Issue 1000

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eUpdate

04/18/2024

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 | 04/18/2024 | Issue 1000

1. Celebrating 1,000 issues of the Extension Agronomy eUpdate!

On April 18, 2024, we mark a significant milestone in our journey of sharing agronomic information with those associated with agriculture in Kansas and beyond. We proudly announce the 1,000th issue of the Extension Agronomy eUpdate, a testament to over eighteen years of dedication, innovation, and collaboration.

From the first issue on September 29, 2005, to today, the Extension Agronomy eUpdate has been a trusted resource of objective, research-based information for farmers, agronomists, agricultural extension agents, and many others. With each weekly edition, we've strived to deliver timely, relevant, and practical information to support sustainable agricultural practices, enhance crop productivity, and navigate the dynamic challenges of modern farming.

As we reach this remarkable milestone, this article reflects on the countless hours of research, the dedication of our contributors, and the support of our readers who have made this journey possible. We hope you enjoy learning about the creation and early years of the eUpdate and the recollections of some key individuals, which are shared below.

From Steve Watson, eUpdate Editor (Issues 1 to 648; 2005-2017)

One day in 2005, I was working in my office in Throckmorton Hall when Jim Shroyer stopped by. Jim was one of two Extension Crop Production Specialists at the time. He and Dan Devlin, then the Extension Environmental Quality Specialist, were thinking about starting up an electronic newsletter for Extension Agronomy to go primarily to all the Extension Agriculture Agents in Kansas. I was the communications person for the department at the time, so Jim asked if I wanted to work with him and the others in Agronomy to make it happen. I said, "Sure," and asked if he had a name for the newsletter. He said he did – the Agronomy eUpdate.

To make it useful and successful, I felt it was important that the newsletter be published weekly. Doing a weekly publication like this is very hard, and most newsletters gradually die out as people go on to other things. Additionally, we decided the newsletter would need a permanent editor who understood what kind of information ag agents and producers need during the year. We expanded our collaborators beyond the agronomy department to include K-State plant pathologists, entomologists, economists, ag engineers, and animal scientists.

The method of delivery has changed over the years, but not the quality of the information. For the first several years, distributing the eUpdate relied heavily on Extension Agronomy office specialist Troy Lynn Eckart. She worked diligently to send out the eUpdate as an email attachment every Friday afternoon. That delivery method gradually changed over the years. Due to the skill of Arthur Selman, the department's IT specialist, the eUpdate was converted to an online format in 2013. After I retired in 2017, we hired Kathy Gehl – an agronomist by training and a good writer – to be the editor. She has upheld and improved the newsletter during her tenure. The email format underwent a significant update in November 2019, and in January 2021, the release day was moved to Thursday afternoon.

It is a credit to everyone involved that the Agronomy eUpdate has become a premier publication of its kind in the nation and that readers can still count on it to come out every week.

From Jim Shroyer, Extension Crops Specialist and Professor Emeritus

When Dan Devlin, Steve Watson, and I discussed starting the eUpdates, if someone had told us this electronic newsletter would reach so many people for as long as it has, we would've laughed at the thought. It was only going to go to County Ag Agents, but that changed in a hurry. Soon, it had a wider audience and covered more disciplines.

This has truly been a team effort from the start. Troy Lynn Eckart and Arthur Selman are to be applauded for all their work, and Kathy Gehl continues in a stellar fashion. Last but not least, a special thanks to all the contributors who provided pertinent and timely information. This is what made the eUpdate so useful right from the start. Now, on to the next 1,000 issues!

From Gary Pierzynski, past K-State Department Head of Agronomy; current Associate Dean for Research and Graduate Education and Director of the Ohio State Agricultural Experiment Station

The eUpdates have and continue to serve an extremely important role in the Land Grant mission. Users receive valuable information when needed, and sometimes before they even know they need it, which allows K-State Agronomy to extend its impact within Kansas and beyond.

Credit goes to Jim Shroyer and Dan Devlin for the original concept, Steve Watson for keeping it going and providing valuable content, Arthur Selman for making the behind-the-scenes technology work, Kathy Gehl for keeping the whole process up to date, and all the contributors who created the content that is so useful for the audience. Keep up the good work to ensure "Just Another Day in Agronomy"!

From Raj Khosla, K-State Department Head and Professor of Agronomy

I extend my congratulations to the entire team of eUpdate creators and curators. The 1,000th issue of our Extension Agronomy eUpdate is an excellent milestone to attain. However, we couldn't have reached this landmark alone. I want to extend my gratitude to all those who consume the relevant information that our outstanding faculty create and share.

A recent survey conducted by the e-Update team revealed that 91% of our readers find eUpdate articles to be "*highly valuable or extremely valuable*" and that it is a "*go-to resource to share with local farmers*". Another reader reported, "*It is the first thing I read or search for a topic*." Such testimonials affirm our conviction in providing timely and useful information in a bite-size format, which makes it easier to digest and share and could be applied immediately by our clientele and stakeholders. Thank you for your continued support as the Agronomy eUpdate newsletter grows in readership.

I want to take this opportunity to share that the Department of Agronomy is hiring a new Extension Specialist focused on Precision Agriculture and related issues to strengthen our Extension team further. This is a new position that did not exist previously in our department. Please look forward to regular tips and valuable information on precision agronomy in future eUpdates.

I wish the very best to the eUpdate team and look forward to another significant milestone. Congratulations!

From Kathy Gehl, current eUpdate Editor (Issues 649 to current; 2017-present)

One key factor contributing to our success has been our commitment to collaboration. We are proud

to have forged strong partnerships with various departments, county and area extension agents, crop commissions, and other stakeholders. Through these collaborations, we've captured a diverse range of expertise and insight into the needs of farmers in Kansas. These collaborations have been instrumental in enriching the content and reach of the Extension Agronomy eUpdate.

