Issue 1047

K·STATE Research and Extension

## Extension Agronomy

# eUpdate

*04/03/2025*

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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# eUpdate Table of Contents | 04/03/2025 | Issue 1047

# 1. First hollow stem update - March 31, 2025

Cattle should be removed from wheat pastures when the crop reaches first hollow stem (FHS). Grazing past this stage can severely affect wheat yields. For a full explanation, please refer to the companion article in this eUpdate, "Optimal time to remove cattle from wheat pastures: First hollow stem."

**First hollow stem update**

To screen for FHS during this important time in the growing season, the K-State Extension Wheat and Forage's crew measure FHS on a weekly basis in 16 different commonly grown wheat varieties in Kansas. The varieties are in a September-sown replicated trial at the South Central Experiment Field near Hutchinson.

Ten stems are split open per variety per replication (Figure 1), for a total of 40 stems monitored per variety. The average length of the hollow stem is reported for each variety in Table 1. **As of March 31, all varieties evaluated in this trial had reached first hollow stem.**

**Figure 1. Ten main wheat stems were split open per replication per variety to estimate first hollow stem for this report, for a total of 40 stems split per variety. Photo by Romulo Lollato, K-State Research and Extension.**

**Table 1. Length of hollow stem measured between February 17 and March 31, 2025, of 16 wheat varieties sown mid-September 2024 at the South Central Experiment Field near**

**Hutchinson. The critical FHS length is 1.5 cm (about a half-inch or the diameter of a dime). Value(s) in bold indicate the highest FHS group.**

| | First Hollow Stem (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Variety** | **2/17** | **2/24** | **3/6** | **3/10** | **3/17** | **3/24** | **3/31** |
| AP Sunbird | 0 | 0 | 0 | 0.00 | 0.41 | 0.89 | 7.54 |
| AP24 AX | 0 | 0 | 0 | 0.03 | 0.70 | 1.58 | 5.15 |
| AR Iron Eagle AX | 0 | 0 | 0 | 0.06 | 0.44 | 0.95 | 5.67 |
| AR Turret 25 | 0 | 0 | 0 | 0.04 | 0.51 | 1.50 | 4.42 |
| CLH10-153.022 | 0 | 0 | 0 | 0.00 | 0.37 | 1.18 | 3.81 |
| CLH10-1853.014 | 0 | 0 | 0 | 0.03 | 0.37 | 1.08 | 4.60 |
| CP7017AX | 0 | 0 | 0 | 0.01 | 0.50 | 1.04 | 4.77 |
| CP7869 | 0 | 0 | 0 | 0.03 | 0.29 | 1.10 | 5.31 |
| Kivari AX | 0 | 0 | 0 | 0.09 | 0.58 | 1.74 | 4.34 |
| KS Ahearn | 0 | 0 | 0 | 0.01 | 0.34 | 0.85 | 3.90 |
| KS Bill Snyder | 0 | 0 | 0 | 0.00 | 0.29 | 1.07 | 2.73 |
| KS Mako | 0 | 0 | 0 | 0.02 | 0.35 | 0.90 | 4.49 |
| KS Providence | 0 | 0 | 0 | 0.01 | 0.55 | 1.01 | 5.08 |
| KS Territory | 0 | 0 | 0 | 0.00 | 0.29 | 0.73 | 3.09 |
| KS21H36 | 0 | 0 | 0 | 0.01 | 0.22 | 0.69 | 4.06 |
| Sheridan | 0 | 0 | 0 | 0.01 | 0.35 | 1.75 | 4.03 |

Since all varieties have already reached the first hollow stem stage, this will be the last report for the 2024-25 growing season. We note that some fields in north-central or northwest Kansas may not yet have reached first hollow stem (Figure 2) and therefore we advise producers in those areas to closely monitor their fields to make the decision about when to remove cattle from wheat pastures.

**First Hollow Stem Tracking Tool on the Kansas Mesonet**

The Kansas Mesonet has a tool to help track wheat development: Wheat First Hollow Stem (https://mesonet.k-state.edu/agriculture/wheat/hollowstem/). This page tracks soil temperature to calculate wheat growing degree days (GDD) associated with first hollow stem occurrence. This tool employs a wheat growth model developed by Oklahoma State University and the Oklahoma Mesonet, which was validated for wheat growing conditions experienced in south-central Kansas during the 2016-2021 growing seasons. The output of the model provides the probability of first hollow stem occurrence (current and historical) both for early- and late-maturing wheat varieties. A detailed description of this tool is available at https://eupdate.agronomy.ksu.edu/article/wheat-growth-and-development-tool-for-estimating-first-hollow-stem-534-2.

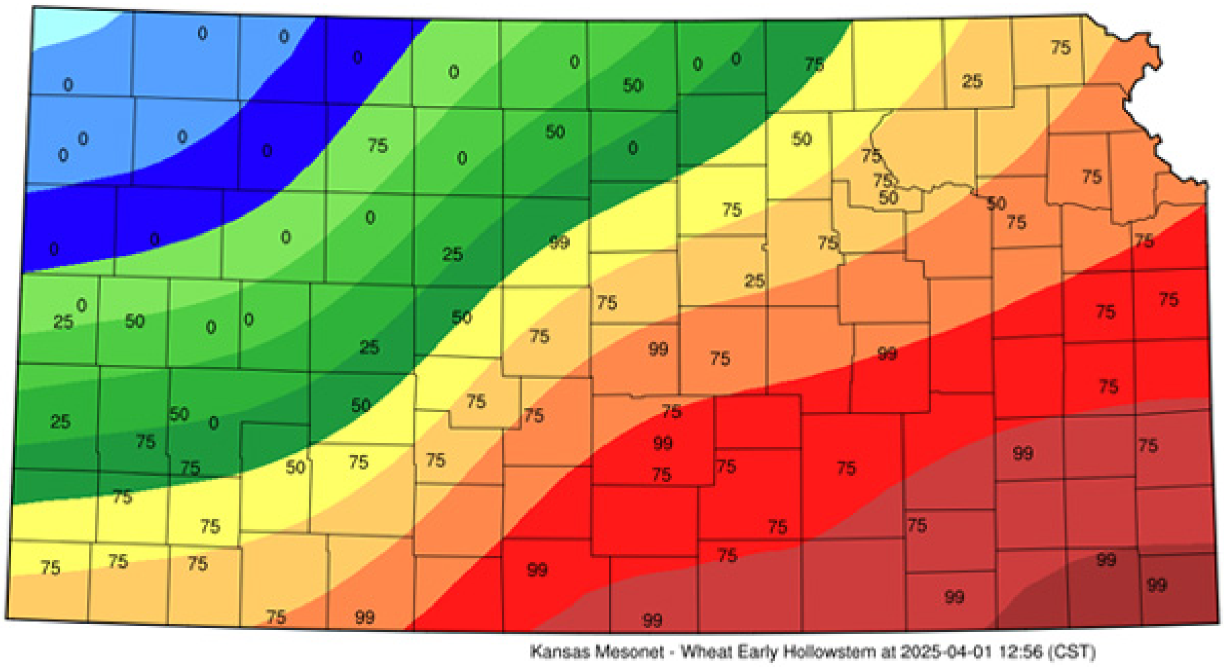


**Figure 2. Values represent the percent probability of first hollow stem occurrence for early maturing varieties. Source: Kansas Mesonet.**

The intention of this report is to provide producers with an update on the progress of first hollow stem development in different wheat varieties. Producers should use this information as a guide. Still, it is extremely important to monitor FHS from an ungrazed portion of each individual wheat pasture to make the decision to remove cattle from wheat pastures.

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## 2. Now is the time to check fields for wheat viruses

It's the pesky time of year when wheat viruses are rearing their ugly heads in Kansas. Wheat streak mosaic virus and Triticum mosaic virus have been confirmed in several Kansas counties already this spring. The widespread prevalence of wheat streak mosaic complex last season, coupled with warm conditions last fall, suggest that we might be in for another year with high levels of this disease. Now is a good time to scout fields and note any yellowing.

Other than the wheat streak mosaic complex, we have a few other wheat viruses that are active in Kansas. While wheat viruses can sometimes be difficult to distinguish by eye, they do behave differently in the field. Here is a review of some key facts about wheat viruses and some timely reminders for sample submission to the Plant Disease Diagnostic Lab.

