Issue 908

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eUpdate

05/26/2022

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. 2022 Kansas Wheat Crop Conditions: a report following the Wheat Quality Tour

2022 Kansas Wheat Crop Conditions: a report following the Wheat Quality Tour

The 2022 Wheat Quality Tour took place May 16 - 19, 2022. About 85 people actively scouted hundreds of Kansas wheat fields in 21 groups spread across six routes (Fig. 1). The groups left Manhattan and headed to Colby on day 1, from Colby to Wichita on day 2, and finally from Wichita to Manhattan on day 3.

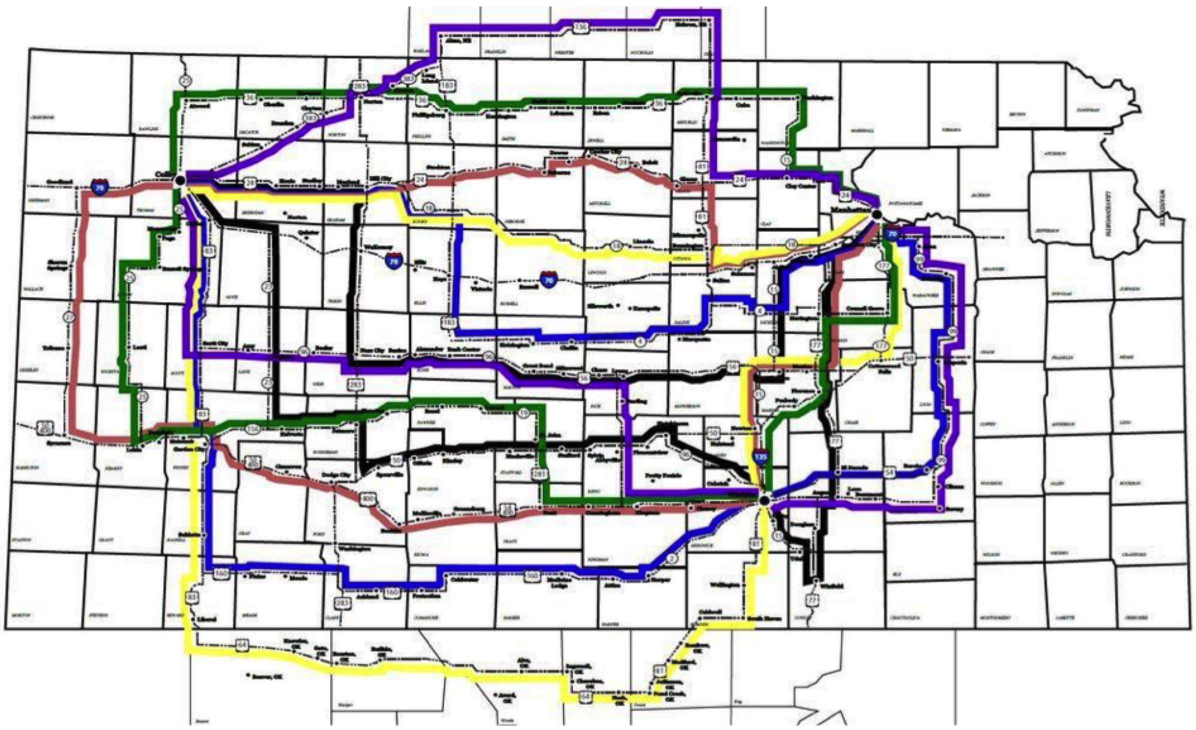

Figure 1. Representation of the six routes (purple, green, pink, yellow, blue, and black) explored during the wheat quality tour. Image courtesy of Wheat Quality Council.

The Kansas wheat crop is currently facing many challenges. Consequently, the overall 2022 production estimate for Kansas resulting from the tour was 261 million bushels of wheat, compared to 364 million bushels estimated by the tour in 2021. Weather conditions during the next 2-3 weeks will be crucial in determining where the final production will actually land. Challenges the 2022 wheat crop has encountered to date include drought stress, heat stress, delayed early spring development, and freeze damage.

Drought stress

Several wheat fields sampled in the western portion of the state (west of a line from Smith to Pratt counties) were showing severe symptoms of drought stress (Fig. 2). These symptoms included current drought stress (younger leaves curled, abortion of older leaves, and yellowing of lower canopy), and long-term drought stress (extremely reduced plant height and biomass, and delayed development). Many of the sampled fields were well into the reproductive stages of development, such as flowering and grain elongation, and were only 9-12 inches tall due to the prolonged stress

(Fig. 2). The lack of growth will not only reduce the crop's yield potential, but also create difficulties during harvest.

For fields under these conditions, yield estimates of 10-20 bushels per acre were common. The conditions deteriorated as the group moved from northwest to southwest Kansas, where drought stress has been more severe (Fig. 3). Precipitation within the next few days is essential to improve crop conditions and ensure some level of harvestable grain yield. If no rain occurs in the next few days, producers will have to face the decision of whether to harvest a crop with extremely limited yield potential or to terminate the crop and switch to a summer crop.

Figure 2. Drought stressed wheat fields in Norton county, Kansas. Symptoms include decreased crop biomass production and height, curled leaves, abortion of older leaves, and yellowing of lower canopy. Photos taken by Romulo Lollato, K-State Research and Extension.

Figure 3. Drought stressed wheat fields in Kearney county, Kansas. Symptoms are similar to those in the photos above: decreased crop biomass production and height, curled leaves, abortion of older leaves, and yellowing of lower canopy. Photos taken by Romulo Lollato, K-State Research and Extension.

Heat stress

The second largest concern affecting the 2022 winter wheat crop in Kansas is heat stress. Many fields in the southern portion of the state were showing signs of heat stress, such as scorched white heads (Fig. 4). Heat stress interacts with drought stress and thus the symptoms tended to be worst in southwest Kansas. However, the poor conditions resulting from the combination of heat and drought stresses extended as far east as Pratt and Kingman counties.

Figure 4. Field in southwest Kansas showing signs of head scorching likely due to heat stress. Photos taken by Romulo Lollato, K-State Research and Extension.

Delayed early spring development followed by accelerated reproductive development

The months of January through March 2022 were cooler than average (Fig. 5) consequently delaying crop development. For instance, in previous years of the wheat tour, stages of crop development around the state ranged from early grain fill in south central Kansas to boot stage in northwest Kansas, and the tour used to be conducted in the first week of May, two weeks prior to this year's tour. This year, in the third week of May, the furthest along fields sampled were in the milk stages of development in south central Kansas, and the majority of wheat in northwest Kansas is just now heading.