Another facet important to increasing the reach of the eUpdate was creating a website for the eUpdate and sharing the articles on social media. During Dr. Pierzynski's tenure as Department Head, he launched the eUpdate on social media (X, formerly Twitter; @KStateAgron), greatly expanding its reach and visibility. Before this, the eUpdate was emailed to a few hundred subscribers. Now, between the email subscribers and our followers on social media, we reach over 12,000 people each week just on our own. Other sources amplify this reach. You can often see eUpdate content appearing in newspapers, online farming magazines, and on the radio (check out K-State's own "Agriculture Today" at https://agtodayksu.libsyn.com/).

As we look to the future, we renew our pledge to continue serving as a trusted ally and a reliable source of information for the agricultural community. Join us in celebrating this momentous occasion! Here's to 1,000 issues of growth, learning, and shared success!

Explore the Extension Agronomy eUpdate archive and stay connected with us at eupdate.agronomy.ksu.edu as we continue to cultivate knowledge, one issue at a time.

Thank you for being part of our journey! Please send me any comments or feedback as we continue to improve this resource for our readers.

Kathy Gehl, Extension Agronomy eUpdate Editor
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2. White grub damage in brome fields

White grubs, the larvae of beetles commonly known as May beetles and June beetles, can be pests of many different commodities. Dead patches in brome fields in Kansas have recently been reported (Figure 1). The sizes of the dead patches varied across affected fields, but in all cases, white grubs could easily be found in soil when collecting samples from the areas (Figure 2). This strongly indicates that the white grubs are responsible for the observed dead zones.

Figure 1. Brome field in Butler County, KS with dead patches from white grubs. Photo by Charlene Miller, K-State Research and Extension.

Figure 2. White grubs in soil taken from a brome field. Photo by Charlene Miller, K-State Research and Extension.

These beetle larvae are belowground pests, feeding on root systems, and can impact a field for several seasons as they take three years to mature fully. Eggs are laid in the spring when adult beetles are attracted to fields. After hatching, the tiny grubs will feed on roots all season long. This first season of feeding often goes completely unnoticed due to the small size of the larvae, which prevents significant root damage. When the soil cools off in the fall, the larvae, now larger from a season of feeding, descend into the soil profile and overwinter there. The following spring, as soil temperatures increase, the larvae move up into the root zone of the field and commence feeding. It is during this second season of feeding that damage can become apparent. The larger size of the grubs means that more root tissue can be consumed faster. So, when white grub populations are large enough, it can lead to the appearance of dead spots in brome fields like those being observed this spring.

Feeding will continue this season, and the grubs will once again overwinter in the soil at the end of the fall. Next spring, feeding damage should be minimal as grubs are nearing maturity and will stop feeding to create an earthen chamber in which they will finish development and emerge as adult beetles the following year.

Options for damaged fields

With the damage already done this year, what can be done about the dead spots? Depending on the

extent of the damaged area, there are a couple of potential options. Replanting the dead areas could be considered if losses are not extreme. Replanting brome in the fall would give the plants time to develop a stronger root system to minimize grub damage the following spring when they resume feeding. Before replanting, treatment of the areas with carbaryl could help reduce the grub population, but this option is not guaranteed to solve the problem as older grubs are less susceptible. It is important to get the insecticide carried into the soil profile where the grubs are more likely to come in contact; surface application will be ineffective, especially if the area is covered with dead vegetation.

In situations where losses are very large, replanting to something else is an option. If this is done, the remaining brome and any other live plants should be destroyed at least 2 to 4 weeks before planting. To reduce injury from remaining grubs, the seed should be treated with an insecticidal seed treatment, and a planting-time insecticide application might be considered.

A replanting option could be a summer annual forage crop. Where most of the brome is dead, kill off the remaining brome with glyphosate and plant a summer annual around June 1. Alternative summer annuals to consider are sudangrass, a sorghum-sudan hybrid, or pearl/foxtil millet. Information regarding these summer annuals can be found in MF2871 Summer Annual Forages: Selection and Production Characteristics. The summer annuals can be grazed or hayed. One concern may be environmental stress. These species can all accumulate nitrates if the weather is dry. Prussic acid could be another issue with the sorghum species. Prussic acid is not an issue if a millet is planted. After utilizing the summer annual, smooth brome could be seeded in the late summer to fall time period. The optimum time for seeding brome varies a little across Kansas, but August 20 to September 15 usually works well. Information regarding seeding and establishment of smooth brome can be found in C402 Smooth Brome Production and Utilization.

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3. Soil temperature, weather forecast, and seed quality are critical for cotton establishment

Cotton can overcome many stresses and produce profitable lint yields when the crop gets off to a good, uniform start. So, when is the "best" time to plant cotton to meet those criteria? In a thermally-limited environment for cotton, such as Kansas, we know we need to plant as early as possible to maximize yield potential. However, those extra heat units from early planting are only useful if you have a stand of plants to benefit.

First, much as with corn, the goal is to achieve an acceptably uniform and optimal stand. The recommended window for cotton planting is relatively narrow compared to that for other summer crops grown in Kansas – roughly May 1 through June 5. However, it is best to monitor soil conditions rather than the calendar. You can monitor soil temperature information on the Kansas Mesonet (http://mesonet.k-state.edu/agriculture/soiltemp/). The Mesonet data can provide a good general idea of soil temperatures and trends. However, a farmer should also monitor actual field conditions at seeding depth, as differences in residue, moisture content, and other factors can result in temperatures that differ from those observed at the local Mesonet station. For various reasons, including seedling chilling, potential herbicide injury, thrips, and seedling diseases, it pays to plant when growers can get an adequate stand and when the crop will grow vigorously.

Soil temperature and the 10-day forecast are two major factors that contribute to that fast start. Cotton seed germination and early growth/emergence are favored by soil temperatures above 64°F and adequate, but not excessive, soil moisture. Based on USDA-ARS research work at Lubbock, TX, seedling cotton requires more than 100 hours above 64°F at the seed level to emerge.

