Issue 791

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These e-Updates are a regular weekly item from K-State Extension Agronomy and Kathy Gehl, Agronomy eUpdate 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 Kathy Gehl, 785-532-3354 kgehl@ksu.edu, or Dalas Peterson, Extension Agronomy State Leader and Weed Management Specialist 785-532-0405 dpeterso@ksu.edu.

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1. Diagnosis of early spring freeze injury on wheat

A series of hard freezes has occurred recently in in Kansas, with minimum air temperatures reaching as low as 16 degrees Fahrenheit and minimum soil temperatures of about 33 degrees (Figure 1). It is still several weeks before the normal dates of the last spring freeze in the state, and a freeze during this time normally does not cause any problems for wheat. The exception might be some fields where the development of the crop is more advanced than normal perhaps due to variety selection, tillage practice (soil temperature), planting date, and emergence date (sometimes quite different from planting date due to soil moisture conditions).

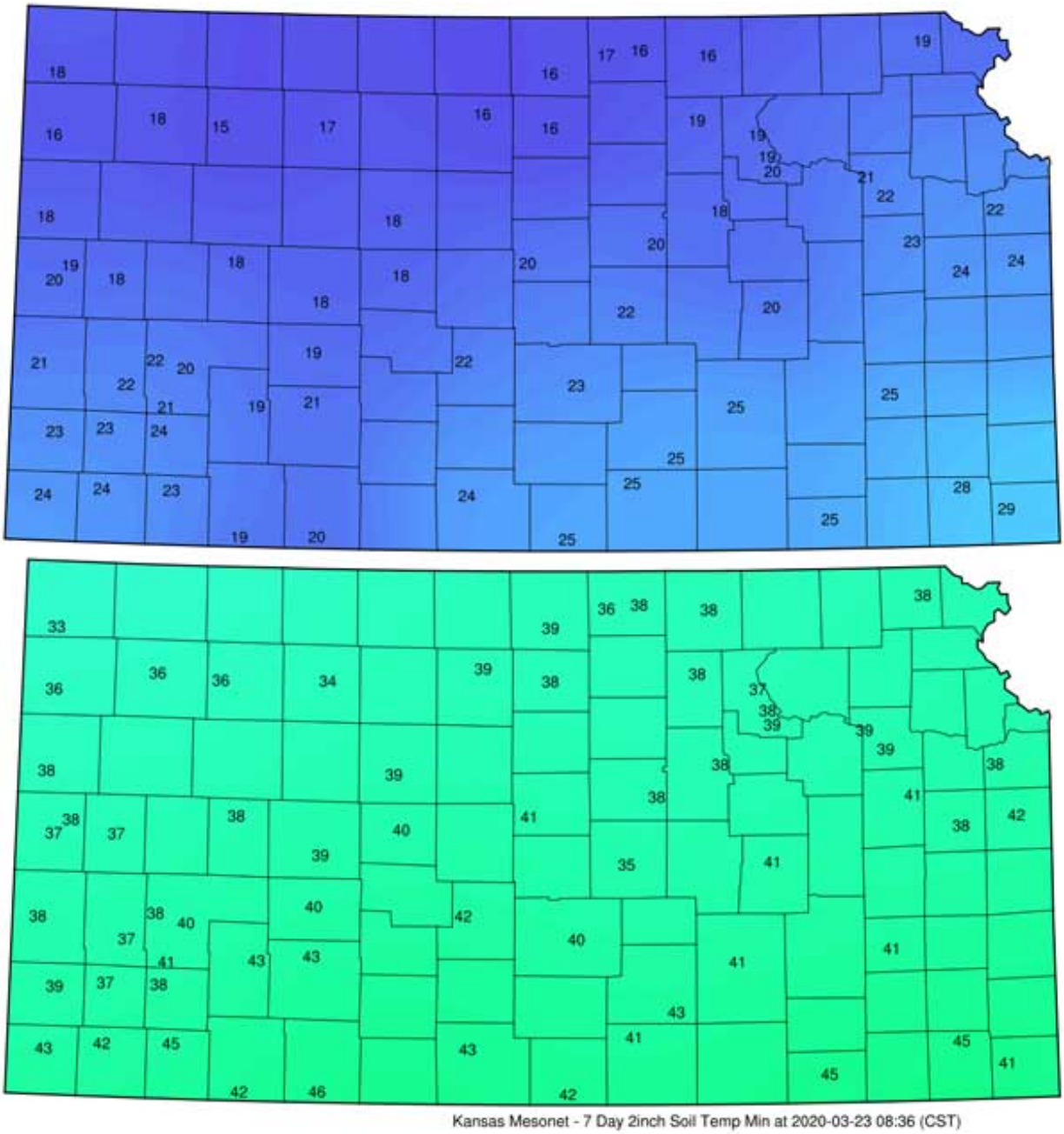

Figure 1. Minimum air (upper panel) and 2-inch soil (lower panel) temperatures recorded during the recent freeze events across Kansas. Maps generated by the Kansas Mesonet.

