Issue 927

Extension Agronomy

eUpdate

10/06/2022

These e-Updates are a regular weekly item from K-State Extension Agronomy and Kathy Gehl, Agronomy eUpdate Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Kathy Gehl, 785-532-3354 kgehl@ksu.edu, or Dalas Peterson, Extension Agronomy State Leader and Weed Management Specialist 785-532-0405 dpeterso@ksu.edu.

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1. Wheat planting conditions in Kansas: Early October 2022

Prolonged drought continues across Kansas. The state only received about half of the statewide average precipitation for September. A late-month precipitation event in north central Kansas saved the state from one of the driest Septembers on record. This event improved soil moisture conditions temporarily for the ones lucky enough to receive above-normal moisture (Figure 1). While this significantly bumped up soil moisture in northwest and north central Kansas, the benefits have rapidly diminished due to warm and breezy conditions. Over the last week, soil moisture has rapidly diminished with negative changes at the 4-inch (10-cm) depth (Figure 2). Areas with little soil moisture change over the last week are already completely dried out.

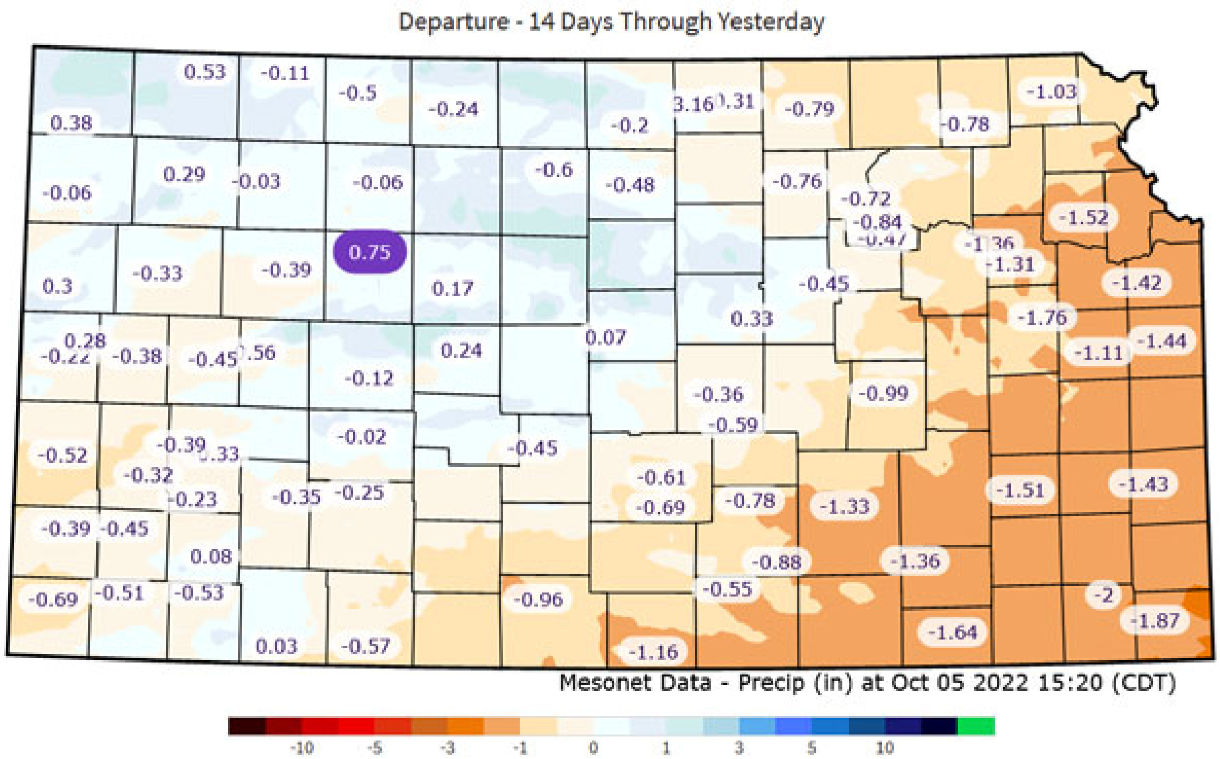

Figure 1. Departure from normal precipitation over the last two weeks, from September 21 to October 4, 2022. Map by the Kansas Mesonet.