Soil Temperatures – Current, Departure from Normal, and Forecast

We often use 60°F at planting depth in Kansas as our baseline temperature. As of April 18, much of the state's southern portion was at/near that threshold after very warm temperatures the last week (Figure 1). However, the air temperatures are expected to be much moderated and cooler in the next few days. Soils for all but the northeast are quite dry, with many locations below 50% saturation (Figure 2). This will result in quickly changing soil temperatures. However, the cooler weather is expected to be brief, with a return to warmer-than-normal expected at the beginning of May (Figure 3). There are hints that moisture will also be on the rise into early May which may help establish more stable soil temperatures as we approach peak planting.

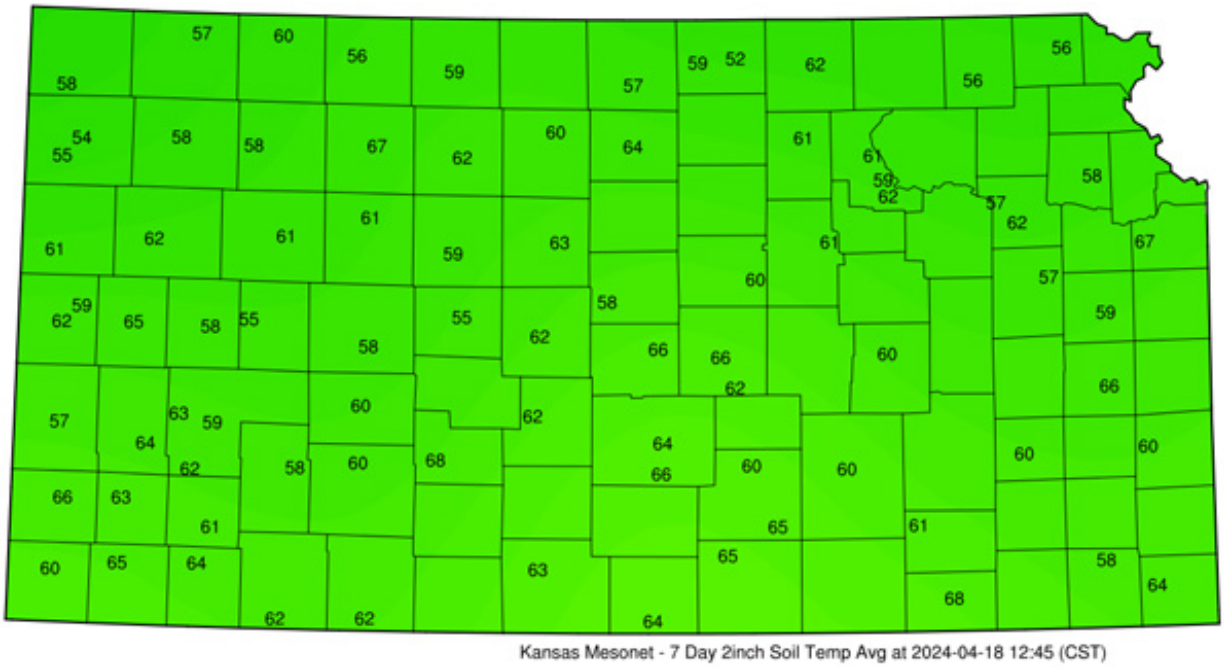

Figure 1. Average 7-day 2-inch soil temperatures (°F) as of April 18, 2024. Data and image courtesy of Kansas Mesonet (mesonet.k-state.edu).

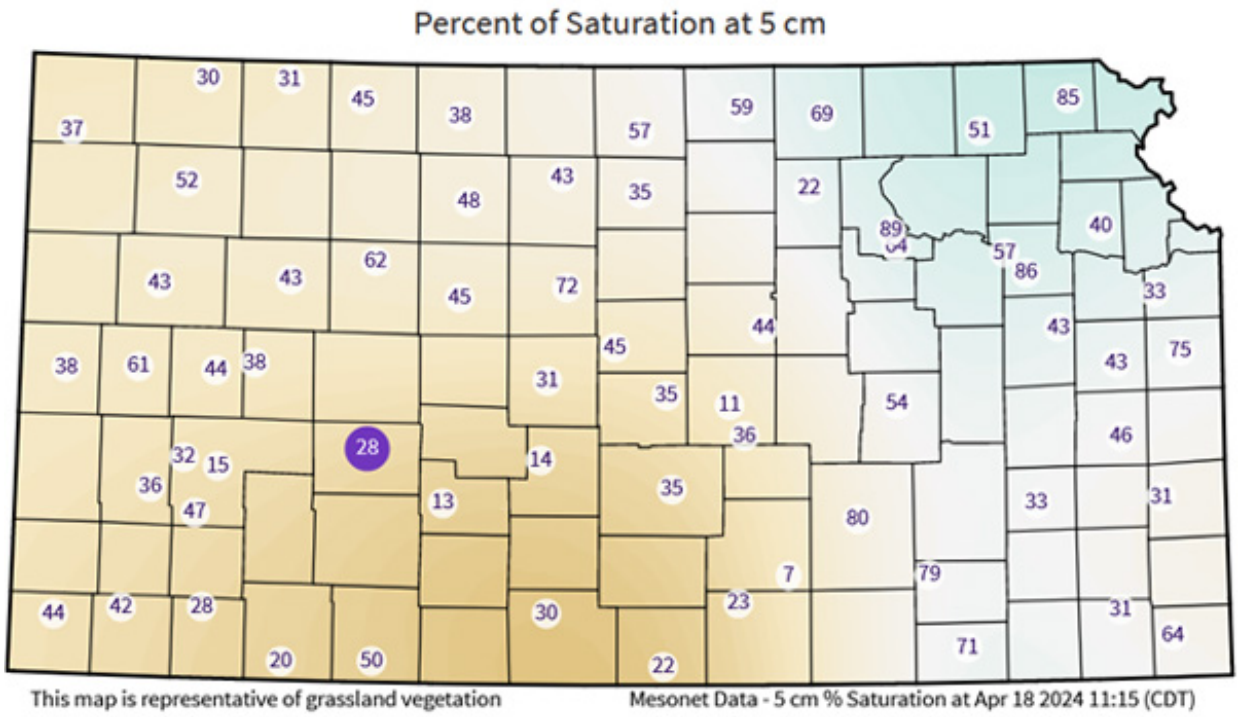

Figure 2. Percent of saturated soil at the 5cm depth on the Kansas Mesonet as of April 18, 2024. Data can be found here: mesonet.ksu.edu/agriculture/soilmoist/

