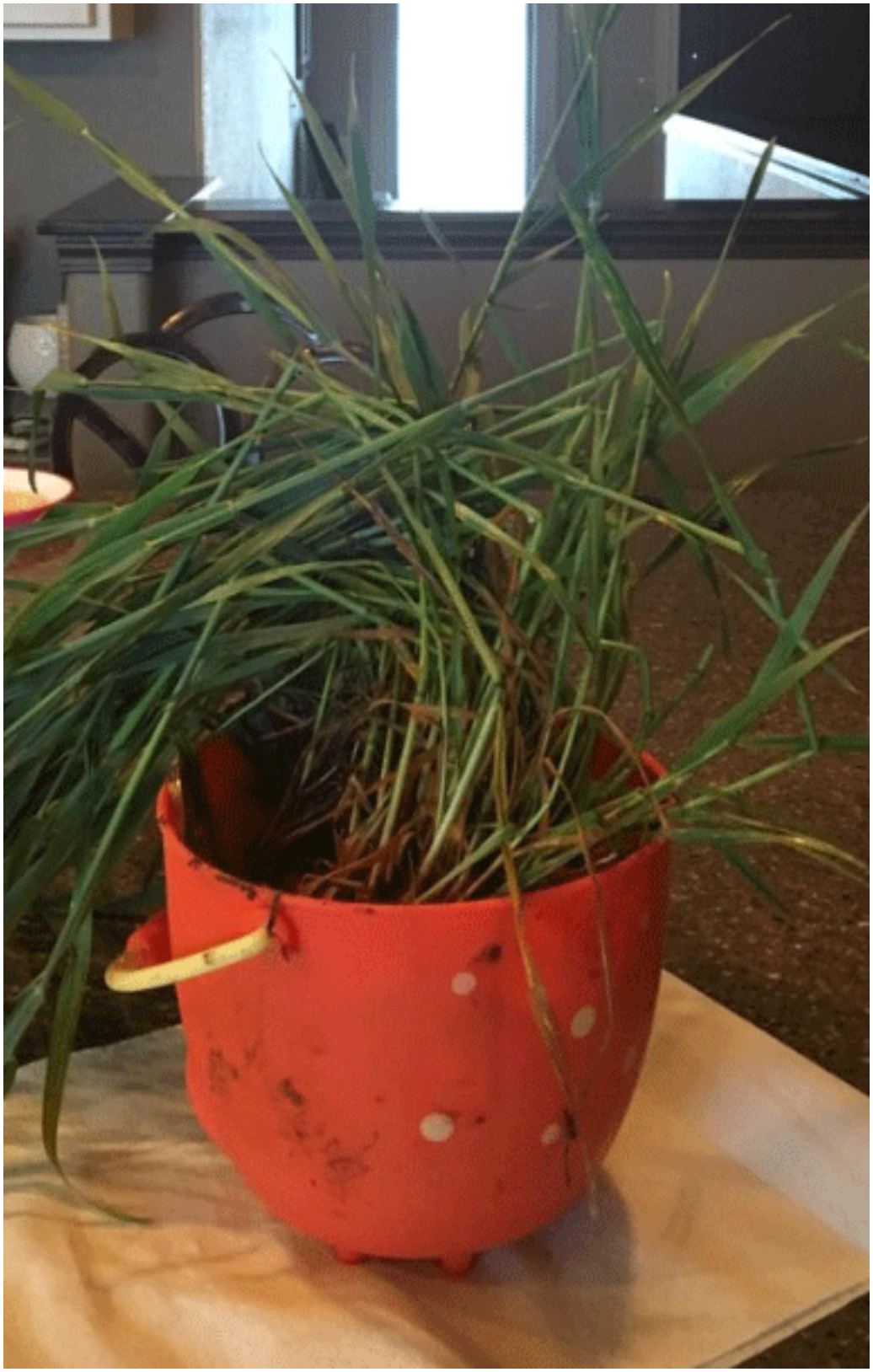

Figure 1. Broken stems of wheat at boot stage as a consequence of the April 29 snowfall. Photo by Rick Horton, wheat producer in Wichita and Finney counties.