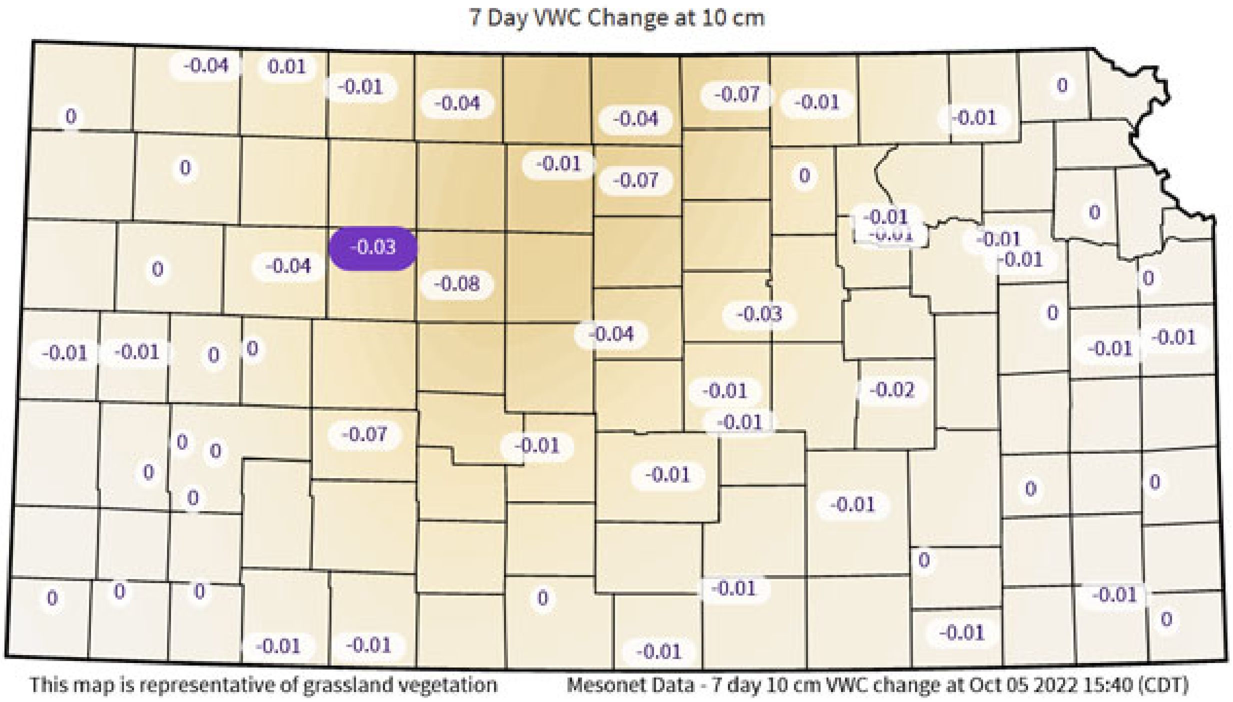

Figure 2. Change in volumetric water content at the 4-inch soil depth (10 cm) over the last seven days, as of October 5, 2022. Map by the Kansas Mesonet.

Weather forecast

The next 7-day precipitation forecast for Kansas indicates that rainfall is expected to be minimal across the state (Figure 3). Totals are only expected to range from 0-0.25 inches which would fall short of the weekly normal precipitation for the second week of October ranging from 0.4 inches in the west to 0.9 inches in the southeast. The 6- to 10-day forecast favors increased probability of above-normal precipitation statewide (Figure 4). The forecast for the coming weeks is more uncertain than normal due to persisting drought and a pattern change (see the companion article on the 2022 Fall Weather Outlook in this eUpdate issue).