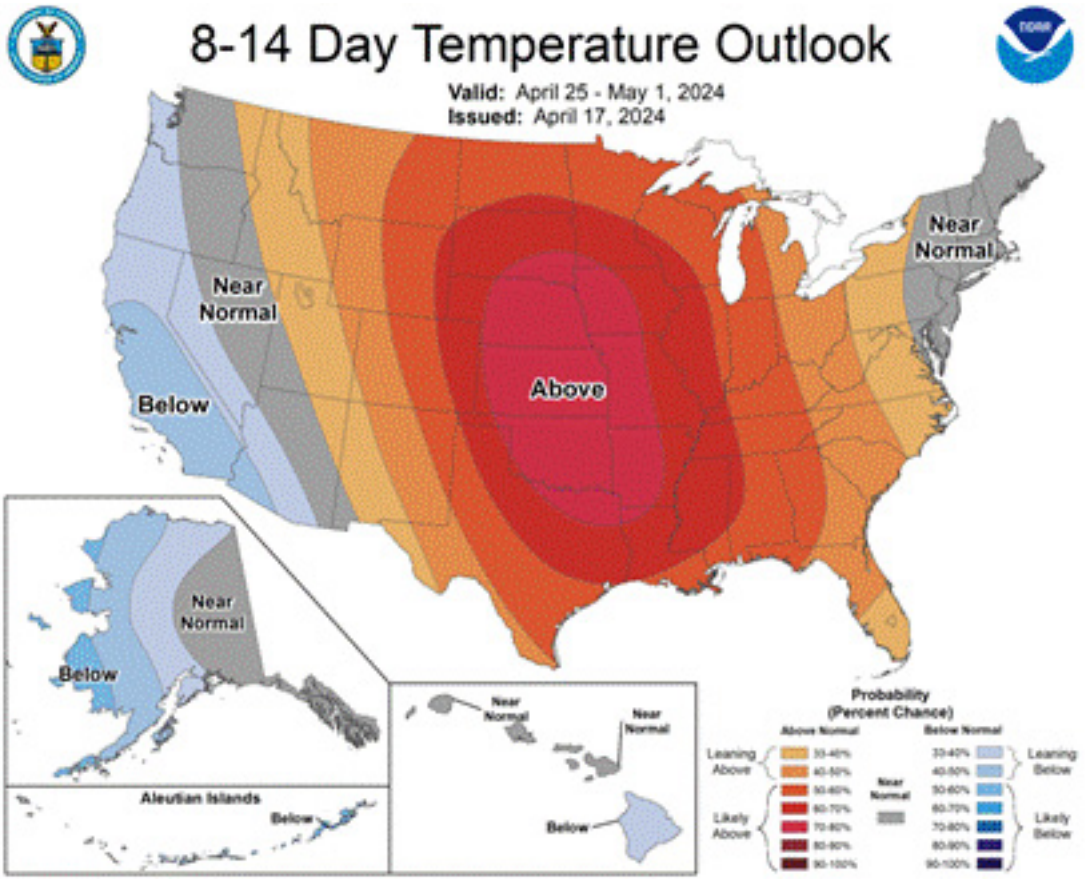

Figure 3. The Climate Prediction Center's 8 to 14-day temperature outlook for the period April 25-May 1, 2024. Source: cpc.ncep.noaa.gov.

In addition to considering soil temperature, growers should plant high-quality varieties (e.g., those with high cold germination and large seed size, good cold tolerance, and early-season vigor ratings).

Information from North Carolina State University's cotton web page illustrating the importance of heat unit accumulation immediately following planting is shown in Table 1.

Table 1. Relationship between predicted DD-60s and Planting Conditions (Source: North Carolina State University, https://cotton.ces.ncsu.edu/)

Predicted DD-60 accumulation for five days following planting	Planting conditions
10 or less	Very Poor
11 – 15	Marginal
16 – 25	Adequate
26 – 35	Good
36 – 49	Very Good
50	Excellent

Avoid planting cotton if the low temperature is predicted to be below 50°F for either of the two nights following planting or predicted daily DD-60s is near zero for the day of planting.

Effects of cold soil on cotton seeds

Cotton seed exposed to cold for the first 2-3 days after planting, OR when the seed is imbibing moisture from the soil, is susceptible to imbibitional chilling injury. The greatest sensitivity is during the first day after planting, when water is being imbibed (Hake et al.), as shown in Figure 4.