The first consequence of this delayed development has been a shortened period of reproductive development, as the crop went through stem elongation in a matter of just a few days. In terms of grain yield, the impacts of the delayed development will depend on the weather conditions during the remainder of May and June. If conditions are cool and moist, the crop might still go through favorable grain fill conditions and produce a decent test weight and fulfill whatever potential is still present.

However, if temperatures are normal or above normal and precipitation is below normal, the crop will go through grain fill during warmer conditions. This can severely limit grain yield. Drought and heat stress during grain fill limit the photosynthetic production of sugars and decrease the accumulation of starch in the grain, reducing grain test weight and grain yield, consequently increasing the percent protein in the grain.

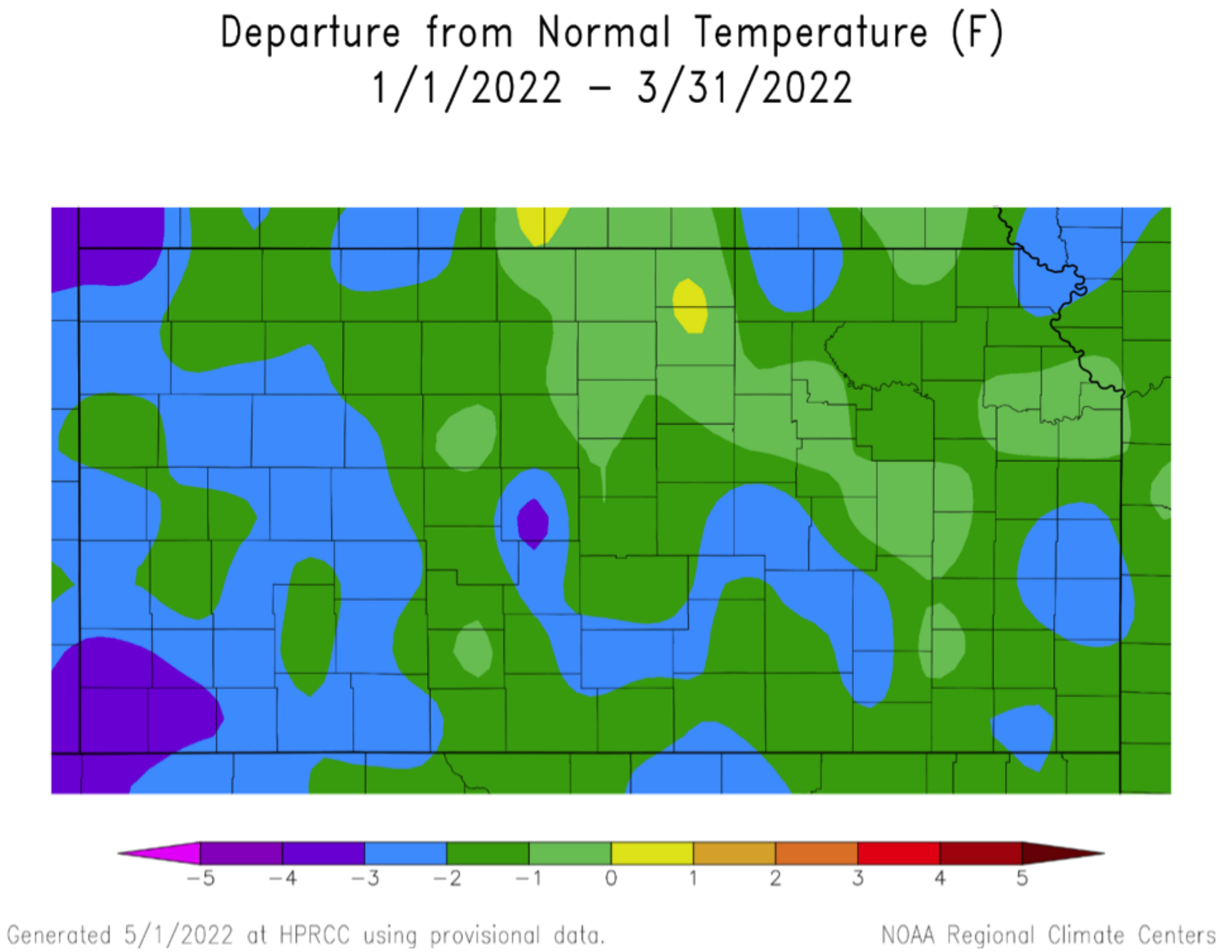

Figure 5. Departure from normal mean temperature during the months of January, February, and March 2022.

Freeze damage

The majority of the state is showing symptoms of freeze damage, not only in the leaves but also to the heads (Fig. 6). Burnback of leaf tissue resulting from a freeze should be mostly cosmetic and not result in yield reduction, but damage to the heads can reduce yield potential. Freeze injury seems to be widespread across the state, but with fairly low within-field incidence of damaged heads. If the crop has enough moisture from here onwards, it should help compensate for the lost tillers and yield reductions from this problem might be minimal. If the crop has been severely damaged by freeze, yield losses might be severe enough to justify no further investment in the crop.

Figure 6. White heads showing symptoms of freeze damage to wheat field in Pratt County, Kansas. Photos by Romulo Lollato, Extension Wheat Specialist with Kansas State University.

Summary

The above factors are a few of the major challenges that the 2022 Kansas wheat crop is currently facing. While each of those factors could restrict wheat yields to a certain extent, the largest uncertainty when estimating wheat production at the state level at this time of year is the weather during grain filling. Although the crop has been severely drought stressed for the majority of the growing season in western and parts of central Kansas, the recent cool and moist conditions during grain fill should help ensure that the current potential of the crop is attained.

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2. Possible causes for white heads in wheat

White heads have been appearing in many wheat fields around Kansas. Sometimes the white heads are just single tillers scattered throughout part or all of a field, and sometimes they occur in small-to-large patches. Heads might be completely white starting from the stem, or may just have a few spikelets showing the discoloration.

There are many causes of white heads. Here are some of the most common causes and their diagnosis.

Freeze injury to stem or crown. Depending on the stage of growth at the time of a late spring freeze, parts or all of the heads may die and turn white (Fig. 1).