**Wheat Streak Mosaic Virus Complex**

The viruses that cause **wheat streak mosaic** need no introduction in many parts of Kansas. Wheat streak mosaic is one of the most economically devastating wheat diseases in the state. While this disease is most common in western Kansas, we have seen an uptick in the frequency of occurrence of this disease in central and eastern Kansas over the last couple of years. This disease complex can be caused by several viruses, including *wheat streak mosaic virus, triticum mosaic virus, and wheat mosaic virus (high plains).* These viruses are moved around by the tiny wheat curl mite, which survives between seasons on volunteer wheat and other grassy hosts. Infections can occur in the fall or spring but can result in more severe yield loss when they occur in the fall after planting. Wheat streak mosaic symptoms develop most rapidly at temperatures above 70?. We often see symptoms appear when temperatures warm in the spring. We expect to see an increase in samples in the diagnostic lab over the coming weeks as the crop moves into and past the jointing stages of growth. Symptoms appear as green and yellow streaks on wheat leaves (Figure 1). The best management strategy is to destroy volunteer wheat immediately after harvest and within two weeks of fall planting. There are some varieties that carry limited resistance to these viruses. More info on how your varieties stack up against this complex of viruses can be found in the *Kansas Wheat Variety Guide*: https://bookstore.ksre.ksu.edu/pubs/MF3383.pdf

**Figure 1. Stunted plants infected with wheat streak mosaic virus exhibiting classic green and yellow mosaic symptoms. Photo: Kelsey Andersen Onofre, K-State Research and Extension.**

## Wheat Soilborne Mosaic Virus

**Wheat soilborne mosaic virus** is most common in the eastern two-thirds of Kansas and typically first appears as large, irregular patches of stunted, yellowing wheat in a field. From the road, these can be confused with a number of other production problems such as winter injury, or nutrient deficiencies. Upon closer inspection, leaves appear to have a yellow background with irregular green blotches (Figure 2). Optimal temperatures for symptoms of this virus are cool (around 60 F). The symptoms fade daytime temps rise into the mid-70s. Because of this cool temperature preference, we typically see symptoms at the tillering through jointing growth stages and not later in the season.

This virus is vectored into wheat by a fungal-like organism called *Polymyxa graminis* that can survive in the soil for up to 30 years. When soil moisture is high, this organism produces spores that can swim and attach themselves to wheat roots. After they attach, they shepherd in the virus, and infection occurs. Infection may be the worst in areas of the field with higher moisture (such as low spots) and in continuous wheat fields. Equipment has the potential to move soil-infested spores to new locations.

Luckily, many of the varieties available in the eastern part of Kansas have resistance to this virus. Susceptible varieties are at risk of yield loss caused by the disease. Much of this yield loss is attributed to lower kernel weight and fewer kernels per spike. To check if your variety is resistant, please see the Kansas Wheat Variety Guide: https://bookstore.ksre.ksu.edu/pubs/mf991.pdf. For more information on this virus: https://bookstore.ksre.ksu.edu/pubs/ep166.pdf.

**Figure 2. Wheat with symptoms of wheat soilborne mosaic virus. Photo by Erick DeWolf, K-State Research and Extension.**

**Wheat Spindle Streak Mosaic Virus**

Wheat soilborne mosaic virus can be confused with a second virus known as **wheat spindle streak mosaic virus**. It is not uncommon to see plants infected with both soil-borne mosaic and spindle streak mosaic. This virus is also most common in eastern Kansas. This virus is also transmitted by *Polymyxa graminis* and the conditions for infection (cool, wet soil) are similar. This virus will also show up first as yellowing patches in the field. There are subtle symptom differences between these two viruses, with spindle streak symptoms appearing as thin yellow streaks, or dashes on green leaves (Figure 3). Spindle streak can result in reduced tillering which may drive yield reductions. As with soilborne mosaic virus, variety resistance is really the only management tool that we have but can be highly effective. To check if your variety is resistant, please see the Kansas Wheat Variety Guide: https://bookstore.ksre.ksu.edu/pubs/mf991.pdf.

**Figure 3. Wheat with symptoms of wheat spindle streak mosaic. Notice the yellow, linear lesions that are tapered at both ends. Photo by Erick DeWolf, K-State Research and Extension.**

**Barley Yellow Dwarf**

Unlike the two viruses mentioned above, **barley yellow dwarf virus** is transmitted by several species of aphids while they feed, including bird-cherry-oat aphids, English grain aphids, and greenbugs. Infection can occur in the fall or the spring, with fall infections resulting in the highest potential for yield losses. Avoidance of early planting, variety resistance, and systemic insecticide seed treatments are the best way to manage this virus. Symptoms usually appear as purple to yellow leaf tip discoloration and plants will appear stunted (Figure 4). The symptoms of barley yellow dwarf are most visible between jointing and early stages of grain development when warm temperatures favor disease development. Heads of infected plants may be darkened before harvest and grain can be shriveled, resulting in yield losses.

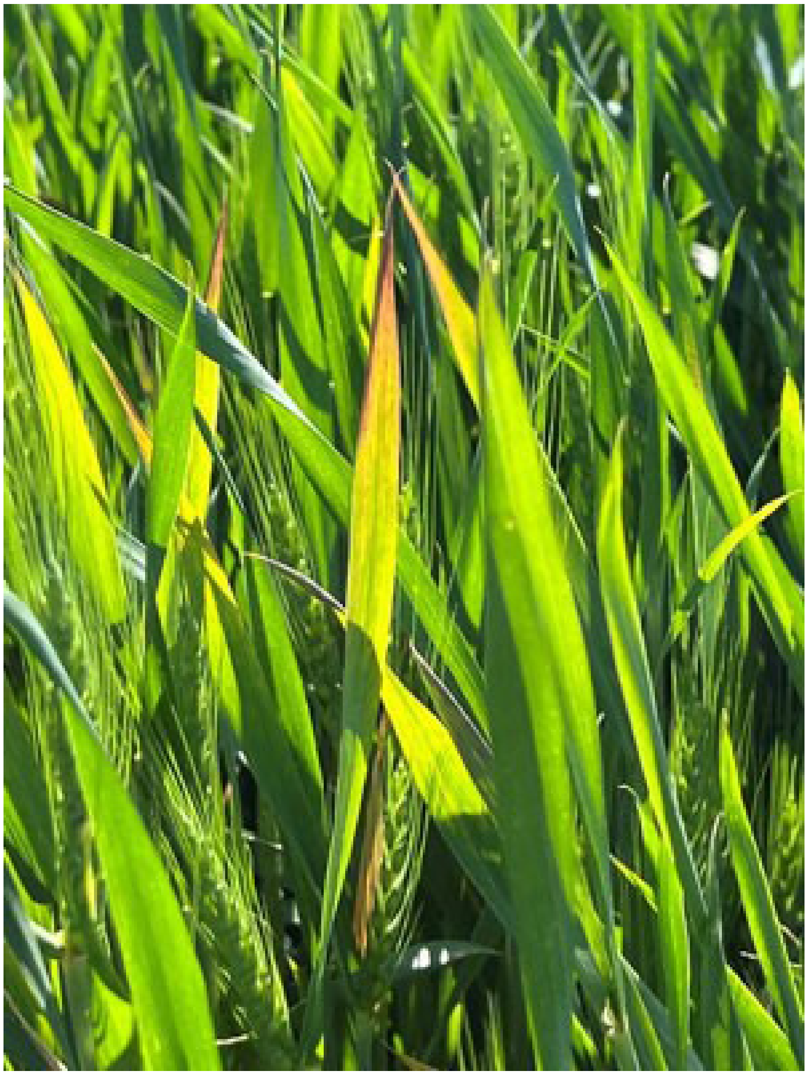

**Figure 4. Classic red/purple leaf tips of wheat infected with barley yellow dwarf. In some cases, symptoms will appear more yellow. Photo by Kelsey Andersen Onofre, K-State Research and Extension.**

See this recent eUpdate article for information on how to best submit a sample for wheat virus testing to the plant disease diagnostic lab: https://eupdate.agronomy.ksu.edu/article/k-state-plant-disease-diagnostic-laboratory-fee-adjustments-634-7.

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## 3. Brown wheat mite activity in western Kansas

Reports of brown wheat mite activity have come in from southwest and southcentral Kansas recently, and the climate outlook for the region is likely to favor continued issues with this pest.

Brown wheat mite (Figure 1) is a sporadic pest of wheat in western Kansas but can also become problematic in eastern Kansas during dry years. Typically, continuous wheat faces a higher risk of damage from this pest, and injury can be confused with drought stress. Mites damage individual cells in the leaf, causing stippling, while concentrated feeding at leaf tips causes plant tissue to dry out and die. Plants take on a scorched appearance and eventually wither (Figures 2 and 3).

**Figure 1. Brown wheat mite. Photo by K-State Entomology.**

**Figure 2. Appearance of a field infested with brown wheat mites. Photo by K-State Entomology.**

**Figure 3. Stippling caused by brown wheat mite feeding. Photo by K-State Entomology.**

Brown wheat mites present in fields right now are from eggs that hatched last fall. They can easily survive cold temperatures and can produce multiple generations during the winter and an additional two to three generations in the spring. These mites are active during the day, with peak activity during the afternoon on warm days. They do not produce webbing like spider mites and can easily be observed moving rapidly on leaf surfaces when scouting a field. Their rapid movement and tendency to drop to the ground when disturbed can make assessing the level of infestation difficult.