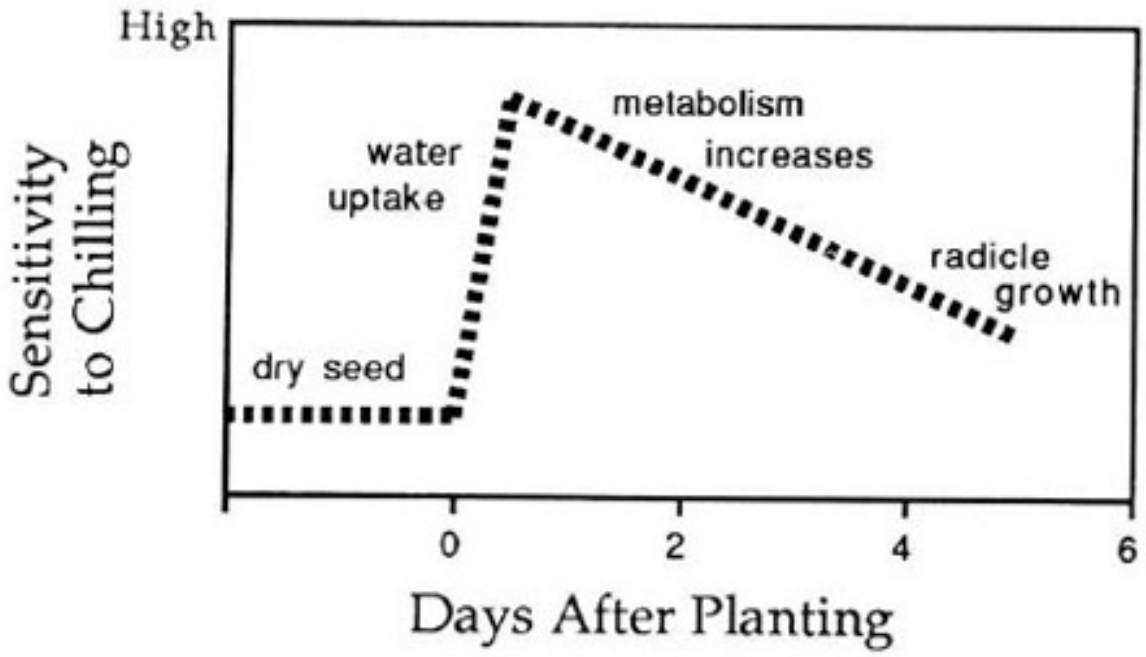

Figure 4. Relative sensitivity of cotton to chilling in the first several days after planting. K. Hake, W. McCarty, N. Hopper, and G. Jividen.

Cotton seeds contain lipids, which must be converted to energy, and cell membranes must develop properly. Seedlings may suffer damage if soil temperatures drop below 50°F during this critical germination period. The first 30 minutes after planting, the seed will absorb up to 60% of the water necessary for germination. Cold soil temperatures (<45°F to 50°F) will most likely lead to injury or seedling death. Damage may result in malformed seedlings, loss of or damage to the taproot, and a greater likelihood of seedling disease problems. Injury usually kills the root tip meristematic tissue, stopping normal taproot growth and leading to lateral root development (Figure 5). If the plants survive, the root system will not develop normally. Additionally, reductions in yield have been documented when less than 25 heat units are received in the first 5 days after planting. For these reasons, it's critical that cotton be planted into a warming soil temperature trend.

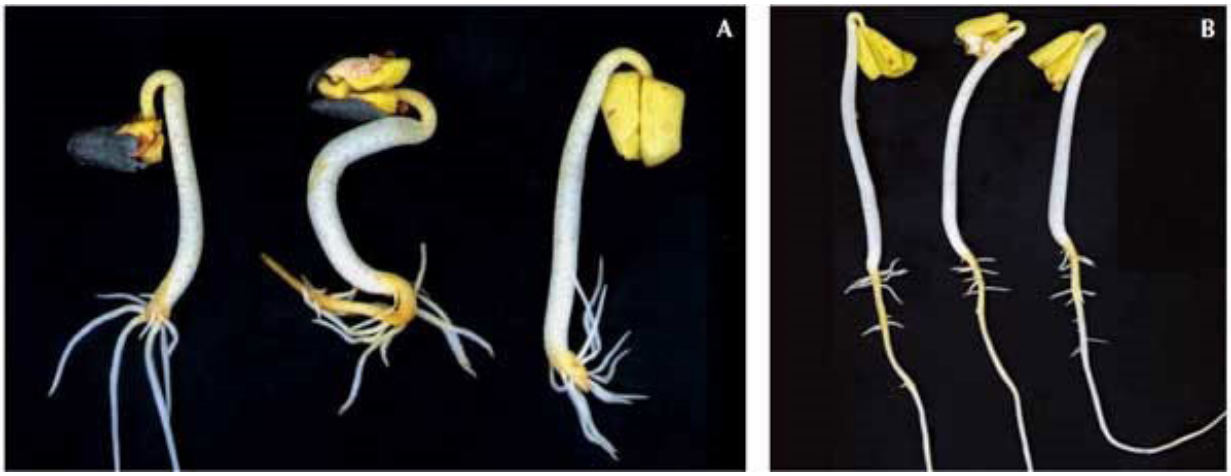

Figure 5. Cotton seedlings subjected to chilling temperatures (A) compared to seedlings not chilled (B) during imbibition from a study conducted by Hopper and Burke. Note the absence of normal taproot growth of the seedlings in A. Seedlings in A and B were exposed to the same temperature (86°F) with the exception of the first six hours of imbibition in which seedlings in A were exposed to chilling temperatures of 40°F. Photos by N. Hopper, Texas Tech University and J. Burke, USDA-ARS, Lubbock, TX.

Seed Quality

Cotton production in Kansas is typically thermally limited, with slower warming in soil temperatures and higher surface residue levels than other cotton-growing areas. It is especially important that producers plant cotton seeds with exceptional seed quality and understand both their warm and gold germination scores on their seed lots.

Warm germination scores are standardized across the industry and are legally required on seed tags. Cold germination tests are not required by law but are available from reputable seed companies. Be cautioned that cold germination test procedures are not necessarily uniform across companies. Be sure to ask and understand what methodology was used before comparing cold germination scores across companies. Generally, the cold germination test for cotton should be conducted at 64.4 degrees, with that temperature held constant for seven days. To be counted as germinated, the seed must sprout, and the radicles of the sprouted seed must reach at least 4 cm in length. However, the results for the cold germination test are not nearly as repeatable as those of the warm test, which is a primary reason why there is no legal standard for cold germination. Producers should plan to plant cotton seeds with the highest cold germination scores first. Cold scores greater than 85% are generally preferred for early planting.