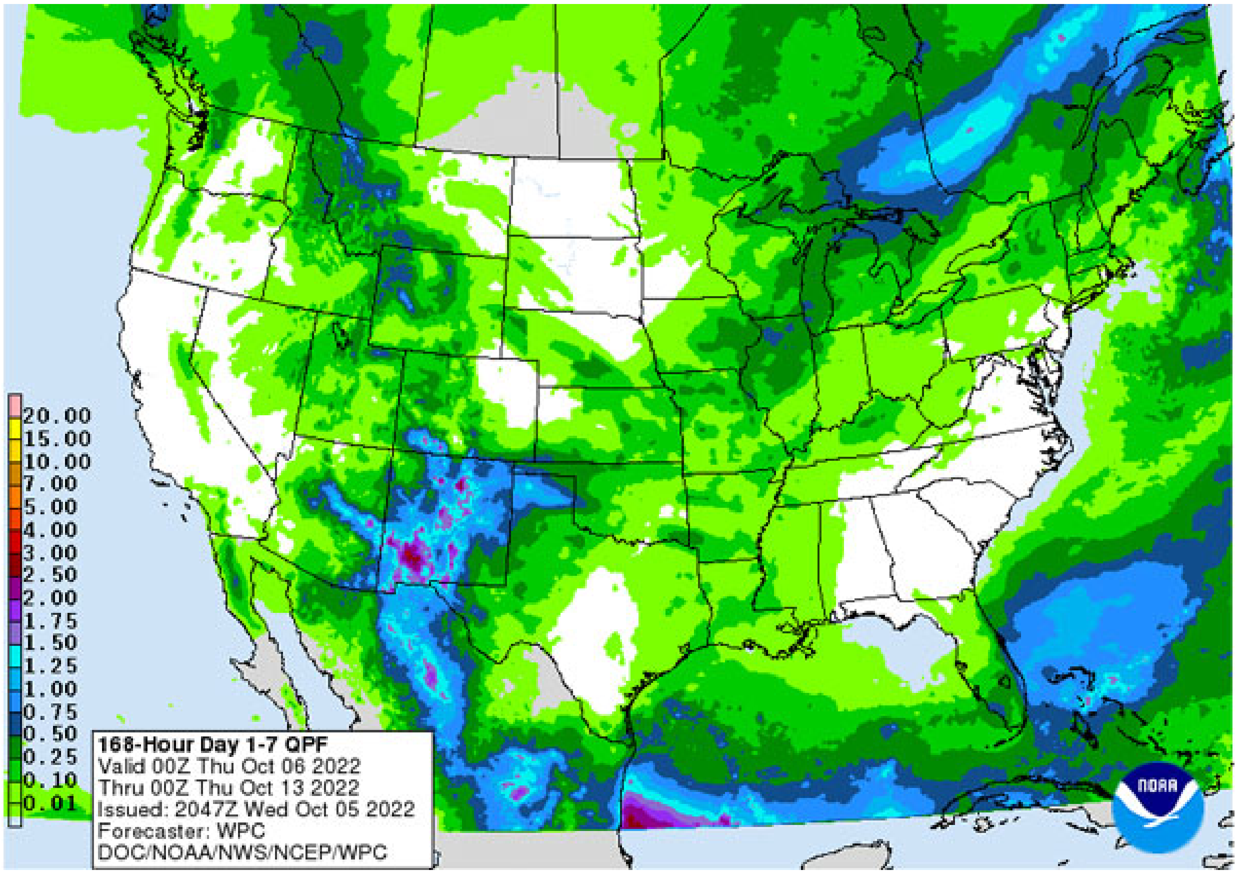

Figure 3. Weekly precipitation forecast as of October 5, 2022 by the National Weather Service Weather Prediction Center (NOAA). Precipitation probabilities in Kansas for the next 7 days range from 0.00 to 0.25" inches.