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. Additionally, yield loss from stem damage (Fig. 2) will be greater at this stage than at boot stage. Many fields in the western portion of Kansas, particularly southwest, were at or past this stage of development.

Figure 2. Broken stems of wheat with awns beginning to appear. While the above picture was not resulting from snowfall, similar symptoms might be experienced due to the mechanical damage imposed by the heavy snow on the wheat canopy. Photo by Romulo Lollato, Extension Wheat Specialist with Kansas State University. Photo from a stem-bending simulation study conducted near Manhattan during 2015-16.

Flowering

Several fields in the southwest portions of Kansas were flowering as of April 29 – May 1, especially in the southern counties (Meade Co. and surrounding area). In this stage of development, wheat is particularly vulnerable to damage from freezing weather. Temperatures of 30-32 degrees or lower for

about 2 hours or more, can damage anthers.

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 3). If they are damaged by a freeze, they will begin twisting within 2 to 3 days (Figure 4). Shortly afterward, they will begin to turn whitish or brown (Figure 5). 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.

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 6). 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.

Unfortunately, temperatures below 32 degrees were experienced in a great portion of western Kansas consecutively during the April 29 – May 1 period, and temperatures were below freezing for more than 10 hours each day (please see accompanying article in this issue of the Agronomy eUpdate on actual minimum temperatures and duration of below-freezing temperatures). 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 the southwest region. Additionally, if some of the anthers do survive the cold spell, stem breaking at flowering wheat will induce more severe yield losses than in wheat at earlier stages of development.

Figure 3. 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 4. 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 5. 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 6. 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

Access to real-time Kansas Mesonet weather data is available here: mesonet.ksu.edu

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3. Influence of recent weather on wheat stripe rust and leaf rust

The April 24 to May 1, 2017 period has been a critical week for the Kansas wheat crop. Multiple freeze events and snowfall in much of western region of the state dominate the concerns. What about the impact of the freezing temperatures on the development of disease? Unfortunately, the freezing temperatures are unlikely to kill the stripe rust and leaf rust that were already established in our fields. The frequent rains may stimulate additional disease development in areas of the state that escaped the freeze events.

A look at the weather during the past two weeks indicates that conditions were conducive for continued disease development in central and southeastern regions of the state (Figure 1). Many areas of central Kansas had between 12 to 44 hours of favorable temperature and humidity conditions. The southeast region experienced more than 50 hours of temperature and humidity that were favorable for stripe rust.

Observations from the field indicate that stripe rust has moved to the upper leaves of wheat in some parts of central Kansas (Figure 2). Stripe rust is now severe in some fields that were not protected with fungicides in southeast Kansas. The disease had moved to the upper leaves in this region of the state a few weeks ago. Stripe rust was also detected at low levels in the middle or low canopy in new parts of north central and northwest Kansas. Leaf rust was also reported in some additional counties this week with more activity farther west than we had seen to date (Figure 3). Leaf rust was still restricted to the lower and middle canopy in most fields but there are a few locations where the disease has moved to the upper leaves.