Some companies may be able to provide the Cool-Warm Vigor Index (CWVI) score for their seed. This test, developed in Texas, gives a score that is the combined percentage of the 4-day warm germination test and the cool germination test. Scores of 160 or greater are excellent, Good = 140-159, Fair = 120-139, and Poor = anything less than 120. Farmers would first want to plant seeds with the highest scores and move to lower-scoring seed lots as soil temperatures increase.

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4. Control of late-emerging kochia in wheat or wheat stubble

Getting kochia under control in any cropping system that includes wheat requires control in the wheat crop during the spring and shortly after wheat harvest. This is not always easy, even if early spring herbicide applications for kochia control were made.

Figure 1. Kochia in wheat stubble. Photo by Dallas Peterson, retired K-State Research and Extension.

Late-emerging kochia in wheat

While most kochia emerges early in the spring, emergence can extend over weeks or months. A herbicide applied early in the spring will need to have residual activity to be effective on later-emerging kochia. Group 2 herbicides that contain chlorsulfuron (Glean, others) or metsulfuron (Ally, others) have residual activity on kochia but are ineffective on ALS-resistant kochia. Most kochia populations in Kansas are now ALS-resistant. ALS-resistant weeds are covered in more detail in a companion article in this eUpdate issue.

Similarly, some kochia populations are resistant to Group 4 herbicides, specifically dicamba and fluroxypyr (Starane, others). If sensitive populations are targeted for control, dicamba must be applied before the jointing stage of wheat and fluroxypyr can be applied through flag leaf emergence. Also, with susceptible populations to Group 4 herbicides, Starane NXT (fluroxypyr + bromoxynil) can be a good option as it provided an effective control of glyphosate-resistant kochia across states of the Great Plains. Pixxaro (halauxifen + fluroxypyr) is a combination of two Group 4 herbicides and can be applied up to flag leaf emergence. No kochia populations resistant to halauxifen (Elevore) have been reported in Kansas; however, halauxifen is generally less effective on kochia than fluroxypyr.

Huskie is a combination of a Group 27 herbicide (pyrasfulotole) with a Group 6 herbicide (bromoxynil). It is effective on emerged kochia and can be applied up to flag leaf emergence in wheat. Talinor (bicyclopyrone + bromoxynil) is a similar product that can be used to control kochia. Both of these products should be applied with adjuvants as directed on the labels.

If kochia needs to be controlled later in the season, a few herbicide options are available as harvest aids. Ally (metsulfuron) and glyphosate are labeled, but kochia will likely be resistant to these herbicides. If populations are not resistant, dicamba may be applied after wheat has lost green at the nodes but at least 7 days before harvest. In addition, seed wheat must have a germination test before it can be used. Sharpen (saflufenacil) and Valor (flumioxazin) are PPO-inhibiting (Group 14) herbicides that can be applied after the grain reaches 30% moisture. At least 3 days must pass before harvest after a Sharpen application, and at least 10 days are required after Valor is applied. Be sure to check herbicide labels for adjuvants and application timings for any products you may consider using as a harvest aid. More information about herbicides labeled for harvest aids in wheat can be found in this eUpdate article from late June 2023: https://eupdate.agronomy.ksu.edu/article_new/update-pre-harvest-weed-control-in-wheat-551-2

Kochia control in wheat stubble after harvest

If kochia has not been completely controlled in the wheat crop, it may be present when wheat is harvested. In most cases, the kochia plants will get "topped" by the combine as the wheat is harvested. If kochia has been topped, producers should wait until some regrowth has occurred before applying herbicides to the wheat stubble to control it.

A combination of glyphosate plus either dicamba or fluroxypyr may be the most effective treatment to control kochia in wheat stubble. Even if kochia populations are resistant to glyphosate, the tank-mix combinations with dicamba or fluroxypyr will probably provide good control, as long as the kochia aren't too big, too stressed, or resistant to dicamba and/or fluroxypyr. Some 2,4-D can be added to the mixture to help control other broadleaf weeds, although 2,4-D generally will not help much in controlling kochia. Dicamba or fluroxypyr tanked mixed with a pound of atrazine and 2 oz of saflufenacil (Sharpen) have provided excellent kochia control following harvest. However, only corn or sorghum may be planted the following spring if atrazine is used.

Paraquat (Gramoxone, others) can also be used to control kochia after wheat harvest. Paraquat activity will be increased if applied with a Group 5 herbicide like atrazine. Metribuzin (Dimetric, others) can be used instead of atrazine if soybeans will be planted the following spring. Wheat can be planted 4 months after a metribuzin application. Paraquat is a contact herbicide that requires thorough coverage, which can be achieved by selecting nozzles to apply medium- to coarse-sized droplets and using spray volumes of 15 to 20 gallons per acre.

To improve kochia control after wheat harvest, apply the postharvest treatments in the morning hours or after the field has received some moisture, not when the kochia plants are under maximum stress. If kochia has been severely drought-stressed before treatment, waiting a couple of days following a good rain may increase control.

For more detailed information, see the "2024 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland" guide available online at https://bookstore.ksre.ksu.edu/pubs/SRP1183.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. Users should read and follow all label instructions.

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5. Weed resistance to WSSA Group 2 herbicides is widespread: What do growers need to know?

Weed resistance to WSSA Group 2 herbicides is a global challenge that all growers, including those of major crops in Kansas, must be aware of. This crucial issue directly impacts their crop management strategies and overall productivity.