The economic threshold is estimated to be several hundred mites per foot of row in early spring. Stressed plants are most likely to succumb to damage. A solid rainfall is typically all that is needed to knock brown wheat mite populations below damaging levels, but that does not look to be in the forecast any time soon. Fields with noticeable populations of mites should be scouted for their eggs. Brown wheat mites lay two different types of eggs on soil clods and debris; red “winter” eggs and white “summer” eggs (Figure 4). The white eggs will remain dormant through the rest of the growing season and hatch in the fall. Red eggs will continue to hatch this spring and add to the current population. By late April, adults begin to lay the white, diapausing eggs. Once there are more white eggs in the field than red eggs, the population is naturally declining and treatment is not likely warranted.

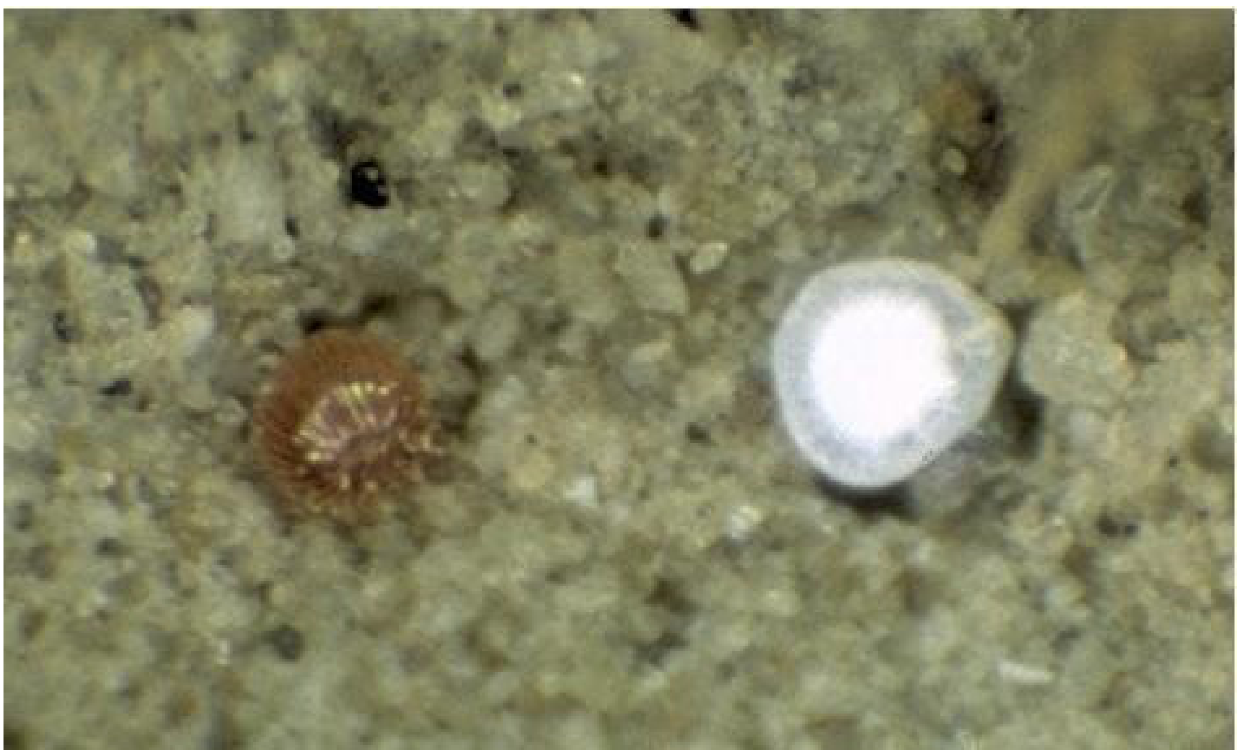

**Figure 4. Brown wheat mite eggs. Left: winter eggs that will be hatching now, Right: summer eggs that will be hatching in the fall. Photo by K-State Entomology.**

For fields that require treatment, options for control of brown wheat mites are limited. Chlorpyrifos and dimethoate offer control, but there are also some products for suppression of brown wheat mite populations (Table 1). As always, be sure to follow all directions on the labels for proper use of any chemical.

**Table 1. Products registered in Kansas for control or suppression of brown wheat mite. For more specific information relative to any insecticide, always refer to the actual label on the product.**

| Trade Name | Chemical Name | Mode of Action Class | Purpose | Rate |
|---|---|---|---|---|
| Numerous products | *Chlorpyrifos* | 1B | Control | 0.5-1 pint/A |
| Dimethoate | *Dimethoate* | 1B | Control | .3-.5 pint/A |
| Besiege | *Lambda-cyhalothrin and chlorantraniliprole* | 3A+28 | Suppression | 10 fl.oz/A |
| Proaxis | *Gamma-cyhalothrin* | 3A | Suppression | 3.84 fl.oz/A (.015 lb a.i./A) |
| Silencer | *Lambda-cyhalothrin* | 3A | Suppression | 3.84 fl.oz/A (.03 lb a.i./A) |
| Warrior II with Zeon Technology | *Lambda-cyhalothrin* | 3A | Suppression | 1.92 fl.oz/A (.03 lb a.i./A) |

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## 4. Soybean planting date and maturity group selection

For maximizing soybean yield, there are key practices that cannot be overlooked. This article presents tips for selecting the best planting date and maturity group across the different crop regions in Kansas.

After considering the effects of genetic yield potential and the environment, planting date is one of the primary management practices under the farmer's control that can highly influence soybean yields. In recent years, Kansas producers have been planting soybeans slightly earlier -- at the rate of about one-third-of-day per year. In 2024, the "50% planting date" mark was achieved around May 26 statewide (ahead of the 42% historical average) – with planting progress moving closer to mid-May if conditions are optimal at that time (USDA-Crop Progress Reports).

**Planting dates and maturity group guidelines**

Soybeans can be planted over a wide range of dates with adequate soil moisture conditions, although germination and emergence could be reduced and/or delayed in cool soils (less than 60°F). In the last few years, many farmers have anticipated soybean planting dates relative to the ones presented in Figure 1, in many situations, planting soybeans before corn. The recommended maturity group varies across Kansas by area (Figure 2).