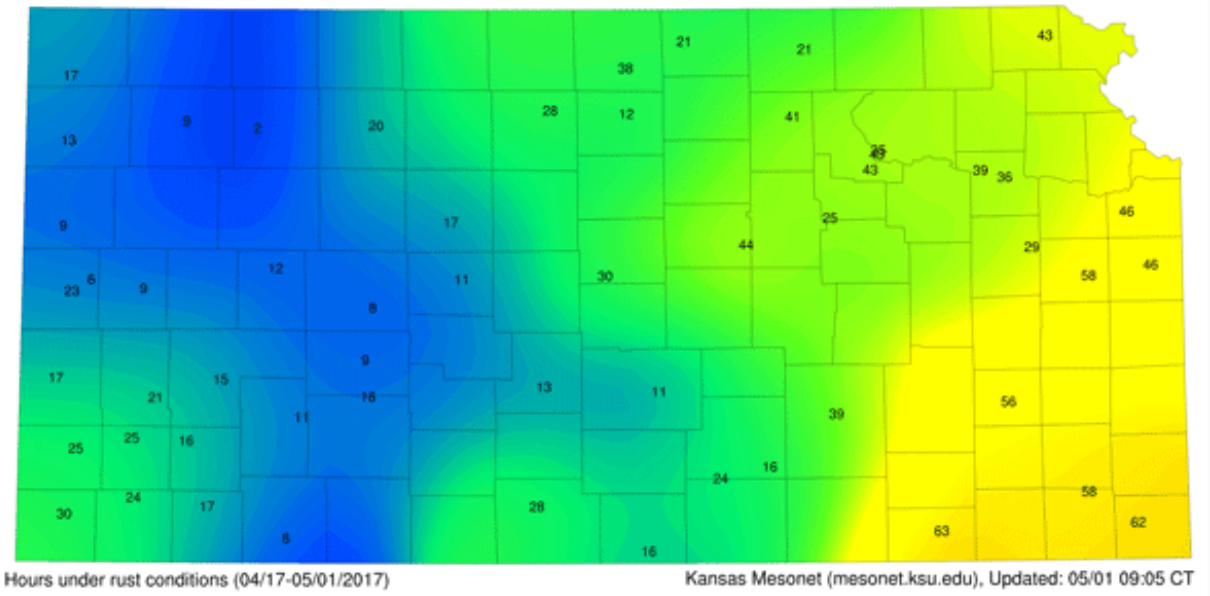
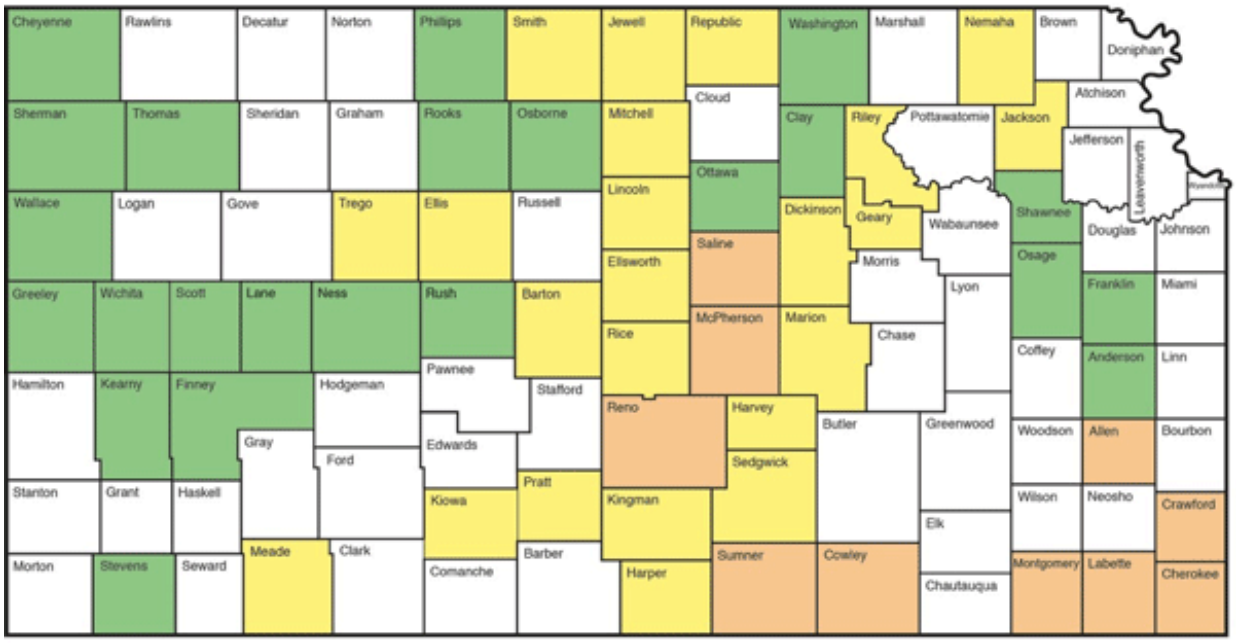