For over four decades, WSSA Group 2 herbicides have been a tool for growers worldwide[1]. These herbicides, which target the enzyme called Acetolactate Synthase (ALS), have been used in all major crops to control a wide range of weed species. For instance, the active ingredient chlorsulfuron, found in products like Glean and Finesse, was the first sulfonylurea herbicide registered for use in the United States in 1982, specifically for the control of broadleaf and some grasses in cereal crops[2].

Unfortunately, these herbicides are well-known for their ability to select resistant weeds. This resistance can lead to significant control failures, leading to important yield losses and annual revenue loss. Previous research showed that resistance to Group 2 herbicides was reported to have occurred with as few as three applications of these herbicides[3], and rigid ryegrass populations that received four or more previous applications of these herbicides and tested for herbicide resistance were all resistant to these herbicides[4].

More weed species are resistant to these Group 2 herbicides than to any other herbicide group. The frequent cases of herbicide-resistant weeds to Group 2 herbicides can be attributed to their intense use, the strong selection pressure they apply, and the 'resistance mechanism.' They were repeatedly used as the main strategy for weed control in many cropping systems.

Group 2 herbicides are also heavily used in Kansas cropping systems (e.g., winter wheat, grain sorghum, sunflower) and include herbicides such as Amber, Ally Xtra, Affinity SG, Affinity Broadspec, Beyond, Express, Finesse, Glean, Harmony, ImiFlex, Peak, Permit, Zest, etc. An expanded list of Group 2 herbicides used in Kansas can be found at https://bookstore.ksre.ksu.edu/pubs/chemweedguide.pdf.

Herbicide-resistant crop trait technologies are a valuable tool for 'over-the-top applications,' which means applying herbicides directly to the crop foliage without damaging the crop due to the presence of the traits introduced. Wheat, grain sorghum, and sunflower have trait technologies allowing over-the-top applications of specific Group 2 herbicides (Table 1).

Table 1. Crops with ALS-inhibiting herbicide resistance traits and the herbicides that those traits provide resistance.

Crop	Trait	Products (active ingredients)
Wheat	Clearfield (1- and 2-gene)	Beyond Xtra (Imazamox)
Grain sorghum	Igrowth	Imiflex (Imazamox)
	Inzen	Zest (Nicosulfuron)
Sunflower	Clearfield	Beyond (Imazamox)
	ExpressSun	Express (Tribenuron)

Weeds with resistance to ALS herbicides in Kansas

Five years after chlorsulfuron registration, the first sulfonylurea-resistant prickly lettuce was reported. Also, earlier research reported that sulfonylurea-resistant kochia populations were collected in 1987 from wheat fields near Liberal, KS[2].

A list of weeds that have evolved resistance to Group 2 herbicides in Kansas is provided in Tables 2a and 2b[5]. Marestail, flixweed, and bushy wallflower were reported resistant to seven different Group 2 herbicides. Each of them also has cross-resistance, meaning they are resistant to Group 2 herbicides belonging to more than one family. For example, marestail is resistant to Varro (thiencarbazone-methyl) from the Triazolinone family and to the Sulfonylurea family. The Sulfonylurea family has herbicides with active ingredient names ending by (with the suffix) uron, such as chlorsulfuron. Palmer amaranth is resistant to four different products but is also cross-resistant to Sulfonylureas and Imidazolinones, called the "imi's", which have active ingredients with the prefix ima (imazamox and imazethapyr).

From a chemical perspective, one of the most effective ways to delay herbicide resistance is to select a program with herbicides from multiple groups or sites of action.

The pivotal role of crop rotation in weed management cannot be overstated. Its absence leads to a less diverse weed community, reducing the effectiveness of herbicide options for weed control. The risks of resistance are significantly lower in systems where crop rotations are frequently practiced, underscoring the importance of this practice in maintaining a better weed control program.

It's important to note that rotations of Group 2 herbicides, from a chemical family to other Group 2 herbicides of different chemical families, provide the same selection pressure and are ineffective in slowing the evolution of resistance. Herbicide-resistant crop rotation without the diversity of herbicide sites of action (e.g., ALS-resistant winter wheat followed by ALS-resistant grain sorghum) will have no effect on reducing the evolution of herbicide-resistant weeds. Instead, rotating different herbicide-resistance crop traits (in the same or a different crop) increases herbicide MOA diversity within cropping systems, such as rotating Clearfield winter wheat crops with Double Team grain sorghum, which can enhance herbicide MOA diversity within the cropping system, thereby reducing the risk of herbicide resistance.

Table 2a. Weeds and herbicide resistance to WSSA Group 2 herbicides in Kansas. Resistance is indicated by cells with yes/green shading.

Brand (chemical)	**Palmer**[1]	**Waterhemp**	**J. brome**[2]	**Cheat**	**Marestail**	**Flixweed**
Accent Q (Nicosulfuron)						
Ally (Metsulfuron-methyl)					Yes	Yes
Amber (Triasulfuron)						Yes
Autumn (Iodosulfuron-methyl)					Yes	
Beacon (Primisulfuron)						

Beyond Xtra (Imazamox)	Yes		Yes	Yes		Yes
Classic (Chlorimuron-ethyl)		Yes				
Express (Tribenuron-methyl)					Yes	Yes
Glean (Chlorsulfuron)	Yes				Yes	Yes
Harmony (Thifensulfuron-methyl)	Yes	Yes			Yes	
Maverick (Sulfosulfuron)			Yes	Yes		Yes
Olympus (Propoxycarbazone)			Yes	Yes		
PowerFlex HL (Pyroxsulam)			Yes	Yes		Yes
Pursuit (Imazethapyr)	Yes	Yes				
Resolve (Rimsulfuron)					Yes	
Varro (Thiencarbazone-methyl)					Yes	

[1]Palmer amaranth; [2]Japanese brome

Table 2b. Weeds and herbicide resistance to WSSA Group 2 herbicides in Kansas. Resistance is indicated by cells with yes/green shading.