In years when the freeze occurs about the boot stage or a little earlier, there can be injury to the lower stem, which then cuts off water and nutrients to the developing head and that stem simply does not develop. In years when the wheat is in the early heading stage at the time of the freeze, the freeze can damage the heads directly.

Often, wheat on north-facing slopes, on ridge tops, or in low-lying areas will be most affected by freeze injury. But freeze injury can also be so severe that it occurs throughout the fields, in no particular pattern. Crown rot is another potential problem that can be traced back to freeze injury.

When the crown is damaged by cold temperatures or a freeze, part or all of the tillers can die. If the tiller from a damaged crown forms a head, this head will almost always be white. The crown will have internal browning, and stands will usually be thinner than normal.

Figure 1. Freeze-damaged wheat heads. Photos by Romulo Lollato, K-State Research and Extension.

Hail. Hail can cause a white head to appear when it breaks the connection between the stem and the head (Figure 2). Occasionally, hail can also damage just a portion of a head, and cause that damaged portion to turn white. The hail impact to the heads may also remove spikelets and expose the rachis (Figure 3).

Figure 2. Wheat field in Sumner County showing a high incidence of white heads due to hail damage. Photo taken May 22, 2019 by Romulo Lollato, K-State Research and Extension.

Figure 3. The heads in this photo have had a few spikelets removed due to hail impact and have their rachis exposed. Photo by Romulo Lollato, K-State Research and Extension.

Heat stress. Heat stress can scorch wheat heads and make them turn white, usually starting from the top and moving downwards (Fig. 4). Depending on the level of heat stress, entire tillers may be scorched in a given plant.

Figure 4. White wheat heads caused by heat stress. Notice the scorched appearance starting from the top of the head and moving downwards. Photo by Romulo Lollato, K-State Research and Extension.

Dryland root rot (also known as dryland foot rot). This disease, caused by the *Fusarium* fungus, causes white heads and often turns the base of the plants pinkish (Fig. 5). As with take-all, dryland root rot causes all the tillers on an infected plant to have white heads. This disease is usually most common under drought stress conditions, and is often mistaken for either drought stress or take-all.

Figure 5. White wheat head caused by Fusarium root rot. Detail on the right shows pink discoloration inside the stem typical of the Fusarium pathogen. Photo by Romulo Lollato, K-State Research and Extension.

Head scab. When there are periods of rainy weather while the wheat is flowering, as seen across North Central and Northwest Kansas this growing season, some heads may become infected with Fusarium head blight and turn white. The heads of some red-chaffed varieties turn a darker red when infected with scab, but the heads of most varieties turn white. Symptoms can be restricted to one or few spikelets in the head, but often times the upper half or the entire head might be affected (Fig. 6). Head scab is most common where wheat is grown after corn, or after a wheat crop that had head scab the previous year. Head scab can be identified by looking for pink spores of the Fusarium fungi, as well as by a darker discoloration to the rachis of the wheat head. During the current growing season, head scab has been observed at low levels in south-central and southeast Kansas, but it is probably still early to see symptoms in north-central and northwest Kansas as it takes approximately three weeks from flowering for the first symptoms to appear.

Figure 6. Wheat heads affected by head scab or Fusarium head blight. Symptoms range from one or few spikelets that turned white, to the upper half or entirety of the head. Photo by Romulo Lollato, K-State Research and Extension.

Take-all. This disease often causes patches of white heads scattered throughout the field. It occurs most frequently in continuous wheat, and where there is a moderate to high level of surface residue. Take-all is also favored by high pH soils, so a recently limed field might also show symptoms. To diagnose take-all, pull up a plant and scrape back the leaf sheaths at the base of a tiller. If the base of the tiller is shiny and either black or dark brown, it is take-all. All tillers on a plant infected with take-all will have white heads. Plants will pull up easily.

Sharp eyespot. This disease is common in Kansas, but rarely causes significant yield loss. Sharp eyespot causes lesions with light tan centers and dark brown margins on the lower stems. The ends of the lesions are typically pointed. If the stems are girdled by the fungus, the tiller may be stunted with a white head. Each tiller on a plant may be affected differently.

Wheat stem maggot. Wheat stem maggot damage is common every year in Kansas, but rarely results in significant yield loss. It usually causes a single white head on a tiller, scattered more or less randomly through part or all of a field. One typical symptom of white heads caused by wheat stem maggot is that the flag leaf and lower stem are often green, and only the last internode (peduncle) and head are white. If you can grab the head and pull the stem up easily just above the uppermost node, the tiller has probably been infested with wheat stem maggot. Scout for symptoms of chewing close to the base of the plants, which could indicate that the head has died as function of wheat stem maggot (Figure 7).

Figure 7. White wheat head due to wheat stem maggot, characterized by a white head and peduncle but with a healthy and green lower stem. Detail on the right shows chewing of the base of the peduncle by the maggot. Photo by Romulo Lollato, K-State Research and Extension.

Premature dying. As wheat begins to mature, plants in some areas of the field may have an off-white color similar to take-all (Figure 8). This premature dying could be due to drowning, hot dry winds, or some other stress. The pattern of discolored heads will often follow soil types or topography, and may occur in large patches. The grain will be shriveled and have low test weight.

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Figure 8. Large patches of drowned wheat in central Kansas (upper photo) and south central Kansas (lower photo). Photos taken May 16 and 17, 2017, by Romulo Lollato, K-State Research and Extension.

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3. Considerations when harvesting short wheat

In many areas of Kansas, prolonged drought has resulted in short wheat and thin stands. Harvesting wheat in these situations can be a challenge. Special attention needs to be given to cutting height, machine adjustments, and operator control. In short wheat, getting the heads into the combine with less straw will be a challenge. In some cases, the reel may not be able to effectively convey the wheat back from the cutter bar to the auger, nor hold it in place during cutting. Short cutting will also mean more contact potential with the ground and reduced levels of surface residue which will likely negatively impact cropping systems in water-limited environments.

In the case of material conveyance, stripper headers, air reels, and draper headers may be a great help.

Stripper headers

Stripper headers allow the grain to be harvested efficiently while leaving the maximum amount of standing residue in the field. Research has shown that this preservation of wheat residue can reduce evaporative losses of water after harvest, aid in the moisture retention of snow, and improve the yields of the next year's crop.