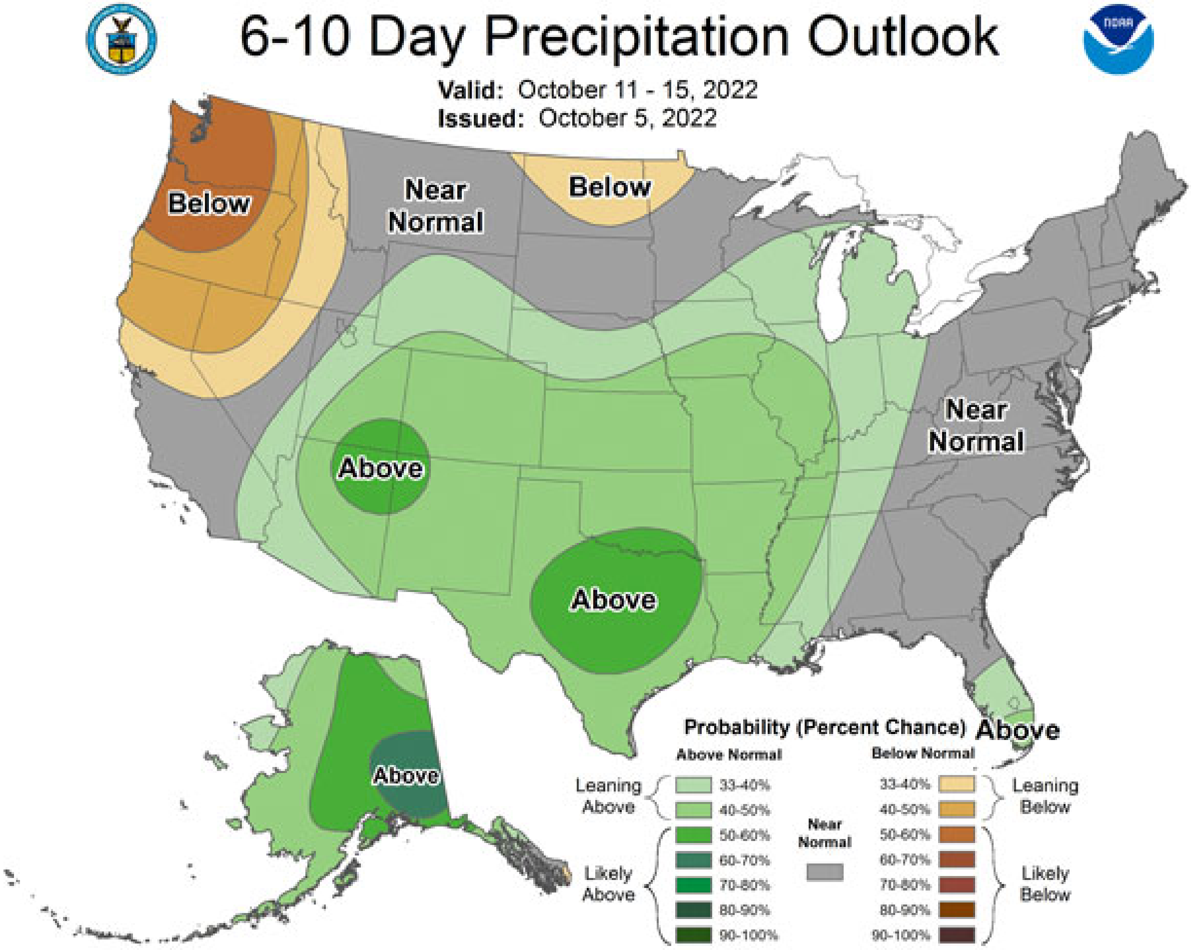

Figure 4. The 6- to 10-day precipitation forecast as of October 5, 2021 by the Climate Prediction Center, NOAA.

Wait for rain or continue with planting progress?

The current wheat-planted acreage in Kansas, according to the USDA-NASS crop progress report, was 30% as of October 2, 2022. This is behind the 5-year average of 39%. Likewise, only 6% of the crop has emerged so far (behind the 5-year term average of 17%).

The biggest question in growers' minds at the moment is: **Should I continue planting the crop, or should I wait for rain?**

Each grower must consider his or her own situation to take this decision, as the rainfall distribution shown in Figure 1 is interpolated across weather stations and might not represent the reality for a few fields that were far from a given weather station.

Advantages of progressing with crop planting now is to take advantage of the available moisture where recent rainfall occurred (that is, where moisture is still available which is the case for some regions in north central Kansas), and also a good seed distribution in dryer soils where rainfall did not occur. In this situation, growers also have the opportunity to plant a large number of acres before it rains. However, if no rain occurs in the near future, the crop might not emerge until it rains later in the fall or even winter, delaying the "effective planting date" to whenever the rain actually occurs. Thus, at this point in time, growers should start to treat these fields as if they were sowing late, where increases in seeding rate and applications of in-furrow starter fertilizer are recommended. These might also be situations in which seed treatments can be beneficial, as the seeds will be exposed to weather in the fields for several days.

The worst-case scenario would include planting into a limited amount of moisture, just enough for emergence of some plants but not enough to maintain these seedlings after they emerge. This situation can result in uneven stands and high stand variability within the field (Figure 5), or even crop failure. Thus, if good moisture cannot be reached in about the top 1.5-2 inches of soil, growers would likely be better off sowing it shallower and waiting for rain.