Brand (chemical)	**Wallflower**[3]	**Sunflower**[4]	**Kochia**	**Henbit**	**Shattercane**	**Cocklebur**[5]
Accent Q (Nicosulfuron)					Yes	
Ally (Metsulfuron-methyl)	Yes					
Amber (Triasulfuron)	Yes					
Autumn (Iodosulfuron-methyl)						
Beacon					Yes	

(Primisulfuron)						
Beyond Xtra (Imazamox)	Yes				Yes	
Classic (Chlorimuron-ethyl)						Yes
Express (Tribenuron-methyl)	Yes					
Glean (Chlorsulfuron)	Yes		Yes	Yes		
Harmony (Thifensulfuron-methyl)						
Maverick (Sulfosulfuron)	Yes					
Olympus (Propoxycarbazone)	Yes			Yes		
PowerFlex HL (Pyroxsulam)						
Pursuit (Imazethapyr)		Yes				Yes
Resolve (Rimsulfuron)						
Varro (Thiencarbazone-methyl)						

[3]Bushy wallflower; [4]Common sunflower; [5]Common cocklebur

How do we rotate herbicides or choose herbicide premixes targeting multiple sites of action?

The herbicide classification chart was developed by weed scientists from the Midwest as a tool to help select herbicides with different sites of action.

The pdf version of the herbicide chart can be downloaded from here:

https://iwilltakeaction.com/wp-content/legacy/uploads/files/62739-1-ta-hrm-classposter-update-17-425-fnl-hr-digital.pdf

The left side of the chart shows the site-of-action groups of herbicides and their meanings. It also includes active ingredients and products that target only one site of action.

An example of familiar herbicide products on the far-right column of this left side of the chart is Liberty, Rely, and Noventa. These products have the active ingredient glufosinate and belong to the WSSA Group 10 herbicide group. This group number, displayed in the far-left column, is associated with the site of action of the herbicide. This site-of-action group number is written on the label of several herbicides. The Group 2 herbicides, the acetolactate synthase-inhibiting herbicides group, is the largest group of herbicides.

The right side of the chart has herbicide premixes, products with multiple active ingredients, and targeting different sites of action. The top product, Acuron, has four different active ingredients and targets three different sites of action.

Familiarizing oneself with this chart can become very helpful when selecting herbicide programs that allow a rotation of sites of action or choosing premixes with different active ingredients targeting various sites of action.

Thinking beyond herbicides

It is also highly recommended that we think beyond herbicides and use multiple integrated weed management strategies to preserve these chemistries. Cultural practices that improve crop competitiveness and suppress weeds, such as cultivar selection, narrow row spacing, high seeding rates, and planting date adjustments, can help. Also, the use of mechanical practices, when appropriate, will help. Additionally, the integration of cover crops for weed suppression and the management of weed seed at harvest to reduce weed seedbanks will help prolong the effectiveness of these chemistries. An additional resource can be found at https://bookstore.ksre.ksu.edu/pubs/MF3448.pdf

References

[1]Tranel & Wright (2002)
[2]Thompson et al. (1994)
[3]Powles et al. (1997)
[4]Gill (1995)
[5]Heap (2024)

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. Users should read and follow all label instructions.

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6. 2024 Kansas Wheat Plot Tours - Preliminary Schedule

The Department of Agronomy and K-State Research and Extension will host several winter wheat variety plot tours in different regions of the state starting May 15, 2024. Make plans to attend a plot tour near you to see and learn about the newest available and upcoming wheat varieties, their agronomics, and their disease reactions. Below is a preliminary list of plot tour dates, times, and general locations. Specific directions to each location will be added in a future eUpdate article. The plots highlighted in red with gray shading are still tentative. This list will be continuously added to and updated in the coming weeks.

Date	Day of week	Tentative time	District	County	Location	Agent/Contact
5/15	Wednesday	11:00 AM		Kingman	Spivey	Grace Schneider
5/15	Wednesday	6:00 PM		Pratt	West of Pratt	Jenna Fitzsimmons
5/16	Thursday	8:00 AM		Barton	Hoisington	Stacy Campbell
5/16	Thursday	11:00 AM		Barber	Isabel	Robin Eubank-Callis
5/16	Thursday	6:00 PM		Pawnee	Kinsley	Kyle Grant
5/16	Thursday	6:00 PM		Riley	Manhattan	Gary Fike
5/17	Friday	9:00 AM		McPherson	Marquette	Shad Marston
5/17	Friday	12:00 PM		McPherson	Moundridge	Shad Marston
5/17	Friday	3:00 PM		McPherson	Inman	Shad Marston
5/20	Monday	12:00 PM		Harvey	Camp Hawk	Ryan Flamming
5/20	Monday	6:00 PM		Sumner	Belle Plaine	Randy Hein
5/21	Tuesday	8:00 AM		Sedgwick	Andale	Jeff Seiler
5/21	Tuesday	11:00 AM		Sedgwick	Clearwater	Jeff Seiler
5/21	Tuesday	6:00 PM		Sumner	Caldwell	Randy Hein
5/22	Wednesday	TBD	Post Rock			Sandra Wick
5/22	Wednesday	TBD	Post Rock			Sandra Wick
5/22	Wednesday	TBD	Post Rock			Sandra Wick
5/22	Wednesday	TBD	Post Rock			Sandra Wick
5/23	Thursday	8:00 AM	Phillips-Rooks			Cody Miller
5/23	Thursday	5:00 PM	Cottonwood	Hays		Stacy Campbell
5/24	Friday	7:00 AM	Midway	Russell	Russell	
5/24	Friday	11:00 AM	Midway	Ellsworth	Lorraine	
5/24	Friday	8:00 AM	Central KS	Ottawa	Minneapolis	Jay Wisbey
5/24	Friday	11:00 AM	Central KS	Saline	Solomon	Jay Wisbey

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