The most advanced wheat fields in Kansas are currently about Feekes 6 (first node) in south central Kansas. However, many fields have not jointed yet across the state, either due to a later planting date or a later emergence date due to a dry fall (southwest Kansas).

Important factors determining freeze damage

A number of key factors determine freeze damage: the stage of development of the wheat, the density of the stand and condition of the plants, the amount of residue on the soil surface, the extent and duration of low temperatures, temperature gradients within the field (position on the landscape), soil moisture, and the wind speed.

Stage of development.

Greenup. Wheat that hasn't started to joint yet (Feekes 3 through 5) might suffer damage to the existing foliage, but the growing points are still below the soil surface and will be protected by the soil. As a result, the plants should escape injury. This wheat will have cosmetic damage to the leaves, however, that will show up almost immediately as leaf tip burn (Figure 2).

Jointing. Wheat that is jointed or beyond is more sensitive to freeze damage than wheat at green-up because the growing point is above ground. It can still tolerate temperatures in the mid to upper 20's with no significant injury, but if temperatures fall to 24 degrees or lower for several hours, the lower stems, leaves, or developing head can sustain injury. North central and northwest Kansas reported several hours below 24 degrees (Figure 3), so fields currently jointed in that area could suffer freeze damage. Luckily, most of the wheat fields getting to this stage in Kansas are located in the south central part of the state, which did not experience as many hours below 24 degrees F.

Figure 2. Leaf burn from freeze damage. By itself, this is cosmetic damage only. Photos by Romulo Lollato, K-State Extension Wheat and Forages Specialist.

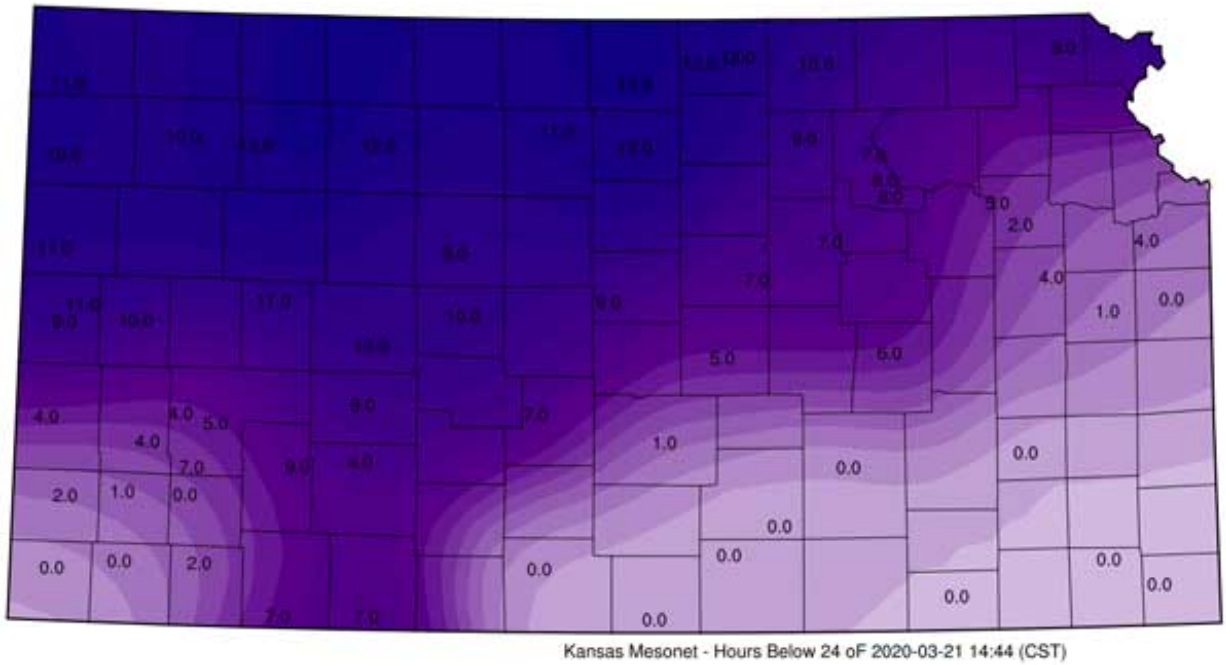

Figure 3. Number of hours below 24 degrees Fahrenheit recorded during the recent freeze events across Kansas. Map generated by the Kansas Mesonet.