Figure 1. Distribution of weather conditions that were favorable for the development of stripe rust in Kansas. Map shows the number of hours that temperature was between 45-55F and humidity was greater than 87%. Source: Kansas Mesonet and the KSU Weather Data Library.

Distribution of Wheat Stripe Rust

May 1, 2017



Disease Risk

- Stripe rust not observed
- Stripe rust observed on lower leaves
- Stripe rust observed on upper leaves

Disease observation map based on reports from: KSU: E. De Wolf, R. Lollato, S. Duncan, D. Shoup, L. Haag, AJ. Foster, A/ Boor, L. Brooks, J. Carr, J. Coltrain, J. Falk-Jones, D. Hallauer, D. Hibdon, C. Long, T. Maxwell, C. Miller, J. Morris, M. Ploger, Z. Simon, S. Wick Consultants: B. Miller; Growers: J. Blasi, D. Ediger, S. Van Allen

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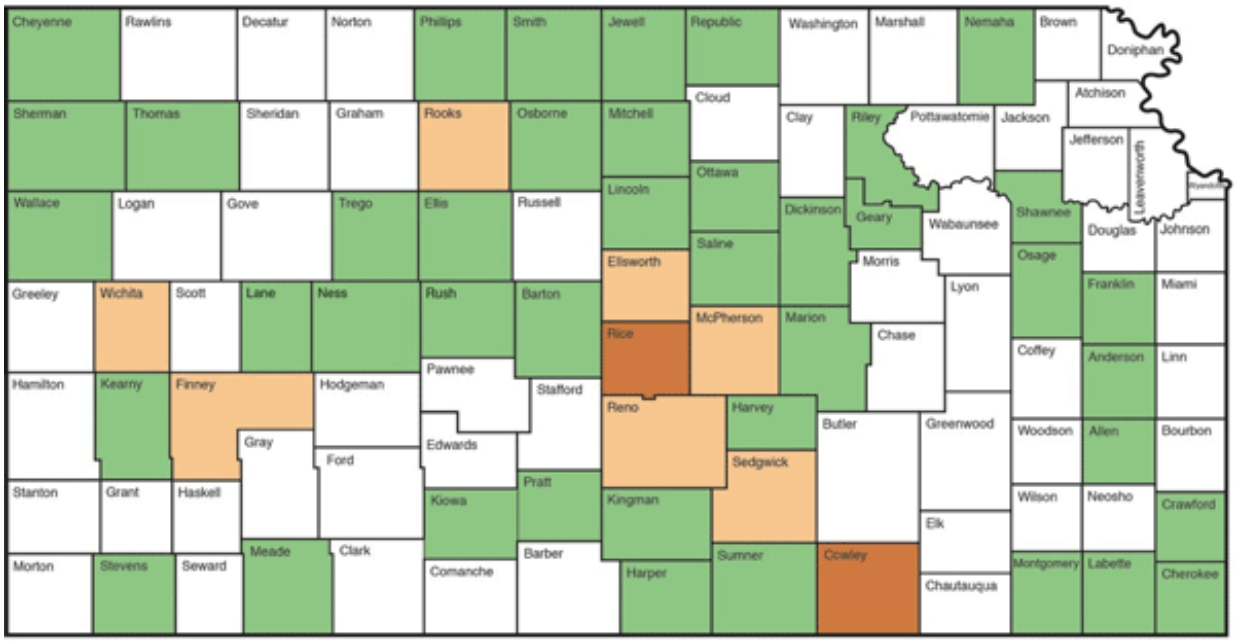
Distribution of Wheat Leaf Rust