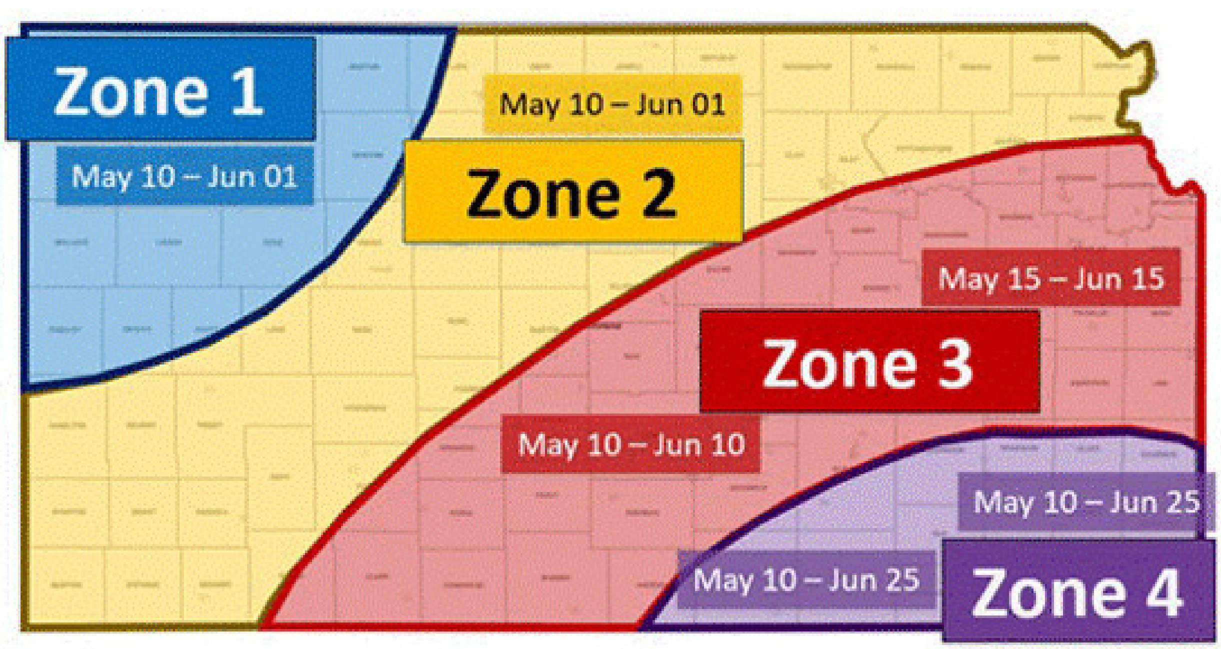


**Figure 1. Recommended soybean planting dates under dryland conditions. K-State Research and Extension.**

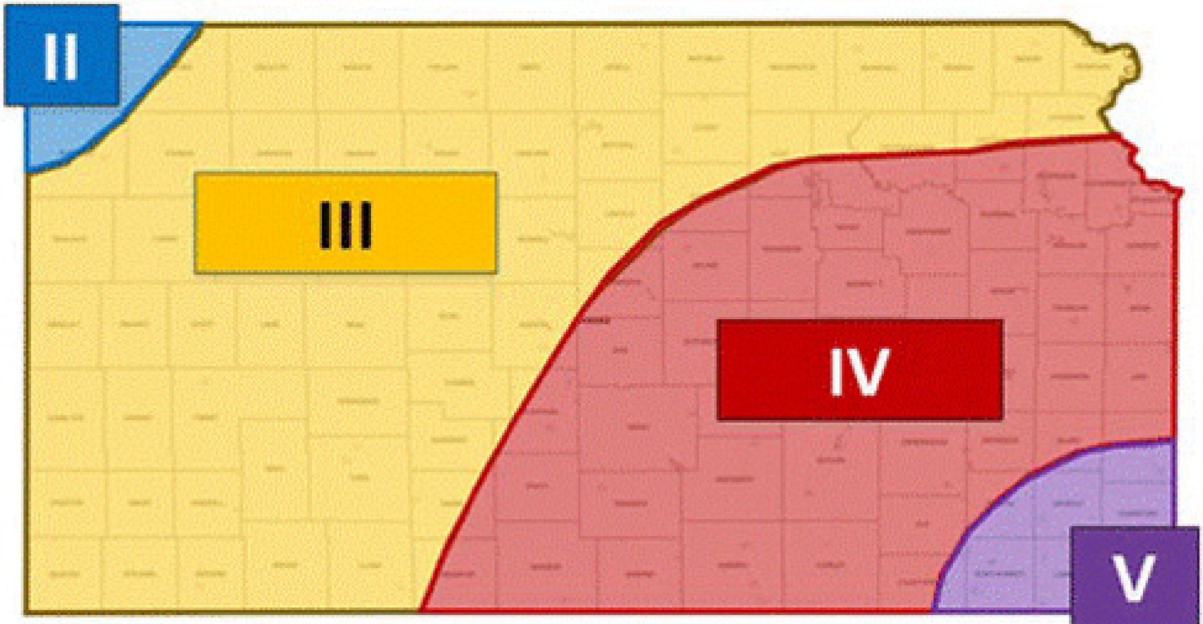


**Figure 2. Recommended soybean maturity groups (II to V) across Kansas. K-State Research and Extension.**

Over the four years at the Kansas River Valley Experiment Field, soybean yields were either stable or increased when planting in late March/early April compared to planting in mid-to-late April and early-to-mid May (Figure 3).

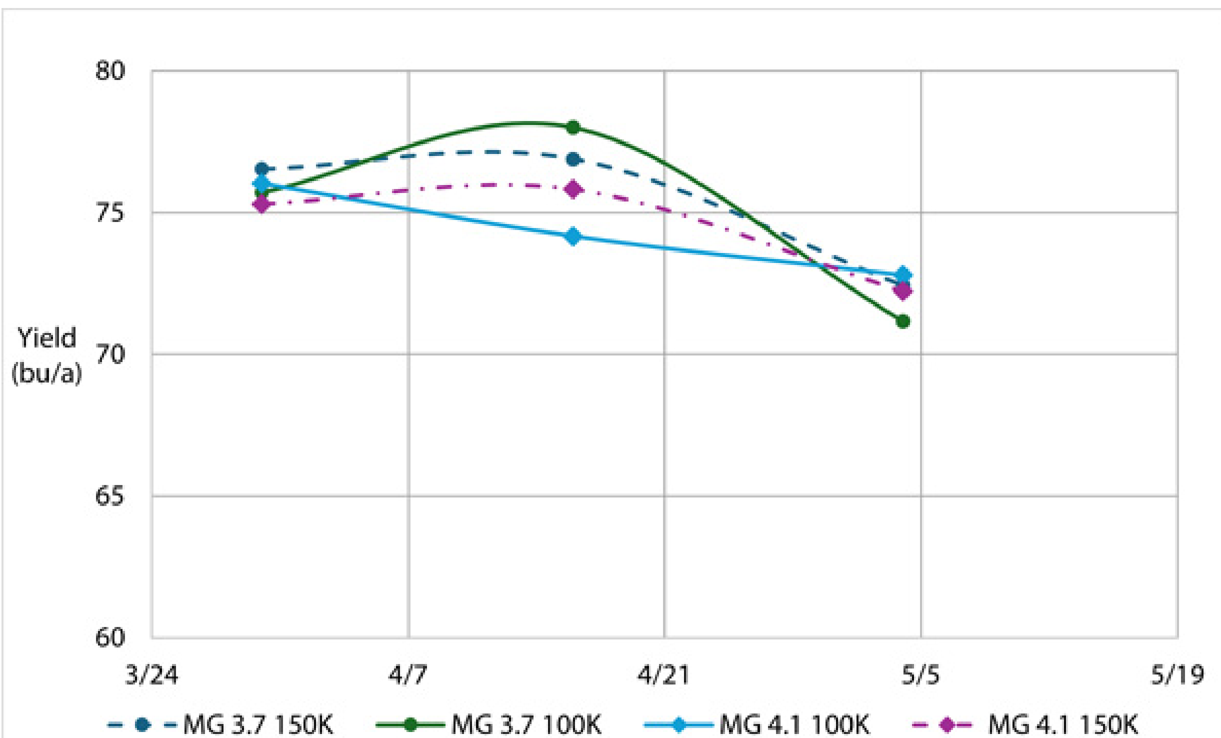


**Figure 3: The effect of planting date on irrigated soybean yield at the Kansas River Valley Experiment Field in 2021-2024. Each line represents a maturity group (MG 3.7 or MG 4.1) and seeding rate (100K or 150K).**

Generalized for Kansas, maximum soybean yield is reduced by 0.3 bu/a per day as planting dates get later in the season, with higher yield when planting in mid-April compared to moderate yields (50 bu/a) when planting in mid-July. These results highlight the importance of early planting for obtaining maximum yields and the yield penalty associated with later planting dates. Earlier planting means more risk (variability in yield) but a potentially higher yield or reward. Later-planted beans tend to be less variable with better yield stability, though maximum yield potential can be lost.

Historically, there has been a trend of planting soybeans early, before corn in some cases. A note of caution is that lower soil temperatures will delay emergence and could compromise stand uniformity. In addition, dry conditions can further delay overall emergence, impacting early season uniformity.

If planting early, try to maximize plant survival and reduce threats to emergence by:

- Avoiding planting when soil temperatures are below 60°F. If planted into soils cooler than 60°F, seedlings may eventually emerge but will have poor vigor.
- Treating seeds with fungicide and insecticide.
- Selecting varieties with resistance to soybean cyst nematode and sudden death syndrome.

**Final considerations**

- Ultimately, weather patterns dictate soybean yields, especially under dryland conditions. There is no guarantee that any certain planting date will always work out best for soybean yields across Kansas. The distribution and amount of rainfall and the day/night temperature variations around flowering and during the grain-filling periods also greatly impact soybean yields. When the risk of drought stress during the growing season is high, diversifying planting dates may be the best approach.
- When planting early (the push to plant soybeans before corn), seed should be treated with a fungicide and insecticide. Select varieties with resistance to soybean cyst nematode and sudden death syndrome. In general, do not plant in soils that are too wet and until soil temperatures are close to 60°F. If planted into soils cooler than 60°F, seedlings may eventually emerge but will have poor vigor.
- In drier areas and shallow soil, yields have been most consistent when soybeans are planted in late May to early June. By planting during that window, soybeans will bloom and fill seed in August and early September, when nights are cooler, and the worst of heat and drought stress is usually over.

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## 5. Soybean row spacing and seeding rates: What works best in Kansas?

Seed cost is a critical economic factor, and selecting the proper seeding rate is a key management practice. This article reviews key factors in determining optimal soybean seeding rates and row spacing.