Density of the stand and condition of the plants. If the stand is thick, that will tend to reduce the extent of freeze damage as the warmth of the soil will radiate up into the canopy. On the other hand, well-fertilized succulent wheat has often sustained more freeze injury than wheat that is not as well fertilized. Thin stands are at higher risk of injury because the air can penetrate the stand more easily. If the plants were wet before the freeze, this can result in a coat of ice on the plants that may protect the growing point to some extent. If temperatures get too low, however, the cold will go through the ice.

Residue. No-till fields can many times sustain more freeze damage because the residue acts as a blanket and doesn't allow the heat from the soil to radiate up into the plant canopy.

Extent and duration of low temperatures. Significant injury becomes much more likely if the temperatures in the damaging range last for two hours or longer.

Soil moisture. There is often less freeze injury at a given temperature when soils are wet than when dry. Wetter soils tend to radiate a little more warmth than dry soils. On the other hand, drought-stressed plants tend to be more hardened against cold injury and their lower leaf water content tends to decrease the severity of the freeze injury.

Wind speed. Windy conditions during the nighttime hours when temperatures reach their lows will reduce the amount of warmth radiating from the soil and increase the chance of injury.

Temperature gradients within the field (position on the landscape). Low spots in the field are almost always the first to have freeze injury. The coldest air tends to settle in the low areas, especially under calm wind conditions.

Wheat variety. Although the sensitivity to freezing temperatures at a given growth stage is very similar across all varieties, varieties can differ in their release from winter dormancy in as much as three weeks. Because of differences in winter-dormancy release, late-release varieties may escape a freeze injury because they are delayed in their development. For instance, a late-release variety may be at Feekes 4 or 5 and therefore less sensitive to freeze damage than an early-release variety planted at the same time which might have reached Feekes 6 or 7.

Injury symptoms

There are many possible scenarios after a freeze, and producers should not take any immediate decision following a freeze event. Several days of warm temperatures are needed to properly assess freeze damage to the wheat crop. Where wheat was at the jointing stage, producers should watch their fields closely over the next 7 to 10 days from the freeze event for the following:

- The color of newly emerging leaves. If they are nice and green, that probably indicates the tiller is alive. If newly emerging leaves are yellow, that probably indicates the tiller is dead. The color of existing leaves is not terribly important, except for the flag leaf, which should not have emerged at this point in time yet. Existing leaves will almost always turn bluish-black after a hard freeze, and give off a silage odor. Those leaves are burned back and dead, but that in itself is not a problem as long as newly emerging leaves are green.
- The color of the developing head or growing point in wheat that has jointed. As long as heads are light green, crisp, and turgid, the head in that tiller is fine. If the head is whitish, flaccid, and mushy, it has died (Figure 4).

- Ice in the stems. If there was ice in the stems below the first node the morning of the freeze, those tillers may be damaged (although not always) and may not produce grain. You may see split stems from ice accumulation.
- Stem integrity. If the wheat lodged immediately after the freeze, that indicates stem damage. Later tillers may eventually cover the damaged tillers. Even if there is no immediate lodging, look for lesions or crimps anywhere on the stems. If these symptoms are present, it usually means the wheat will lodge at some point during the season. If the stems look undamaged, that's a good sign.

Figure 4. Following an early freeze, crops at jointing might still develop healthy heads (left panel), but depending on minimum temperatures and duration of the freeze event, the developing head might be killed even if still within the stem (right panel). The dead head is whitish and flaccid while the healthy head is light green and turgid. Photos by Romulo Lollato, Wheat and Forage Specialist, K-State Research and Extension.

The best thing producers can do for the first few days is simply walk the fields to observe lodging,

crimped stems, and damaged leaves. Producers should not take any immediate actions as a result of the freeze, such as destroying the field for re-cropping. It will take several days of warm weather to accurately evaluate the extent of damage. After several days, producers should split open some stems and check the developing head.

Where stems and/or growing points were killed by the freeze, new tiller growth (coming from the crown area) will occur (Figures 4 and 5). In many cases, new tiller growth can be observed even when the stems do not show any symptoms of freeze damage for some time. In those cases, the first sign that the tillers are dead is the sudden growth of new tillers at the base of the plant.

If secondary tillers may begin growing normally and fill out the stand, the wheat may look ragged because the main tillers are absent. Producers should scout for bird cherry oat aphids and other potential insect or disease problems on these late-developing tillers. Enough tillers may survive to produce good yields if spring growing conditions are favorable. If both the main and secondary tillers are injured, the field may eventually have large areas that have a yellowish cast and reduced yield potential.

Figure 5. Left: A stem that was split open by having ice form within the stem. This stem has died and a new tiller has begun to grow at the base. Right: Some of the tillers on this plant had freeze damage to the lower stems. These stems are dying, but the symptoms may not be immediately evident. The growth of new tillers from the base of the plant is a sure sign that the main tillers are dead or dying. Note the brown lesion on the stem with the two new tillers. Photos by Jim Shroyer, professor emeritus, K-State Research and Extension.

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

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