May 1, 2017



Disease Risk

- Leaf rust not observed
- Leaf rust observed on lower leaves
- Leaf rust observed on upper leaves

Disease observation map based on reports from: KSU: E. De Wolf, R. Lollato, S. Duncan, D. Shoup, L. Haag, A.J. Foster, L. Brooks, M. Buchanan, J. Carr, J. Coltrain, J. Falk-Jones, D. Hallauer, D. Hibdon, C. Long, T. Maxwell, C. Miller, J. Morris, M. Ploger, Z. Simon, S. Wick; Consultants: B. Miller; Growers: J. Blasi, D. Ediger, S. Van Allen

The reports of disease moving to the upper leaves in central Kansas and additional reports of disease further west are cause for concern. However, the concerns about freeze injury and damage done by recent snow complicate the decision to apply a fungicide to manage rust or other diseases. Growers in areas that escaped the freeze should be considering fungicide applications to prevent further development of stripe rust and leaf rust in susceptible varieties. Growers that are uncertain about yield potential because of damage from recent freeze events and snowfall should be more cautious. Growers with wheat that is at the flag leaf emergence or boot stage of development may have 10-14 days to make their final decision about fungicide applications for this year. Where possible, growers should wait to see how the crop recovers before investing in a fungicide application.

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4. Corn planting in Kansas: Update on soil temperatures

During April 28 to May 1, low temperatures were experienced across Kansas that can produce potential damage to 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.

A map for the duration of soil temperature at the 2-inch depth below 45 degrees F is presented in Figure 1. The main areas of concern are where soil temperatures were below 45 F for more than 8 to 10 hours, affecting all of western Kansas and parts of the north central region (very low temperatures were registered at Scandia). Note that for the western region, soil temperatures below 45 degrees F have an overall duration of at least 20 hours or more than 48 hours (Fig. 1).