From a regional perspective, we are either reaching the optimum planting window (north central Kansas) or we are already past the optimum planting window (northwest Kansas) for wheat. In these regions, if there is no moisture available for immediate emergence and growers decide to plant the crop, they should already start increasing seeding rates and adding more in-furrow phosphorus fertilizer to compensate for a late emergence. In south central and eastern Kansas, the optimum planting date is usually not until October 10-15, so there is still time to make this decision and the rain forecast is more favorable. In these cases, growers could still maintain their original seeding rate for optimal sowing time.

For more information on planting wheat into dry soils, please see a previous eUpdate article from September 15, 2022: https://eupdate.agronomy.ksu.edu/article_new/considerations-when-planting-wheat-into-dry-soil-512-1

Figure 5. Uneven wheat stands resultant from sowing into dry soils. Photo by Romulo Lollato, K-State Research and Extension.

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2. Check herbicide labels before using soybeans for livestock feed

Drought conditions throughout Kansas are forcing farmers to consider harvesting soybeans for forage, rather than grain. Many factors should be considered when making this decision and some were discussed in a previous eUpdate (https://eupdate.agronomy.ksu.edu/article_new/drought-and-heat-stress-in-kansas-soybean-fields-508-1). However, herbicide applications made during the growing season are an additional concern that has been raised by farmers. An herbicide label is the law, and many herbicide labels do restrict the use of soybeans as a forage. Table 1 summarizes statements related to feeding soybeans.

Table 1. Summary of restrictions for grazing/haying soybeans treated with various herbicides.

Herbicide	**Comments related to haying and/or grazing**
Anthem Maxx	DO NOT graze or feed treated soybean forage or hay to livestock.
Assure II	Do not feed forage, hay, or straw from treated areas to livestock unless stated otherwise under the specific crop use directions.
Classic	**Do not** graze treated fields or harvest for hay within 14 days after application.
Cobra	Do not graze animals on green forage or stubble. Do not feed treated soybean silage (ensiled soybeans) to cattle. Do not utilize hay or straw for animal feed or bedding.
Dual Magnum	DO NOT graze or feed treated forage, hay or straw from soybeans to livestock for 30 days following a preplant surface, preplant incorporated or preemergence application. DO NOT graze or feed treated forage or hay from soybeans to livestock following a postemergence application.
Engenia	Allow at least 14 days between final application and harvest or feeding of soybean hay.
Enlist Duo	Do not graze treated soybean. Do not harvest for forage or hay.
Enlist One	Do not graze treated soybean. Do not harvest for forage or hay.
FirstRate	Forage or Hay: Do not apply within 25 days before harvest. Soybeans: Do not apply within 70 days before harvest.
Flexstar/Reflex	Do not graze treated areas or harvest for forage or hay.
Flexstar GT 3.5	Do not graze treated areas or harvest for forage or hay.
Fusilade DX	Do not harvest soybeans for 60 days following the last application.
Fusion	Do not graze or harvest for forage or hay.
Harmony GT XP	Do not allow livestock to graze on, or feed forage, hay or straw from treated soybean fields.
Intermoc	DO NOT graze or feed treated forage, hay, or straw. DO NOT graze or feed treated forage or hay from soybeans to livestock after a post-emergent application.

Liberty 280 SL	DO NOT graze the treated crop or cut for hay
Marvel	Do not graze or feed treated soybean forage or hay to livestock.
Outlook	DO NOT graze or feed forage, hay, or straw to livestock
Perpetuo	DO NOT graze treated fields or harvest for forage or hay
Poast Plus	Only processed meal from seed or hay may be fed to animals.
Prefix	Do not graze or feed treated forage or hay from soybeans to livestock following a postemergence application of Prefix Herbicide.
Pursuit	DO NOT graze or feed treated soybean forage, hay, or straw to livestock.
Raptor	No comments on label
Resource	Do not graze treated fields or harvest for forage or hay.
RoundUp PowerMax3	Allow a minimum of 14 days between application and harvest of soybean grain or feeding of soybean grain, forage or hay.
SelectMax	DO NOT graze treated fields or feed treated forage or hay to livestock
Sequence	DO NOT graze or feed treated forage or hay to livestock following a postemergence application.
Synchrony	DO NOT graze or feed treated forage or hay to livestock following a postemergence application
Tavium	DO NOT graze or feed treated forage or hay to livestock following a postemergence application.
Thunder Master	DO NOT graze or feed treated soybean forage, hay or straw to livestock.
Torment	Do not graze treated areas or harvest for forage or hay.
Ultra Blazer	Do not use treated plants for feed or forage.
Warrant	DO NOT graze treated area or feed treated soybean forage to livestock following application of this product.
Warrant Ultra	DO NOT graze treated area or feed treated forage to livestock following application of this product.
XtendiMax	Livestock Grazing or Feeding Permitted.
Zidua SC	No comments on label

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.