**Key terminology: seeding rate, survival rate, and plant density**

There are three important terms: (1) "Seeding rate" refers to the target number of planted seeds per acre. (2) "Plant population" or "plant density" refers to the effective number of plants growing in a field. (3) "Survival rate" refers to the percent of sown seeds that germinate and emerge. Normally, we may expect about 80% of the seeds planted to survive to become part of the final plant population. Thus, for calculation purposes, it's best to start by knowing the desired final plant density and then using the expected survival rate to calculate back to the number of seeds per acre you'll need to plant. Below is an example:

$$\text{Seeding rate}\left(\frac{seeds}{acre}\right) = \frac{\text{Plant density target}\left(\frac{plants}{acre}\right)}{\text{Survival rate}\left(\frac{plants}{seeds}\right)}$$

Example of seeding rate calculation with a plant density target of 100,000 plants/acre and expected survival rate of 80% (0.8 plants/seed):

$$\frac{100{,}000\ \cancel{plants}/acre}{0.8\ \cancel{plants}/seed} = 125{,}000\ \frac{seeds}{acre}$$

*Note: The seed survival rate varies depending on specific environmental conditions and the quality of the planting practice. Thus, before deciding the seeding rates, it is necessary to consider potential soil and weather conditions that could affect the success of the final stand establishment to achieve the proper plant density required.*

**Adjusting seeding rates by yield environment**

Identifying yield potential for each environment in your field is a good practice to use when refining the soybean seeding rate decision. A study by Carciochi, Ciampitti, and others in 2019 evaluated soybean seed yield response to plant density by yield environment using a database of hundreds of experiments across the Midwest. Seeding rates ranged from 69,000 to 271,000 seeds/a. The data was classified by yield environments as follows: **Low** (<60 bu/a), **Medium** (60-64 bu/a), and **High** (>64 bu/a).

The main outcomes of this study were:

- **Most probable values.** On average, optimum plant densities were:

- Low-yield environments: 127,000 plants/a
- Medium-yield environments: 96,000 plants/a
- High-yield environment: 97,000 plants/a

- **Expected uncertainty.** In 50% of cases, optimum plant densities ranged from:
  - Low-yield environments: 109,000 - 144,000 plants/a
  - Medium-yield environments: 77,000 to 114,000 plants/a
  - High-yield environments: 76,000 to 117,000 plants/a

- In low-yield environments, the need for higher optimal plant density was not related to a low plant survival rate, but to a reduced potential growth rate per plant.
- Another reason for the need for higher plant density in low-yield environments is that there is often less precipitation during the reproductive period in these environments, reducing the crop's reproductive ability (reduction in yield contribution from branches).

**Effect of row spacing on seeding rates and yield**

The optimum soybean seeding rate is tied to other practices, such as **row spacing** and planting date (see companion article on soybean planting dates). The final number of seeds per linear foot of row decreases as row spacing narrows. For example, at a target plant density of 105,000 plants per acre and 85 percent germination, 30-inch rows will have twice the number of seeds per linear foot as 15-inch rows (6 vs. 3 seeds per linear foot). However, the seeding rate per acre would remain the same for both row spacings, as only the number of seeds per linear foot would change, not the seeding rate per acre.

There are still many questions about row spacing for soybean production. A summary of K-State research from 2015 to 2017 that included a series of six On-Farm experiments in eastern and central Kansas (a collaboration between K-State, Kansas Soybean, and the United Soybean Board) were conducted, one each in Franklin County, Hutchinson, Jefferson County, and Manhattan. For the 2017 season, two additional studies (a collaboration between K-State, Kansas Soybeans, and the North Central Soybean Research Program) were conducted in Ashland Bottoms near Manhattan and Franklin County.

Compared to the conventional 30-inch row spacing, narrow row soybeans (15-inch or less) showed similar or slightly greater yields (**2-12%**), particularly in a low yield environment (< 0 bushels per acre) independent of planting date, seeding rate, or maturity. Above this yield threshold level, soybeans did not show a yield response to changing the row spacing (Figure 1). However, the data suggested that response to row spacing is inconsistent, as indicated by the wide margin error of responses and the variability between site years.

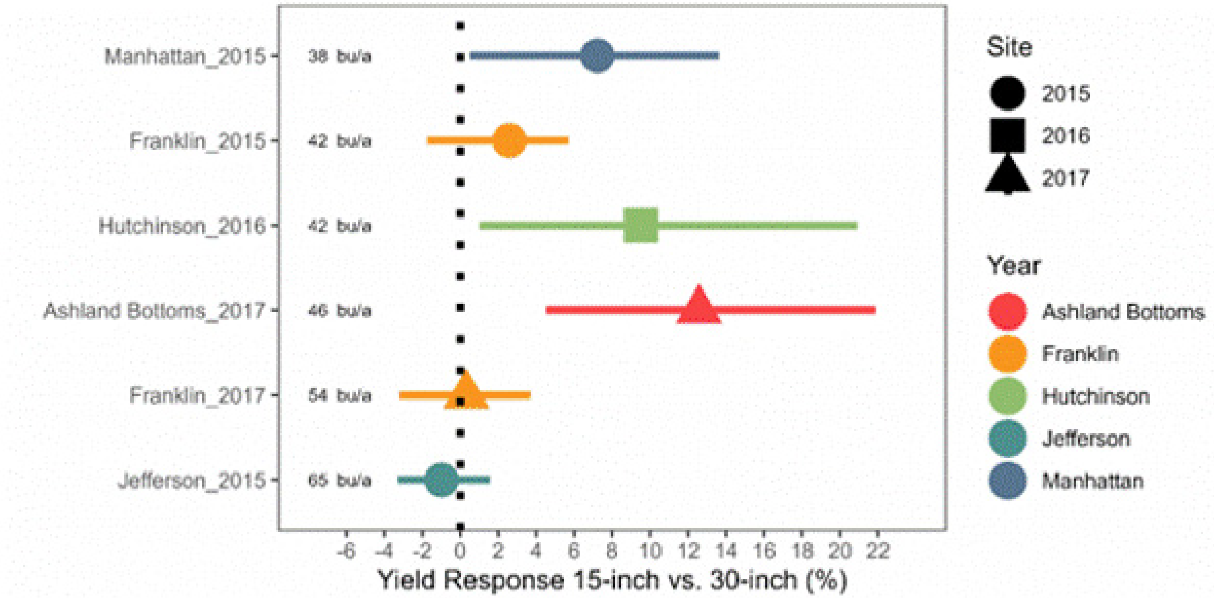


**Figure 1. Observed yield response in soybeans to narrow rows (15-inch) compared to conventional spacing (30-inch). The average yield of 30-inch strips is indicated on the left side of the figure (bu/a). At the lowest-yielding site, Manhattan (2015), soybeans in 15-inch row spacing had an average of about 6% higher yields than those in 30-inch rows. In the highest yield environments, Jefferson County (2015) and Franklin County (2017), there was very little yield difference between 15- and 30-inch rows. On-Farm Experiments (2015-2017). Collaborators: Kansas State University, United Soybean Board, North Central Soybean Research Program.**

**Take home message**

Benefits of narrow row spacing:

- Early canopy closure for better light interception and improved weed control.
- Reduced potential for soil erosion.

Disadvantages of narrow rows:

- Potential reductions in the final stand at a given seeding rate due to equipment and within-row compaction.
- In very dry years, narrow row spacing may consume soil water earlier in the growing season, reducing the amount of water available for the critical period around pod-setting and seed filling.
- In wet years, very narrow spacing (less than 15 inches) may allow less airflow within the canopy and favor the occurrence of certain diseases, such as white mold.

Adjusting seeding rates based on plant survival rates, soil conditions, and planting dates can reduce the risk of yield and profit losses due to lower-than-optimal densities in a low-yield environment while limiting higher seed costs due to higher-than-optimal densities, especially for medium and high yield environments. Soybean plant density levels above the optimal plant density increase the risk of lodging and disease development without adding a yield benefit.

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## 6. Improve weed control by combining residual herbicides with varying water solubility

Residual herbicides are a key component of effective weed management programs. Applying multiple residual herbicides is a recommended practice, with combinations generally designed for effectiveness on the range of weed species present in the field. In addition, selecting multiple effective herbicides is increasingly important to mitigate resistance to residual herbicides, such as the Group 14 herbicides [flumioxazin (Valor, others) and sulfentrazone (Spartan, others)] and the Group 15 herbicides [acetochlor (Harness, Warrant, others), dimethenamid (Outlook), *S*-metolachlor (Dual, others), and pyroxasulfone (Zidua, others)]. One factor that may be overlooked when selecting herbicide combinations is the water solubility of the herbicides.

Water solubility is a numeric value, usually reported in the metric unit mg/L. It indicates how much of the herbicide's active ingredient can be dissolved in water at room temperature. The solubilities of some residual herbicides are listed in Table 1.

In general, herbicides with a solubility of less than 100 mg/L have low solubility, while herbicides with a solubility greater than 1,000 mg/L are considered to have high solubility. Herbicides with relatively low water solubility will be more easily 'activated' or available for plant uptake via water present in the soil when compared to herbicides with relatively high water solubility. Herbicides with relatively high solubility will require more rainfall to move the herbicide to the zone where weed seeds are germinating and/or roots are growing. Conversely, the duration of residual activity provided by herbicides with high water solubility will be shortened if the herbicide is lost from the root zone by rainfall or irrigation. However, herbicides with lower water solubility will not be as readily leached. Herbicide availability for plant uptake or leaching out of the root zone is also affected by the strength with which the herbicide is bound to clay and organic matter in the soil, which is not necessarily a function of water solubility. The strength of the herbicide binding to clay and organic matter is called sorption. This interaction's effects are reflected in how some residual herbicides adjust application rates based on soil texture or organic matter content.