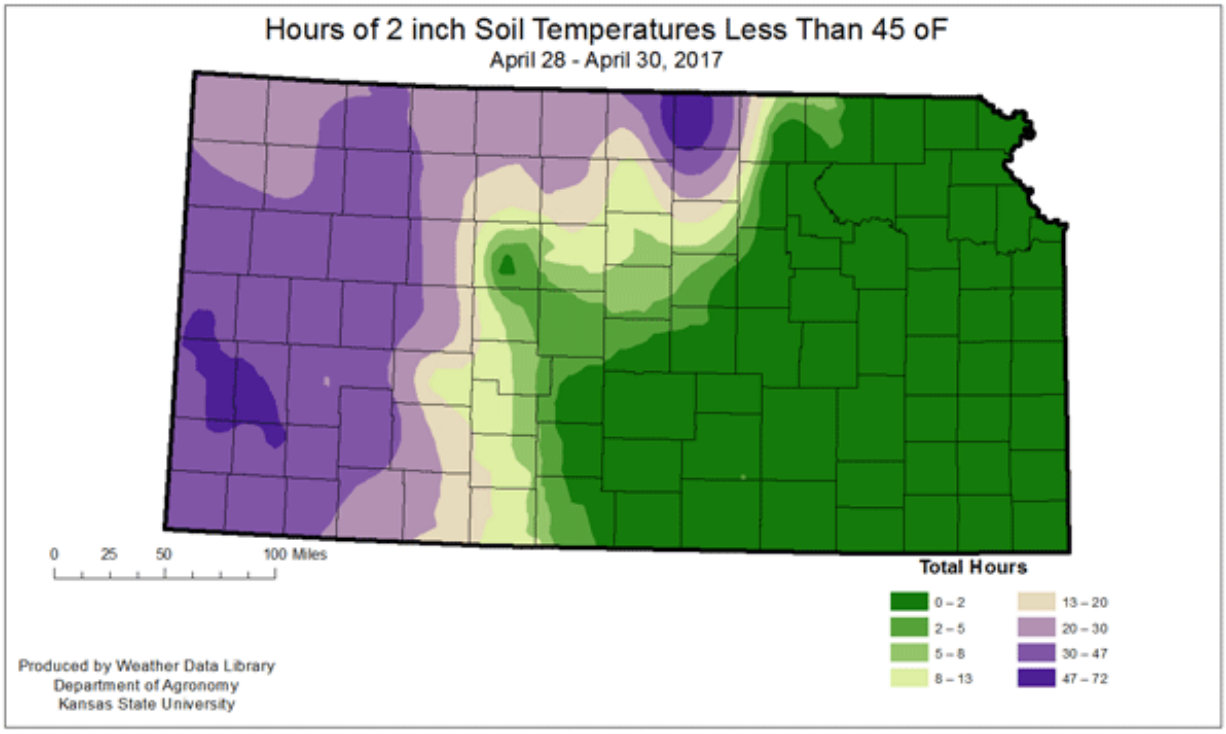

Figure 1. Duration of soil temperatures below 45 degrees F at 2-inch soil depth for the period from April 28 to May 1, 2017.

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.

Soil temperatures below 45 degrees F at 4-inch soil depth were less widespread than at the 2-inch soil depth, but still affected large areas across the western part of the state with durations of more than 20 hours (Fig. 2).

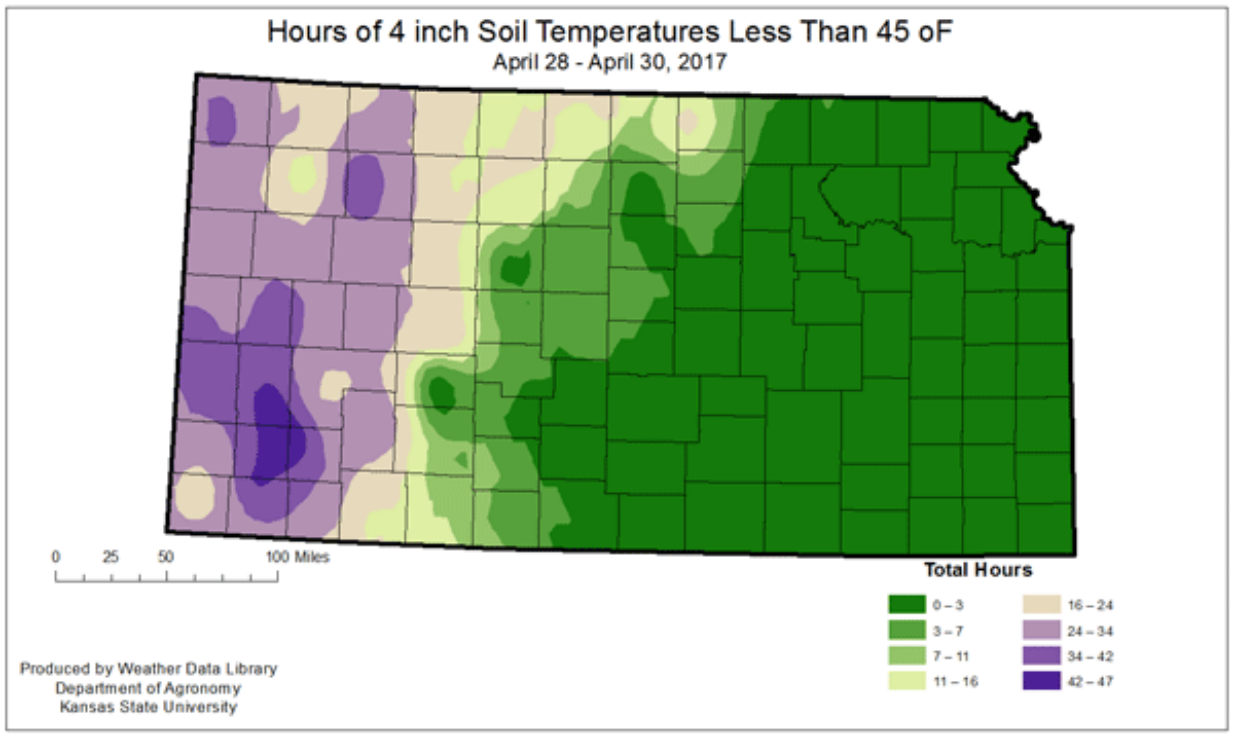

Figure 2. Duration of soil temperatures below 45 degrees F at 4-inch soil depth for the period from April 28 to May 1, 2017.