For more information, see 2022 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, K-State publication SRP-1169.

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3. Tar spot of corn: A new threat to Kansas corn

Tar spot of corn, a disease caused by the fungus *Phyllachora maydis*, has been confirmed in Nemaha (9/15) and Doniphan (10/05) counties in Kansas. Through a collaborative effort with K-State County Extension Crop Agents, five fields in Nemaha county and one field in Doniphan county have been confirmed positive for tar spot. Tar spot lesions are black, raised, and have a round/elliptical shape. This pathogen can survive in crop residue (Figure 1).

Figure 1. Tar spot of corn. Purple arrows are indicating a few of the tar spot lesions. Photo courtesy of Rodrigo Onofre, K-State Research and Extension.

Tar Spot was detected in US for the first time in 2015 and has quickly spread through the Midwest (Figure 2). To date, it has been reported in Illinois, Indiana, Wisconsin, Michigan, Minnesota, Kentucky, Iowa, Ohio, Florida, Georgia, Pennsylvania, New York, Nebraska, and Missouri. First observations in our neighboring states, Nebraska and Missouri, were made last season. This disease is favored by mild temperature (60F to 73F), high relative humidity (>75%), and a prolonged leaf wetness period (>7h). Severity of tar spot is dependent on the weather. Irrigated corn may be at particularly high risk for yield or silage loss.

Producers should consider harvesting fields confirmed to have tar spot last to mitigate additional disease spread. Because of this, scouting prior to harvest is critical.

Current management recommendations for this disease:

- Avoid highly susceptible hybrids
- Introduce crop rotation (this pathogen survives in corn residue)
- Manage irrigation
- Use fungicides that have active ingredients with more than one mode of action.

Efficacy ratings for fungicides labeled for the control of tar spot can be found at the Crop Protection Network website, link:

https://cropprotectionnetwork.s3.amazonaws.com/CPN2011_FungicideEfficacyControlCornDiseases_04_2022-1650470887.pdf