**Table 1. Herbicide solubility and precipitation requirements for several commonly used active ingredients.**

| Herbicide active ingredient | Example | SOA Group | Precipitation requirement on label | Water solubility (mg/L at 68 F) | Solubility category |
|---|---|---|---|---|---|
| Dicamba | Clarity | 4 | adequate | 250,000 | Very high |
| Atrazine | Aatrex 4L | 5 | sufficient | 35 | Moderately low |
| Metribuzin | Tricor | 5 | 1/4" | 10,700 | High |
| Diflufenican | Contrivo | 13 | N/A | 0.05 | Very low |
| Flumioxazin | Valor | 14 | activating | 0.8 | Very low |
| Sulfentrazone | Spartan | 14 | 1/2-1" | 784 | Moderate |
| Acetochlor | Harness | 15 | 1/4-3/4" | 282 | Moderate |
| Dimethenamid-P | Outlook | 15 | needed | 1,499 | High |
| Flufenacet | Component of Trivolt | 15 | N/A | 51 | Moderately low |
| Pyroxasulfone | Zidua | 15 | 1/2" | 3.5 | Low |
| *S*-metolachlor | Dual II Magnum | 15 | 1/2-1" | 480 | Moderate |

| | | | | | |
|---|---|---|---|---|---|
| Bicyclopyrone | Component of Acuron | 27 | N/A | 1,200 | High |
| Isoxaflutole | Balance Flexx | 27 | adequate | 6.2 | Low |
| Mesotrione | Callisto | 27 | 1/4" | 1,500 | High |

Combining herbicides with different water solubilities can reduce the risk of residual herbicide failure. Precipitation during the first two weeks after an herbicide application is the key factor influencing the effectiveness. In addition, developing a tank mix that includes herbicides with high, medium, and low solubility helps ensure at least one residual herbicide is activated across a range of precipitation conditions.

For example:

- a corn preemergence tank mix might look like mesotrione (high), *S*-metolachlor (moderate), and atrazine (moderately low)
- for soybeans, it could be a tank mix of metribuzin (high), acetochlor (moderate), and flumioxazin (very low).

As stated above, herbicide availability is a function of both water solubility and sorption, so this is not a strict rule. Still, it can be a useful guide to ensure you have the best residual herbicide program possible.

For more detailed information, see the "2025 Chemical Weed Control for Field Crops, Pastures, and Noncropland" guide available online at https://bookstore.ksre.ksu.edu/pubs/SRP1190.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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## 7. Using drones for early season field scouting

Spring is a critical time for growers as it is when the most essential agricultural decisions are made. During this time, fields are scouted to monitor crop residue cover, standing water, weed presence, plant stand counts, and nutrient status. Such monitoring can help to make decisions such as the proper planting time, replanting decisions, weed control, drainage, and fertilizer application plans, which will impact the overall crop yield of the year. Therefore, early season field scouting is essential and significantly affects our ability to make all our early season management decisions. Generally, such monitoring is done by walking or driving through the field in a zigzag or 'W' shape pattern and is quite accurate; however, it might be challenging as it is time-consuming, labor intensive, and only describes a limited portion of the field.

The advancement of precision agriculture technology, such as drones, can provide an efficient solution for early-season field scouting. In contrast to traditional scouting, drone scouting can be less time-consuming, have more thorough field coverage, and be less labor intensive. Such a drone has a sensor or camera that can provide a bird's-eye view of the whole field and complete scouting in 15–30 minutes, depending on the field size.

**Drone types**

Three different types of drones and sensors are used in scouting agricultural fields. The most used drones are fixed-wing and multi-rotary. **Fixed wings**, which have wings that give a small airplane look, usually have more considerable coverage due to longer battery life (Figure 1). Still, their limitation is that they cannot hover around any particular area while flying. Moreover, fixed-wing drones need larger take-off and landing areas, as they cannot do vertical take-off and landing. On the other hand, **multi-rotary** types of drones have rotating propellers, and compared to fixed wings, they generally have slower speeds and less coverage. However, they can hover around certain areas to scout specific field parts. The third type of drone is a **hybrid drone** with features including fixed wings and a multi-rotor.

**Figure 1. Fixed wing drone with multi-spectral sensor that can be used for agricultural field scouting. Photo by Deepak Joshi, K-State Research and Extension.**

**Sensor types**

Two types of sensors are particularly used for scouting purposes. The first is an ‘RGB camera, which can detect only visible lights reflected by objects, i.e., Red, Green, and Blue, as our human eyes do. Such RGB camera-based drones provide true–color images of the field (Figure 2-left) and can be useful in visual assessments such as counting plants, detecting weeds, and more. Another type of sensor used is a multi-spectral sensor that can capture additional spectrum of lights beyond visible lights, such as near-infrared (NIR). Various vegetation indices can be calculated using multispectral sensor imagery, such as Normalized Difference Vegetation Indices (NDVI), Green Normalized Difference Vegetation Indices (GNDVI), etc. (Figure 2-right). These can provide more information than the RGB camera, including the soil nutrient and moisture status, plant disease, and weed identification not provided by visible lights.

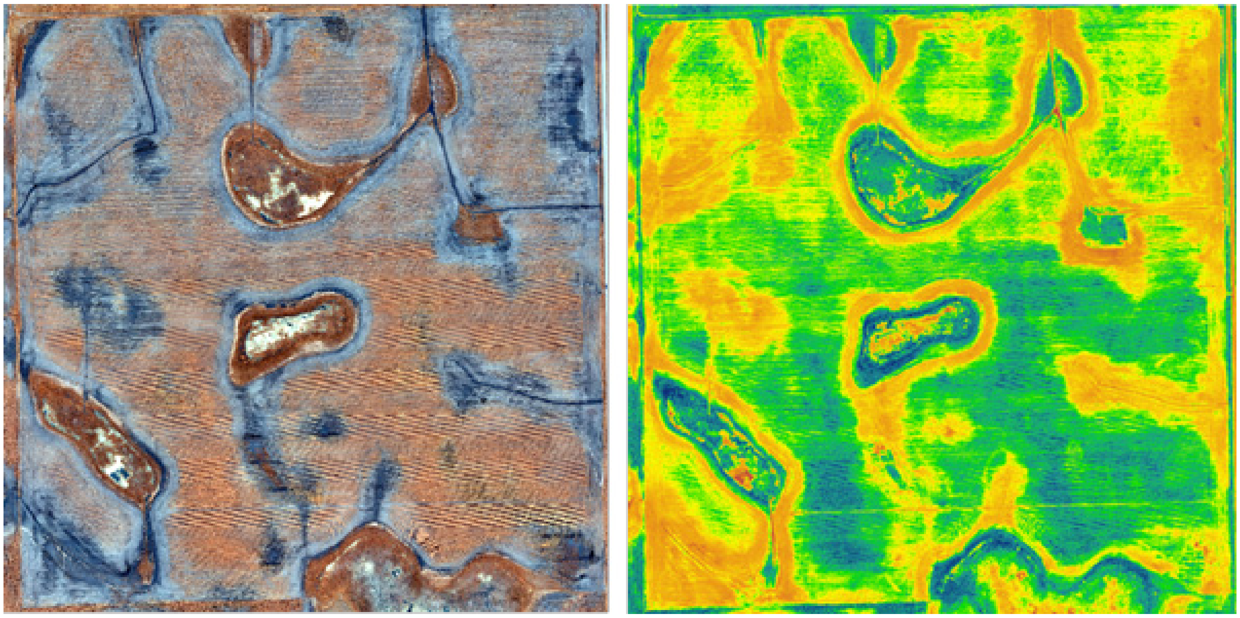

**Figure 2. A true-color image (left) and a GNDVI map (right) of the field were collected using a drone during the early season to monitor standing water, weed patches, early germination, and canopy coverage. Darker areas in the true-color image indicate higher soil moisture or standing water; brown areas represent plant density; dark brown with rough texture represents weed patches. Similarly, in the GNDVI map, darker green indicates higher plant density or greater canopy coverage. Images provided by Deepak Joshi, K-State Research and Extension.**

Besides sensor/camera quality, flight altitude also impacts the quality of the image. For example, the higher the flight altitude, the lower the ground resolution, and vice versa. However, a lower flight altitude covers less ground area per image and might take longer to cover the entire field. So, it is all about finding the right balance based on our scouting goal. In general, flight altitudes of 200-400 feet are commonly used for precision agriculture scouting. Also, it is essential to remember that the FAA regulations don't allow the drone to be flown higher than 400 feet above ground. More details about FAA rules and regulations can be found at https://www.faa.gov/uas?utm_source=chatgpt.com.