To properly use a stripper header, note the following:

- Operators need to be aware of the stripping rotor height and the relative position of the hood to the rotor. This position needs to be set correctly so that heads approach the rotor at the proper angle for stripping.
- Keep the nose of the hood orientated so that the top of the wheat heads are even with, or slightly below, the forward point of the nose. This may require operating the header with the nose in a slightly lower-than-normal position relative to the rotor. However, it's important to note that running a stripper header lower than necessary will result in increased power consumption and accelerated finger wear.
- Combine ground speeds should be kept high (above 4 mph) to maintain collection efficiency and minimize header losses.
- Several people have reported that adjusting header height with a stripper header is not as critical as it is with a conventional header, and that a stripper header could easily be run by non-experienced people (see step 1).
- Continue to adjust stripping rotor speed throughout the day as conditions change. If rotor speeds are too high, that will result in detachment of the entire head and unnecessary increases power requirements. Rotor speeds that are too slow will result in unstripped grain remaining in the head. In general, rotor speeds will be less in thin short wheat than in better stands.

Air reels

Air reels will also aid in the material conveyance from the cutter bar to the auger in reel-type units when crops are light or thin. These units are made in several different types including finger air reels, non-reel, and units that fit over existing reels. Examples of manufacturers are Crary (West Fargo, ND) and AWS (Mitchell, Ontario Canada). Non-reeled units have the advantage of less eye strain from the continuously rotating header reel, but all units have collection efficiencies compared to conventional reels even in sparse or short crops. These units do not control the amount of wheat stubble left in the field and the operator still has to control the cutting height. In short wheat this may mean little to no field stubble will be left for next season's moisture collection and for these reasons stripper headers may be better choice for certain areas of Kansas.

Draper headers and flex heads

Draper headers may help with the conveyance of material since they have a very short distance between the cutterbar the conveyance belt. The ability to tip the cutterbar completely back will aid in keeping harvested crop material moving across the cutter bar and onto the belt as well as ensuring some stubble remains standing on the soil surface. Cleats on the belt need to be in good to new condition to maximize conveyance of crop material away from the cutterbar. Set gauge wheels properly to maximize cutting height and leave standing residue.

Flex heads will also help deal with the lower cutting heights and potential ground strikes. In thin stands of wheat it is even more important that sickles and guards are in good condition as there is less crop material pushing into the cutting area, which would normally help ensure cutting by worn sickles and guards. On headers with finger reels, it is quite likely that the short cut wheat will pass in between the fingers rather than being swept backward. Producers may consider adding material over or behind the fingers to act more as a bat to sweep the cutterbar clean. Plastic/vinyl materials or repurposed round baler belting have been successfully used for this purpose.

If harvesting with a draper or flex header, maintain the cutting height as high as possible to preserve standing stubble. Typically, cutting wheat at two-thirds of its full height will result in losses of less than 0.5 percent as any missed heads contain light weight grain that will be lost as tailings during the harvesting process.

Conventional headers

For many farmers, new equipment may not be an economical choice and you may have to make do with a conventional head on your combine. In this case, adjust the reel to get the best movement of the heads from the cutter bar to the auger. Combining in slightly damp conditions may help prevent shatter and decrease losses. If wheat heads have flipped out of the header from the top of the auger, an extra "auger stripper bar" may necessary. A small strip of angle iron can be bolted slightly behind and below the auger to help with material conveyance. In thin wheat stands it is even more important that sickles and guards are in good condition as there is not as much crop material to push into the cutting area and ensure cutting by worn sickles and guards.

If harvesting with a conventional header, maintain the cutting height as high as possible to preserve standing stubble. Typically, cutting wheat at two-thirds of its full height will result in losses of less than 0.5 percent as any missed heads contain light weight grain that will be lost as tailings during the harvesting process.

Combine adjustments

In addition to material conveyance and cutting height, lower yields and uneven crop flow may also require performing combine adjustments to the concave/rotor cage clearance, cylinder/rotor speed, and fan speed. Follow the manufacturer's recommendations. The leading cause of grain damage under almost any harvesting condition is overly fast cylinder or rotor speed. This will especially be evident in harvesting short wheat as there will be less material in the concave or rotor cage to thresh against, increasing the likelihood of grain damage if cylinder/rotor speed is too high.

On conventional machines it may be necessary to reduce concave clearance to attain good separation. On rotary combines it may be advantageous to maintain a typical clearance to provide a more normal threshing condition while using less threshing area. The use of blanking plates on the rotor cage may improve separation. Fan speeds may need to be reduced slightly in order to minimize grain losses. Once adjusted properly, try to keep material crop flow as constant as possible as most threshing and cleaning units work best under these constant flow conditions. As the amount of material passing through the combine decreases the response to various settings such as cylinder/rotor speed, concave/rotor cage clearance, and fan speed will be more sensitive than under more normal operating conditions.

Performing kill-stops during harvest will be especially critical in evaluating grain losses and identifying which stage of the harvesting process is the source. After performing a kill-stop the operator should look at shattered grain losses before the header, losses after the header and before the spread pattern of the combine, and losses in the tailings behind the combine. Losses can be quickly checked by looking at the number of seeds in the tailings and elsewhere around the combine.

Typically, 20 seeds per square foot is equal to 1 bushel per acre for a sampling area equal to the cutting width of the combine. For the tailings area, where the material is concentrated, multiply the 20 seeds per square foot by the header-to-tailings width ratio. For example, a combine with a 7-foot spreader width and 28-foot header would have a factor of 4 (28 divided by 7), and 80 seeds per square foot (20 x 4) would be the correct number for a bushel-per-acre loss. Also, a normal shoe length is typically one foot, so estimated measurements can be done with your foot. Individual field and header losses are determined by looking at areas before and under the combine. Actual combine threshing losses are determined by subtracting these numbers from the tailing loss.

Summary

Although this will be a rough wheat harvest for many farmers, some changes can be made to help maximize harvest efficiencies. If you have ever wanted to try an alternate header (stripper, flex-draper, etc.), this may be the year for you. For those not wanting to buy, renting may also be a viable option.

Producers in dryland production systems need to keep in mind that in very low-yielding wheat years, anything that can be done to preserve what little crop residue is present will have large impacts on evaporative losses and productivity of the next crop.

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4. Pre-harvest weed control in wheat

Making a herbicide application that will not directly influence crop yield is a difficult decision to make. Such is the case with pre-harvest weed control applications to wheat fields. However, pre-harvest applications may be beneficial, especially in wheat fields with short or thin stands or fields that were not treated earlier in the season.