Soil temperatures at 7 am May 1 are presented in Figure 3. The main concern for recently planted corn (planted in the last few days) is for the north central part of the state and all the western locations, where soil temperatures dropped below 40 degrees F, reaching a minimum of 34 degrees F at the 2-inch depth in the southwest region and 36 degrees F at the 4-inch soil depth. Note the low variation between temperatures at 2-inch and 4-inch soil depth.

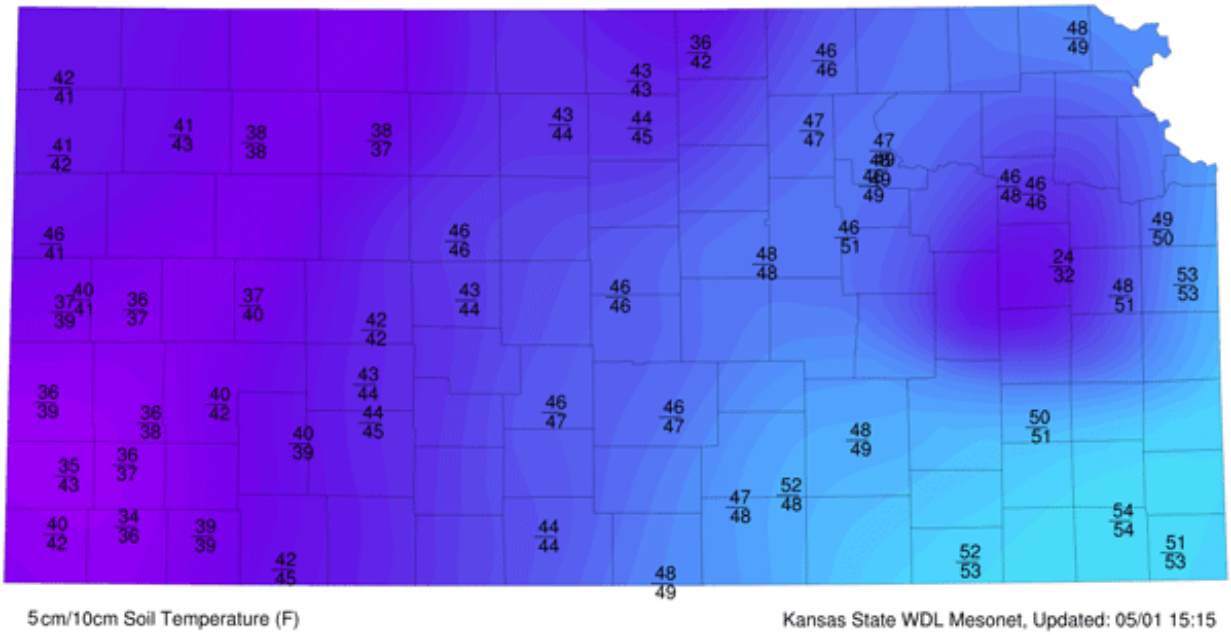

Figure 3. Soil temperatures at 2-inch (upper value) and 4-inch (lower value) recorded at 7 am CT on May 1.

An open window for resuming corn planting seems likely to occur by early next week. If possible, wait and plant under more uniform soil temperature and moisture conditions to guarantee a more uniform early-season stand of plants.

More information about potential damage to recently planted corn will be more evident in the next week or 10 days. An update on planting status of summer row crops will be provided in upcoming issues of the Agronomy eUpdate. Stay tuned!

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