Using images collected by the drone, NDVI, GNDVI, or true color images can be derived, and based on such field maps, we can use them to monitor crop emergence, soil moisture monitoring, weed pressure, and soil nutrient status. Therefore, such drone-based tracking can be used to make multiple early-season management decisions. It can detect walking through the field and monitoring the crop and field, which often might take an entire morning; however, with a drone, you can assess field conditions in a fraction of the time. It is quicker and can provide entire field monitoring, including the areas that are difficult to reach. Aerial scouting should supplement ground truthing for issue spots when applicable.

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## 8. Pre-season irrigation checklist: Maximize efficiency and minimize issues

Giving your irrigation system a thorough check-up and tune-up this spring can lead to more effective water application and potentially, to fewer breakdowns or problems during the heart of the irrigation season. Even if irrigation has started in places like southwestern Kansas, it's important to go through this checklist to potentially save energy and costs while irrigating to the best of the system's abilities. The above-average seasonal temperatures might have made it where some have jumped into irrigation already, though the nights are still cold.

Here are some areas to check before irrigation starts or with the first irrigation occurs. These areas include the pump and pivot itself, but there may be additional areas to consider as this is not an exhaustive list. Some of this checklist might have been done in the fall.

- Clean pipes and structure of animal nests and check for any damage on the wires.
- Check all panel or pump wires for rodent damage.
- Change all lubricants, associated filters, and fluids if not done in the fall: engine, fuel, cooling system.
    - Refill the drip oil reservoir and allow oil to drain into the drip line based on pump column length.
- Grease drive shafts on the pump and motor.
- Check gearboxes for each pivot tower.
- Check spark plugs on gas, propane, or natural gas motors.
- Ensure that the right-angle gear head is free moving and clean and lubricate non-reverse pins.
- Blow out any in line filters of debris and check for damage
- Flush system thoroughly with drains removed/open to prevent plugging nozzles and pressure regulators.
- Close any drains/ valves that were opened.
    - Most newer pivots have automatic frost drains that do not need maintenance, but it's a water loss orifice that shouldn't be overlooked.
    - Tighten all pressure valves back into operation if loosened or removed for winter months
- Run the motor at the normal operating speed for 45 minutes and walk along the system looking for faulty sprinklers. Look for plugging, broken sprinklers, partially opened valves (if present), unusual distribution/movement, and leaks. If no faulty sprinklers, then any hoses and sprinklers that might have fallen off in the winter.
    - Check the pressure at the pivot point and at the end of the system, particularly at the highest point of the field. Compare this to the design pressure indicated in the pivot chart and adjust accordingly.
    - Nozzle wear depends on the quality of the water and the system operating pressure. As a rule of thumb, sprinkler replacement should be considered after approximately 10,000-12,000 hours of operation.
    - Be sure to replace malfunctioning nozzles with ones listed on the computer printout you received from the manufacturer (i.e. pivot chart).
    - Visually inspecting the sprinkler in operation before the irrigation season starts can help identify whether water application is uniform and adequate and whether repairs are needed.

- If in an area with water quality concerns, grab some water samples for water quality testing to anticipate necessary mitigation.
- Check the chemigation pump and safety equipment operation.
    - Check hoses and replace them if cracking is noticeable.
- Check for correct air pressure and extreme wear and tear in each pivot tire

Performing a preseason checkup of your irrigation equipment this spring should be part of your regular maintenance schedule. Component wear happens, resulting in less uniform water application, increased energy use, and untimely breakdowns during your irrigation season. Identify and replace worn components now to have your system ready when you need it.

**Figure 1. Picture of a pivot running at the SW research center in Garden City. Photo by Logan Simon, K-State Research and Extension.**

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## 9. How likely is a late spring freeze in Kansas?

April 1 has traditionally marked the beginning of the growing season in Kansas. It's certainly convenient to pick the first day of a month to begin seasonal tracking of precipitation and degree days, but it is not guaranteed that planting on that exact date is risk-free, as April is still subject to freezing temperatures. Take this week, for example. Temperatures were in the 20s in northwest Kansas on the morning of the 3rd. The Cheyenne County Mesonet was the coldest spot, with a chilly 21°F reading. Winter-like as this sounds, it's not all that unusual this far into spring. Goodland's normal low for April 3 is still below freezing at 31 degrees. This report explores the chances of a freeze after April 1 across all of Kansas.

The National Centers for Environmental Information (NCEI) have calculated average daily high and low temperatures for thousands of locations across the US. These averages, based on the period 1991-2020, can be used to calculate the probability of a freeze for any location on any given day. Here in Kansas, there are 165 available sites with daily normals. We will look at only 27 of these sites, three in each of Kansas' nine climate divisions (Table 1).

**Table 1. Probabilities of a freeze (a minimum temperature of 32° or less) occurring at selected Kansas locations on or after the given dates, based on 1991-2020 NCEI daily climate normals.**

| Region | Location | Apr 5 | Apr 10 | Apr 15 | Apr 20 | Apr 25 | Apr 30 | May 5 | May 10 | May 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| Northwest | Goodland | >99% | >99% | >99% | 99% | 94% | 80% | 57% | 33% | 15% |
| | Hill City | >99% | >99% | 98% | 91% | 76% | 54% | 32% | 16% | 7% |
| | Oberlin | >99% | >99% | >99% | 98% | 91% | 76% | 54% | 32% | 16% |
| North Central | Beloit | 99% | 95% | 84% | 66% | 45% | 27% | 14% | 6% | 2% |
| | Phillipsburg | >99% | >99% | 98% | 90% | 73% | 48% | 26% | 12% | 4% |
| | Washington | >99% | 99% | 95% | 84% | 64% | 41% | 23% | 11% | 5% |
| Northeast | Holton | >99% | 98% | 93% | 80% | 62% | 42% | 26% | 14% | 6% |
| | Manhattan | 98% | 93% | 81% | 62% | 41% | 24% | 13% | 6% | 2% |
| | Troy | 99% | 95% | 84% | 67% | 46% | 29% | 16% | 8% | 3% |
| West Central | Scott City | >99% | >99% | >99% | 97% | 89% | 70% | 45% | 24% | 10% |
| | WaKeeney | >99% | 99% | 96% | 87% | 68% | 44% | 23% | 10% | 4% |
| | Wallace | >99% | >99% | >99% | 99% | 93% | 79% | 55% | 30% | 13% |
| Central | Ellsworth | >99% | 99% | 96% | 86% | 67% | 43% | 23% | 10% | 4% |
| | Hays | 99% | 97% | 91% | 78% | 57% | 35% | 17% | 6% | 2% |
| | Marion | 88% | 74% | 55% | 35% | 19% | 9% | 4% | 1% | <1% |
| East Central | Emporia | 93% | 81% | 63% | 42% | 24% | 12% | 5% | 2% | 1% |
| | Olathe | 87% | 72% | 52% | 32% | 17% | 8% | 3% | 1% | <1% |
| | Topeka | 93% | 82% | 64% | 44% | 27% | 14% | 7% | 3% | 1% |
| Southwest | Dodge City | 99% | 97% | 89% | 74% | 53% | 31% | 16% | 7% | 2% |
| | Garden City | >99% | 99% | 97% | 89% | 72% | 47% | 26% | 12% | 4% |
| | Hugoton | 99% | 96% | 87% | 69% | 45% | 22% | 9% | 3% | 1% |
| South Central | Larned | 99% | 95% | 85% | 67% | 44% | 23% | 10% | 4% | 1% |
| | Medicine Lodge | 92% | 82% | 67% | 48% | 30% | 16% | 8% | 3% | 1% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Wichita | 87% | 74% | 57% | 39% | 23% | 11% | 4% | 1% | <1% |
| Southeast | Coffeyville | 81% | 65% | 46% | 29% | 16% | 7% | 3% | 1% | <1% |
| | Eureka | 98% | 93% | 81% | 62% | 40% | 22% | 10% | 4% | 1% |
| | Fort Scott | 87% | 71% | 51% | 31% | 16% | 8% | 4% | 2% | 1% |

An explanation of the contents of Table 1 is in order. Let's take a look at the row for Manhattan. In the column headed by Apr 10, we see 93%. This percentage is the chance of a freeze on or after the given date. For this example, there is a 93% chance of a freeze occurring on or after April 10 in Manhattan. Two columns to the right show a lower chance, 62%, of a freeze on or after April 20. By the end of April, the chance of a freeze is only 24%, and on or after May 10th, it drops to 6%.