When broadleaf weeds grow rapidly at the end of the growing season, several potential concerns arise such as harvest difficulties, dockage problems, weed seed production, and soil water depletion. A pre-harvest herbicide application can address these concerns. However, it is very difficult to estimate the value of pre-harvest weed treatments as its more immediate potential benefits would be measured in terms of improved harvest efficiency and lower dockage. It may not pay to treat wheat with lower weed densities unless harvest is delayed.

Other potential benefits are longer-term. If the weeds are about to set seed, a pre-harvest treatment can go a long way toward reducing weed problems in future years by preventing seed production. Also, if weed densities are high, water depletion for subsequent crops could become significant unless the weeds are controlled prior to harvest.

Herbicides labeled for use as harvest aids in wheat are listed in Table 1. There are differences in how quickly they act to control the weeds, the interval requirement between application and grain harvest, and the level or length of control achieved. All of them will require thorough spray coverage to be most effective. Paraquat is sometimes mentioned as a possible herbicide for pre-harvest application but is **not** labeled for pre-harvest treatment in wheat**.** Application of paraquat to wheat is an illegal treatment and can result in a quarantine and destruction of the harvested grain, along with severe fines.

Figure 1. Weeds in wheat near harvest time. Photo by Dallas Peterson, K-State Research and Extension.

Table 1. Herbicides for use a pre-harvest weed control options in wheat.

Herbicide and rate	Weeds controlled	Application timing	PHI* (days)	Comments
Metsulfuron (Ally, others) 0.1 oz	Some broadleaf weeds	Hard dough stage	10	Use 0.25 to 0.5 % v/v nonionic surfactant) Apply in combination with glyphosate or 2,4-D Do not use on soils with a pH greater than 7.9 12- to 34-month rotation interval for soybeans Kochia, pigweeds, and marestail may be resistant
2,4-D LVE 1 pt of 4lb/gal product or 2/3 pt 6 lb/gal product	Broadleaf weeds	Hard dough stage	14	Weak on kochia and wild buckwheat
Dicamba	Broadleaf	Hard dough	7	Do not use treated wheat for seed

0.5 pt	weeds	stage and green color is gone from nodes		unless a germination test results in 95% or greater seed germination.
Glyphosate 1 qt of 3 lb ae/gal product, 22 fl oz of 4.5 lb ae/gal product	Grasses and broadleaf weeds	Hard dough stage (30% or less grain moisture)	7	Consult label for recommended adjuvants Not recommended for wheat being harvested for use as seed Kochia, pigweeds, and marestail may be resistant.
Carfentrazone (Aim EC, others) 1 to 2 fl oz	Pigweeds, kochia, lambsquarters, Russian thistle, wild buckwheat		7	Use 1% v/v crop oil concentrate Acts quickly, usually within 3 days Regrowth of weeds may occur after 2-3 weeks or more, depending on the rate used.
Saflufenacil (Sharpen) 1 to 2 fl oz	Broadleaf weeds	Hard dough stage (30% or less grain moisture)	3	Use 1% v/v methylated seed oil + 1 to 2% w/v AMS or 1.25-2.5% v/v UAN 1 month rotation interval for soybean

*PHI = Pre-harvest interval, or days required between application and harvest.

For more detailed information, see the “2022 Chemical Weed Control for Field Crops, Pastures, and Noncropland” guide available online at https://www.bookstore.ksre.ksu.edu/pubs/CHEMWEEDGUIDE.pdf or check with your local K-State Research and Extension office for a paper copy. The use of trade names is for clarity to readers and does not imply endorsement of a particular product, nor does exclusion imply non-approval. Always consult the herbicide label for the most current use requirements.

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5. Western Corn Rootworm Bt Traits and Resistance

Western corn rootworm resistance to Bt corn continues to be an issue in continuous corn in the United States. Fueled in part by repeated use of the same Bt traits and low refuge compliance during the early phases of adoption, field evolved resistance was first detected in 2009. To date, resistance to every commercially available Bt trait package has been detected in major corn production areas of the country. However, resistance is not uniform across all corn growing regions so be sure to check local conditions when making planting decisions. A list of trait packages targeting corn rootworm can be found in Table 1.

Trait Package	Rootworm Bt Proteins Included	Refuge in Bag	Structured Refuge Requirement
AcreMax CRW	Cry34/35Ab1	10%	
AcreMax1	Cry34/35Ab1	10%	
AcreMax TRIsect	mCry3A	10%	
AcreMax Xtra	Cry34/35Ab1	10%	
AcreMax Xtreme	mCry3A, Cry34/35Ab1	5%	
Agrisure 3122 E-Z Refuge	mCry3A, Cry34/35Ab1	5%	
Agrisure Duracade 5122 E-Z	mCry3A, eCry3.1Ab	5%	
Agrisure Duracade 5222 E-Z	mCry3A, eCry3.1Ab	5%	
Agrisure Duracade 5332-E-Z	mCry3A, eCry3.1Ab	5%	
QROME	mCry3A, Cry34/35Ab1	5%	
STX Refuge Advanced	Cry3Bb1, Cry34/35Ab1	5%	
STX RIB Complete	Cry3Bb1, Cry34/35Ab1	5%	
SmartStax Enlist	Cry3Bb1, Cry34/35Ab1	5%	
SmartStax Pro w/RNAi*	Cry3Bb1, Cry34/35Ab1 + DvSnf7 dsRNA	5%	
VT3P RIB Complete	Cry3Bb1	10%	
Agrisure 3000GT&3011A	mCry3A		20%
Agrisure Viptera 3111	mCry3A		20%
Herculex RW	Cry34/35Ab1		20%
Herculex XTRA	Cry34/35Ab1		20%
Intrasect TRIsect	mCry3A		20%
Intrasect Xtra	Cry34/35Ab1		20%
Intrasect Xtreme	mCry3A, Cry34/35Ab1		5%
SmartStax	Cry3Bb1, Cry34/35Ab1		5%
TRIsect	mCry3A		20%
Yieldgard Rootworm	Cry3Bb1		20%
Yieldgard VT Triple	Cry3Bb1		20%

Table 1. Bt trait packages for corn rootworm control. Information adapted from "The Handy Bt Trait Table" by Chris DiFonzo, Michigan State University, March 2022. *No confirmed rootworm resistance to this trait package as of 2022.