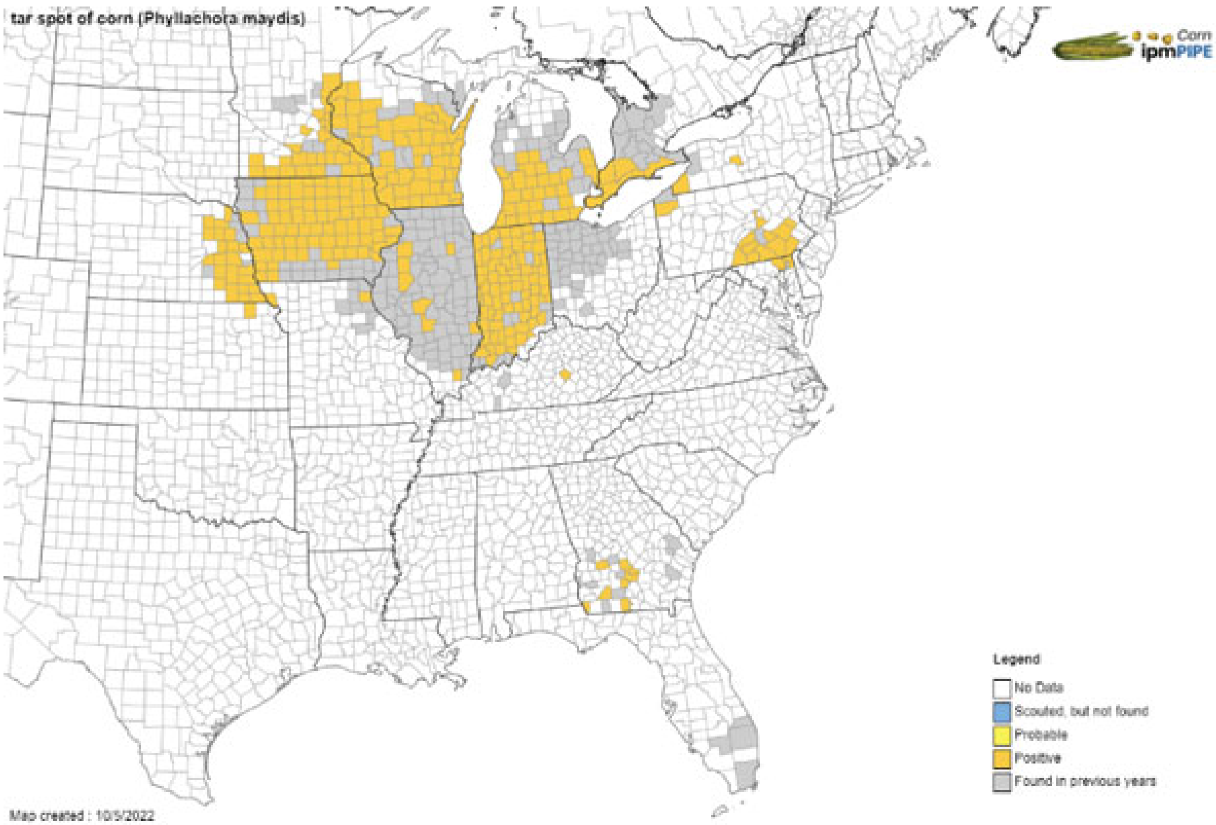

Figure 2. Tar Spot of Corn (Phyllachora maydis) **in Kansas and surrounding states for 2022.**
Source: https://corn.ipmpipe.org/tarspot/

Although it's too late this season to implement the control strategies mentioned above, now is the critical time to identify fields with tar spot as these locations may be at higher risk for the disease next year. For confirmation of tar spot, please submit samples to the K-State Plant Diagnostic Clinic and enclose a completed sample submission form, Link: https://www.plantpath.k-state.edu/extension/diagnostic-lab/documents/2021_PP_DiseaseLabChecksheet.pdf.pdf

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4. Aflatoxin in corn: A potential concern for the 2022 season

Aspergillus ear mold is favored by hot and dry conditions, and for that reason is a concern for the 2022 Kansas corn season. Aspergillus can produce aflatoxin, a known carcinogen that is highly regulated by the Food and Drug Administration (FDA). On the ear, colonies of *Aspergillus flavus* are a greenish-yellow, dime- to quarter-sized mold that grows between the kernels (Figure 1). In severe cases, the mold may cover much larger portions of the ear (Figure 2). Often there is little correlation between the percent moldy ears in a field and actual level of aflatoxin. Corn that dries down rapidly may accumulate less toxin and some field strains are poor producers of aflatoxin. On the other hand, strains that produce copious amounts of aflatoxin may need to be present on a relatively low percentage of ears to cause problems at the elevator.

Figure 1. Aspergillus ear rot colony. Photo by Doug Jardine, K-State Research and Extension.

Figure 2. Severe case of Aspergillus ear rot. Photo by Doug Jardine, K-State Research and Extension.

Most elevators now use one of several commercial quantitative tests that can be performed in a very short time period right at the point of delivery, rather than using the outdated black light method. Samples testing at less than 100 parts per billion (ppb) are usually accepted without penalty. Levels over 100 ppb may be docked a percentage or not accepted at all.

The FDA has established 20 ppb or higher as the level deemed unsafe for human consumption. However, buyers of corn for consumption by humans or pets typically have much more stringent standards and may require levels to be 10 ppb or less. Ethanol plants may also refuse aflatoxin-contaminated grain since the toxin is heat stable and can concentrate as much as three- to four-fold in the distiller's grains. Aflatoxin contaminated corn at any level should not be fed to lactating dairy cows because it can be passed through to the milk.

At 20 to 100 ppb, corn can still be fed to breeding cattle, swine, and mature poultry. Grain testing at 100 to 200 ppb can be used for finishing swine over 100 pounds and for beef cattle. For levels between 200 and 300 ppb, uses are limited to finishing beef cattle only.

Grain with aflatoxin levels higher than 300 ppb cannot be used as feed unless it has been cleaned or blended to safe levels. Blended corn can only be used for direct feeding on the farm where it is blended. It cannot be sold unless a specific blending exemption from the FDA is granted, such as occurred during the 2012 outbreak.

Drought stressed corn harvested for silage may also contain aflatoxin. Producers wishing to have silage tested for aflatoxin can do so through the Kansas State Veterinary Diagnostic Laboratory. Toxicology submission form can be found here: https://www.ksvdl.org/docs/submission-forms/Toxicology-Submission-Form.pdf . See their website at https://vetview2.vet.k-state.edu/LabPortal/catalog/show/4231490 for information on pricing and sample submission.