After the first of April, a freeze is still likely to occur statewide. There is still an 80% chance of a freeze on or after April 30 in Goodland, but just an 8% chance in both Olathe and Fort Scott. On or after May 15, the risk of a freeze is under 10% except in parts of northwest and west central Kansas. The 7-day statewide average soil temperature at 2" typically reaches 50° or greater for the first time on March 31, so one could plant certain crops on April 1 but do so with a high risk of a freeze. If one waits too long to plant, an early freeze in the fall may cut the growing season short before a crop is ready to be harvested. Location is also an important consideration; an early planting date is much later in spring in the northwest than it is in the southeast.

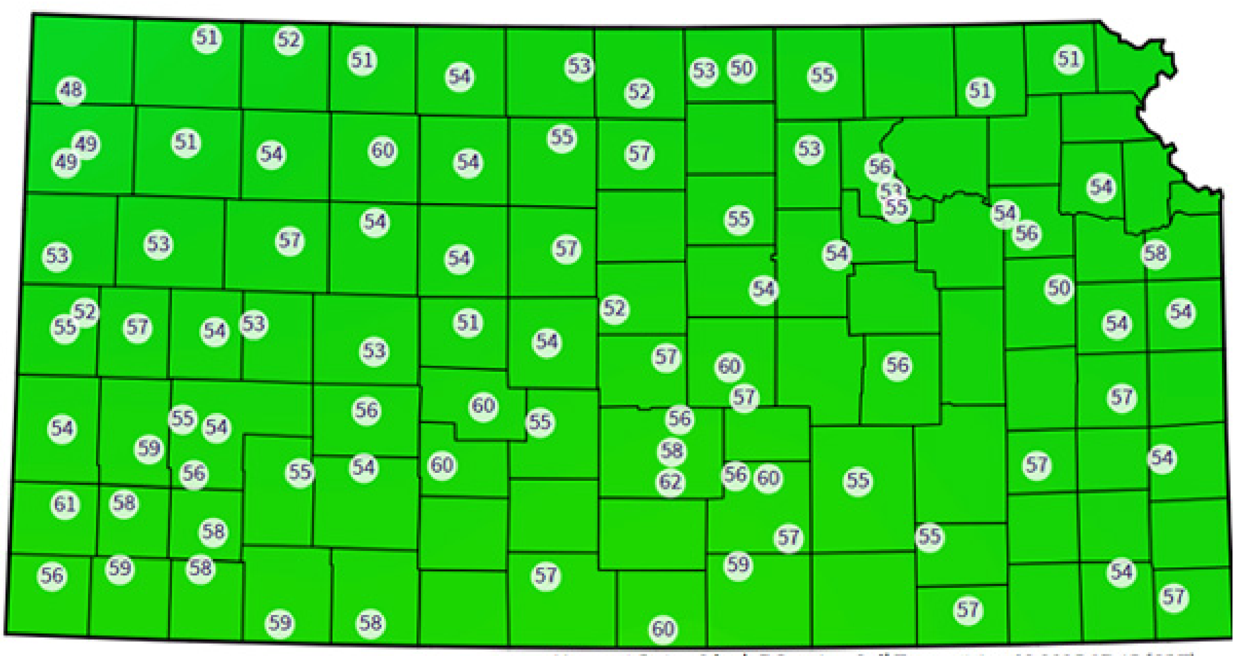
It is worth noting that a low of 32° may not cause any damage to tender vegetation if the duration of freezing temperatures is short-lived. A low of 28° implies a longer period of freezing temperatures that is more likely to damage young plants. A low of 36° suggests frost may form, which could cause damage even if a freeze doesn't occur. If we take a look at the probabilities of temperatures falling to each of these three temperatures, we can get a better idea of the risk of frost (36° or colder), a freeze (32° or colder), and a hard freeze (28° or colder). Table 2 contains the probabilities of these three events for the same nine dates in Table 1. But rather than individual locations, the table contains average dates across all the locations within each climate division. There is a greater than 90% chance of a frost on or after April 15 across the entire state. A freeze is likely in all divisions, but the chances of a killing freeze are less than 50% in eastern Kansas but 90% in northwest Kansas. There is an 80% or better chance of a frost in western Kansas on or after April 30th, and in northwest Kansas, there is still a 42% chance of a frost on or after May 15.

**Table 2. Probabilities of minimum temperatures at or below 36°, 32° and 28° across each of the nine Kansas climate divisions on or after the given dates, based on 1991-2020 NCEI daily climate normals.**

| Region | Threshold | Apr 5 | Apr 10 | Apr 15 | Apr 20 | Apr 25 | Apr 30 | May 5 | May 10 | May 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| Northwest | 36° | >99% | >99% | >99% | >99% | >99% | 97% | 88% | 67% | 42% |
| | 32° | >99% | >99% | >99% | 98% | 90% | 73% | 49% | 28% | 13% |
| | 28° | 99% | 97% | 90% | 76% | 54% | 33% | 17% | 7% | 3% |
| North | 36° | >99% | >99% | >99% | 99% | 94% | 80% | 58% | 34% | 16% |
| Central | 32° | >99% | 99% | 95% | 85% | 65% | 42% | 23% | 10% | 4% |
| | 28° | 96% | 87% | 70% | 49% | 29% | 14% | 6% | 2% | 1% |
| Northeast | 36° | >99% | >99% | 98% | 92% | 78% | 58% | 37% | 20% | 9% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 32° | 98% | 94% | 82% | 63% | 42% | 24% | 12% | 5% | 2% |
| | 28° | 85% | 69% | 48% | 29% | 15% | 7% | 3% | 1% | <1% |
| West Central | 36° | >99% | >99% | >99% | >99% | 99% | 96% | 83% | 59% | 33% |
| | 32° | >99% | >99% | 99% | 97% | 87% | 67% | 42% | 21% | 9% |
| | 28° | 99% | 96% | 87% | 71% | 48% | 27% | 13% | 5% | 2% |
| Central | 36° | >99% | >99% | >99% | 97% | 89% | 72% | 49% | 28% | 13% |
| | 32° | 99% | 97% | 91% | 77% | 57% | 35% | 18% | 8% | 3% |
| | 28° | 91% | 79% | 61% | 42% | 24% | 12% | 5% | 2% | 1% |
| East Central | 36° | >99% | 99% | 95% | 85% | 67% | 45% | 26% | 13% | 5% |
| | 32° | 96% | 88% | 72% | 51% | 31% | 16% | 7% | 3% | 1% |
| | 28° | 76% | 57% | 37% | 20% | 10% | 4% | 2% | 1% | <1% |
| Southwest | 36° | >99% | >99% | >99% | 99% | 94% | 80% | 55% | 31% | 14% |
| | 32° | >99% | 99% | 95% | 83% | 62% | 38% | 19% | 8% | 3% |
| | 28° | 93% | 83% | 65% | 44% | 24% | 11% | 4% | 1% | <1% |
| South Central | 36° | >99% | >99% | 97% | 90% | 74% | 52% | 30% | 15% | 6% |
| | 32° | 97% | 91% | 78% | 59% | 37% | 20% | 9% | 3% | 1% |
| | 28° | 79% | 62% | 42% | 25% | 13% | 5% | 2% | 1% | <1% |
| Southeast | 36° | >99% | 97% | 91% | 76% | 56% | 35% | 19% | 9% | 3% |
| | 32° | 92% | 79% | 61% | 41% | 23% | 11% | 5% | 2% | 1% |
| | 28° | 65% | 46% | 28% | 15% | 7% | 3% | 1% | <1% | <1% |

It is important to remember that these dates are based on 30-year averages. Conditions vary from year to year, and short-term and medium-range forecasts provide useful information on the likelihood of damaging cold conditions in any given spring. What about this year?  Soil temperatures are running about 5 degrees above normal right now, with 7-day averages mostly in the 50s (Figure 1).



Mesonet Data - 2 inch 7 Day Avg Soil Temp at Apr 03 2025 07:45 (CDT)

**Figure 1. Seven-day average soil temperatures across Kansas at the 2" depth, for the period March 27-April 3. Source: Kansas Mesonet (https://mesonet.k-state.edu).**

The forecast for this weekend calls for frost and freezing conditions across much of the state, particularly on Sunday morning when lows in the 20s are forecast for all of western Kansas. Conditions can change quickly this time of year, with rapid swings from warm to cold. We had a few Mesonet sites reach the 90-degree mark on March 27 and 28, yet here we are talking about freezing conditions again a week later. When considering the right time to plant, monitoring forecasts is a must, especially right now. The best advice for now is to proceed cautiously and keep an eye on the forecast for any signs of colder weather in the coming weeks.

You can monitor soil temperatures across the state by visiting the Kansas Mesonet's web page (https://mesonet.k-state.edu) and selecting "Agriculture" from the drop-down menu. You'll also find current temperature, wind speed, and precipitation data for 90 stations on the site, along with growing degree day data which will help with decisions related to planting and condition monitoring, both now and during the growing season.

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