Figure 1. Western corn rootworm larvae. Photo by Anthony Zukoff, K-State Research and Extension.

Whatever hybrid you chose to plant, evaluating corn roots for rootworm damage during the growing season is recommended (Figure 1). Doing so allows you to get an idea of how well your rootworm management practices are working. It also provides a way to detect rootworm problems in first year corn as well as the potential development of resistance to the Bt hybrid planted.

Details for the process of evaluating corn root damage can be found in [*Corn Rootworm Management in Kansas Field Corn*](), K-State Research and Extension publication MF845.

In short, several plants should be dug up throughout the field and their roots washed well for subsequent evaluation using the Iowa State University 1-3 Node Injury Scale. Timing is important. Root samples should be examined after peak damage from rootworm larvae occurs but before roots begin to regrow, typically late June to early July.

Corn rootworm resistance to a Bt protein should be considered if:

* The node injury rating is 1.0 in a field with at least two consecutive years use of the same single corn rootworm Bt toxin, or

* The node injury rating is greater than .5 in a field with at least two consecutive years use of the same pyramided corn rootworm Bt toxins.

It is important to remember that the best management tool for western corn rootworm is rotation. In continuous corn production, this includes rotating Bt traits annually to help slow the evolution of resistance. Rotation to a non-Bt hybrid combined with soil-applied insecticides would be another option for continuous corn. Both of these practices will be useful for prolonging the efficacy of currently available Bt traits.

The table of Bt packages above may look extensive, but there are only 5 traits represented total. Careful selection of a new trait or combination of traits each season is just as important as the rotation practiced with other IPM tools.

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6. Sorghum management considerations: Planting practices

There can be considerable environmental variation across the state during the growing season of grain sorghum, with a high probability of drought after flowering when moving toward the west. Tailoring the right management strategy to every site is critical to increase productivity and reduce the impact of abiotic stressors (Figure 1). The most critical planting practices affecting yields in sorghum are: row spacing, row arrangement, seeding rate/plant population, planting date, and hybrid maturity.

Figure 1. Well-managed sorghum. Photo by Constanza Mackrey, K-State Research and Extension.

Sorghum plants can compensate and adjust to diverse environmental conditions through modifications in the number of tillers, head size, and final seed weight. For sorghum, the final number of seeds per head is the plant component that varies the most; and thus has more room for adjustment than the other plant components (seed weight and number of tillers).

Seeding rates and plant populations

Sorghum population recommendations range from a desired stand of 23,000 to more than 100,000 plants per acre depending on average annual rainfall (Table 1).

Table 1. Grain sorghum recommended seeding rate, plant population and row spacing based on average annual rainfall. Source: https://www.bookstore.ksre.ksu.edu/pubs/MF3046.pdf

Avg. Annual Rainfall (inches)	**Seeding rate (x 1,000 seeds/acre)***	**Recommended Plant Population (x 1,000 plants/acre)**	**Within-row Seed Spacing (70% emergence) 10-inch rows**	**20-inch rows**	**30-inch rows**
< 20	30-35	23-27	21-18	10-9	7-6
20 to 26	35-64	25-45	18-10	9-5	6-3
26 to 32	50-80	35-55	13-8	6-4	4-3
> 32	70-125	50-90	9-5	4-2	3-2
Irrigated	110-150	80-110	5-4	3-2	2-1

* Assuming 70% field emergence.

Because of sorghum's ability to respond to the environment, final stands can vary at least 25 percent from the values listed above, depending on expected growing conditions, without significantly affecting yields. Lower seeding rates minimize the risk of crop failure in dry environments. Sorghum can compensate for good growing conditions by adding tillers and adjusting head size, but yields can be reduced in a dry year if populations are too high. For a high-yielding environment (>150 bu/acre), under narrow rows, high plant populations can be a critical factor for improving sorghum yields.

Higher seeding rates also should be used when planting late. Increase rates by 15-20 percent if planting in late-June or later. Late planting will restrict the amount of time that sorghum plants will have in the season for producing productive tillers, thus decreasing the plants' ability to compensate for inadequate stands.

Recent research in Kansas has confirmed these long-term recommendations. In these studies, sorghum yields were maximized at 25,000 plants per acre (optimum between 20,000 to 30,000 plants per acre) in western Kansas at 17 inches annual precipitation; 40,000 in central Kansas at 30 inches annual precipitation; and 50,000 in eastern Kansas at 32 inches annual precipitation. For western Kansas, final stands of about 20,000 to 30,000 plants per acre can attain yields of 60 to 80 bushels per acre or more. For central and eastern Kansas, final stands of 50,000 to 70,000 plants per acre can maximize yields, with the final objective of having an average of 1 to 1.5 heads per plant.

Having more than the recommended number of plants per acre results in fewer fertile and productive tillers and thinner stems, which will reduce yield in the drier environments and increase susceptibility to drought. On the other side, thin stands can compensate for better-than-expected growing conditions somewhat by producing more and/or larger heads. However, under high-yielding environments, a higher final plant population will be needed to increase yields as much as possible (Table 1).

Planting date

A summary of research data performed in the last several years has confirmed that the optimum planting date for maximizing yields will be around early June (Figure 2). Still, the decision related to the optimum planting date should be timed so plants have the best possible chance of avoiding hot, dry weather at the flowering stage, but can still have sufficient time to mature before the first frost.

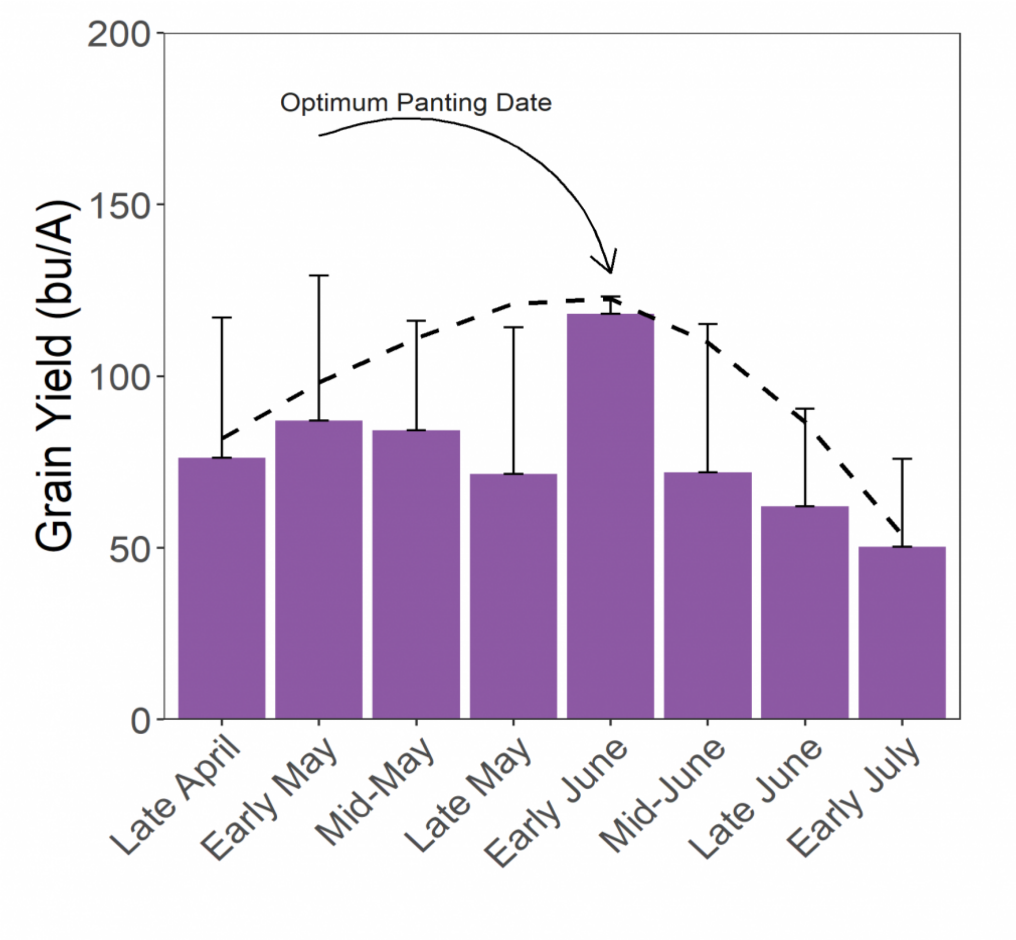

Figure 2. Planting date effect on final sorghum yields (Tribune/ Hutchinson/ Manhattan, Vanderlip; Scandia 1994-96, Gordon; St. John 1993-95, Martin and Vanderlip; Columbus 2000/03, Kelley). From Sorghum: State of the Art and Future Perspectives**, Agronomy Monographs 58, chapter "**Genotype × Environment × Management Interactions: US Sorghum Cropping Systems**" doi:10.2134/agronmonogr58.2014.0067, Ciampitti and Prasad (Eds).**

Planting date has some effect on seeding rates. Sorghum will tiller more readily in cool temperatures and less under warm conditions. As a result, later plantings in warmer weather should be on the high side of the recommended range of seeding rates for each environment since there will be less tillering. The potential for greater tillering with earlier planting dates makes sorghum yields more stable when planted in May and early June compared to late June or July plantings.

Planting depth

Seed placement is also a critical factor when planting sorghum. Optimum seed placement for sorghum is about 1-2 inches deep. Shallower or deeper planting depths can affect the time between planting and emergence, affecting early-season plant uniformity.

Row spacing

The other factor that can influence yield is row spacing. A response to narrow row spacing is expected under superior growing environments, when water is a non-limiting factor. Narrow rows increase early light interception, provide faster canopy closure, reduce evaporation losses, can improve suppression of late-emerging weeds, and maximize yields.

The comparison between wide (30-inch) vs. narrow (15-inch) row spacing shows an overall yield benefit of 4 bushels per acre with narrow rows. In addition, narrow rows out-yielded wide rows in 71 percent of all observations evaluated (Figure 3).

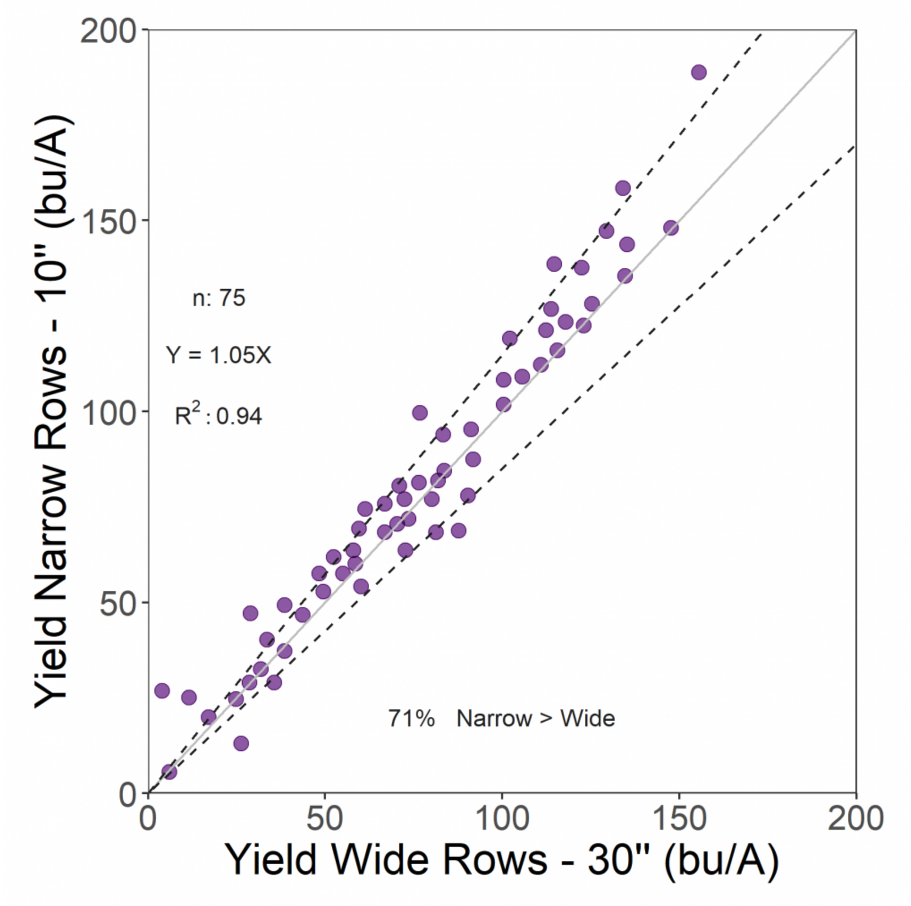

Figure 3. Yield in narrow rows versus yield in wide rows. From a total number of 75

observations, 71% had a greater yield in narrow as compared to wide row spacing. Partial data presented From Sorghum: State of the Art and Future Perspectives**, Agronomy Monographs 58, chapter "**[Genotype × Environment × Management Interactions: US Sorghum Cropping Systems]()**" doi:10.2134/agronmonogr58.2014.0067, Ciampitti and Prasad (Eds).**

A more consistent response to narrow rows was documented when yields were above 70 bushels per acre, with a greater chance of having higher yields when using narrow rows, but the response is not always consistent. Under low-yielding environments, conventional (30-inch) wide row spacing is the best alternative.

Should populations be adjusted with narrow rows?

Research results indicate that the population producing the greatest yield doesn't change with different row spacing, but the magnitude of response to population potentially can be greater with narrower row spacing in high-yielding environments.

Should row spacing be adjusted for planting dates?

Planting date seems to have an interaction with row spacing. Over three years at the North Central Experiment Field, there was essentially no difference in yield between 15- and 30-inch rows for late-May plantings, but there was a 10-bushel yield advantage for 15-inch rows for late June plantings. A similar response was observed at Manhattan in 2009 row spacing had no effect on yields for the May planting, but with the June planting 10-inch rows had an 11-bushel/acre yield advantage over 30-inch rows. In all cases, yields were less with the June planting, but the June plantings at Belleville and Manhattan still averaged more than 115 bushels/acre.

Hybrid selection

The selection of sorghum hybrids should be based not only on maturity, but also on other traits such as resistance to pests, stalk strength, head exsertion, seeding vigor, and overall performance. The selection of a sorghum hybrid based on its maturity should be strictly related to the planting date, expected duration of the growing season, and the probability the hybrid will mature before the first freeze event. Shorter-season hybrids might be a better fit for late planting dates (mid-June to July depending on the regions); while a longer-season hybrid is recommended when planting time is early and the duration of the growing season is maximized. The goal is to plant a hybrid maturity at each particular site/environment (weather and soil type) so the plants can bloom in favorable conditions, and have adequate grain fill duration before the first fall freeze occurs.

Summary

- Determine your desired population based on average rainfall and expected growing conditions. There is no need to go overboard.
- Make sure you plant enough seed for your desired plant population. About 65-70 percent field germination is a good general rule to use.
- Think about using narrower row spacing to close the canopy sooner and potentially capture greater yields in yield environments of 70 bushels per acre or more.
- Planting date and hybrid selection are tied together and are related to the expected conditions during the late summer. Think about this before deciding your planting time and selecting a hybrid.

Suggested Resources for sorghum crop from K-State Research and Extension

"Kansas Sorghum Management 2022" MF3046
https://bookstore.ksre.ksu.edu/pubs/MF3046.pdf

"Narrow-row Grain Sorghum Production in Kansas" MF2388
https://bookstore.ksre.ksu.edu/pubs/MF2388.pdf

"2021 Kansas Performance Tests with Grain Sorghum Hybrids" SRP1168
https://bookstore.ksre.ksu.edu/pubs/SRP1168.pdf

"Sorghum Growth and Development" poster
https://bookstore.ksre.ksu.edu/pubs/MF3234.pdf

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7. Wheat Tour Schedule 2022

The Department of Agronomy and K-State Research and Extension will host several winter wheat variety plot tours in different regions of the state over the coming weeks. Make plans to attend a plot tour near you to see and learn about the newest available and upcoming wheat varieties, their agronomics, and disease reactions.

A list of plot tour locations, dates, times, and directions is provided below. Stay tuned to the eUpdate in the coming weeks as this list is updated.

Date	**Time**	**County/District**	**Location**	**Direction**	**Agent**
5/31	3:00 pm	River Valley District	Clay Center	From K-15/US 24 intersection (Wendy's) in Clay Center, go 4 mi north. Turn west on 22nd Rd. Go 2 ¼ mi. South side of road.	Wade Reh
5/31	5:30 pm	River Valley District	Linn	From Linn, 4 mi south on Osage Rd to 5th Rd. West 1 mi to National Rd. North ½ mile.	Wade Reh
6/1	8:00 am	River Valley District	Belleville (KSU Expt Field)	Take US 36 Hwy 2 mi west of Belleville, north side of road	Wade Reh / Scott Dooley
6/1	11:00 am	River Valley District	Belleville	Polansky Seed, plots 1 mi east of Belleville, adjacent to Polansky's east facility.	Wade Reh
6/1	6 pm	Ellis	Hays	South of Agricultural Research Center-Hays. On 240 the Ave go 3.3 mi to	Stacy Campbell

				Munjor Rd, turn west and go 2 mi to 220th Ave, turn south on 220th and go ½ mile.	
6/2	9:00 am	Walnut Creek District	LaCrosse	½ mi west of 130 on M, south side or road, or 4 mi north of Alexander to M and 1 ¼ mi east.	Jared Petersille / Lacey Noterman
6/2	11:00 am	Walnut Creek District	Ness City	On 60 Road between M and N, 7 mi south and 5.5 mi west of Ness City	Jared Petersille / Lacey Noterman
6/2	5:00 pm	Walnut Creek District	Dighton	Just east of Ehmke's Farm on north side of the road, east of the scale	Jared Petersille / Lacey Noterman
6/3	8:00 am	Chisholm District	Abilene	Steve Hoover farm, on the intersection of Hwys 15 and 18, just north of Abilene	Hayley Whitehair / Rickey Roberts
6/6	1:00 pm	Edwards	Kinsley	North of intersection of 140th Ave and H Rd	Marty Gleason
6/6	6:00 pm	Pawnee	Rozel	From Rozel, go 3 mi west on 156 Hwy to 310th Ave, then 2 ¾ mi north on the west side of road	Kyle Grant
6/7	7:00 am	Twin Creeks District	Oberlin	3 mi west of Oberlin on Hwy 36	Keith VanSkike
6/7	7:00 pm	Twin Creeks District	Dresden	From Dresden, at intersection of Hwys 383	Keith VanSkike

				and 123 go south to Hwys 9 and 123 junction, then go east on Hwy 9 to about 1900 Rd	

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