Once the fungus is detected in grain, the affected corn should be separated from "sound" corn and extra care used in cleaning bins that held contaminated corn.

Producers can reduce the incidence of aflatoxin and other mycotoxins after harvest by taking the following precautions:

- Harvest when moisture content allows minimum kernel damage (24 to 26 percent).
- Adjust equipment for minimum kernel damage and maximum cleaning.
- Dry shelled grain to at least 15 percent moisture, 24 to 48 hours after harvest.
- Dry grain to below 13 percent moisture for long-term storage.
- Cool the grain as quickly as possible after drying to 35 to 40 degrees F, realizing that with current weather conditions, this is not feasible.
- Aerate and test for "hot spots" at one- to four-week intervals during the storage period.

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5. Musk thistle control in the fall

Musk thistle (*Carduus nutans*) is one of 12 noxious weeds in Kansas infesting nearly 500,000 acres. Musk thistle has been reported in nearly every county in Kansas (Figure 1) and is found primarily in pastures, rangeland, hay meadows, alfalfa, fallow, roadsides, and waste areas. Under the new Noxious Weed Law (March 2021), musk thistle is considered a Category C weed. That means that musk thistle is well established within the state and has extensive populations.

Control efforts should be aimed at reducing or eliminating new populations and established stands should be managed with any accepted control method. Accepted control methods include mechanical, chemical, and biological approaches. Mechanical control involves removing the entire plant or just the reproductive parts to prevent the plants from producing flowers/seeds. Mowing, digging, and hoeing are common mechanical methods of controlling musk thistle. A number of herbicides are labeled for use on musk thistle and will be discussed below. Biological control requires a permit and needs to be integrated with other methods. Head and crown weevils are found in the state, but cannot be transported across state lines. A flower fly (*Cheilosia corydon*) is a new candidate species for biological control of musk thistle.

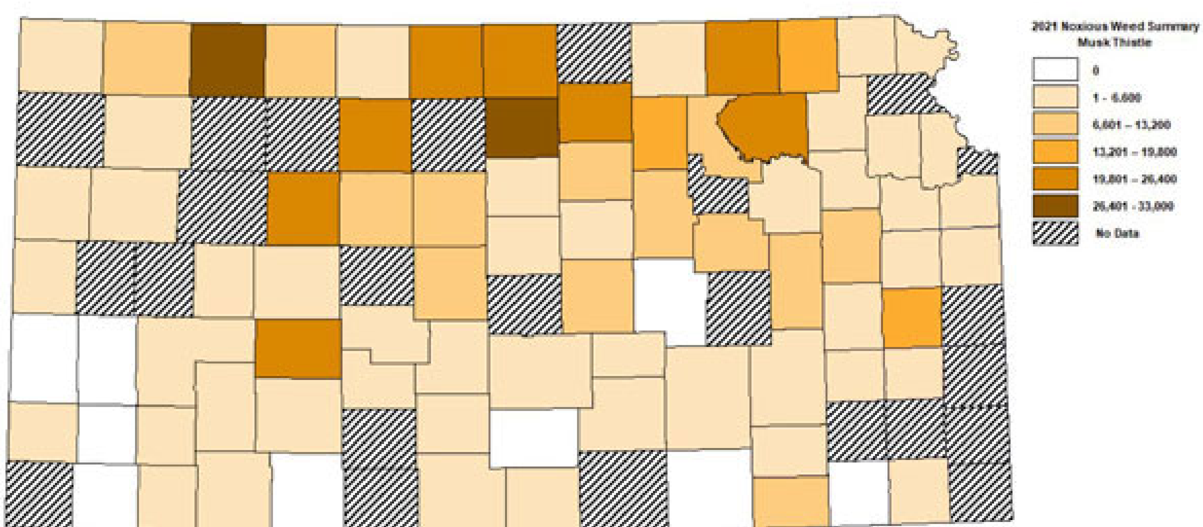

Figure 1. Distribution of musk thistle in Kansas. Map courtesy of the Kansas Department of Agriculture.

Musk thistle is primarily a biennial or winter annual species. Biennials take two growing seasons to complete their life cycle. Thistles that germinate in the spring will spend the entire summer as a rosette, live through the winter, and bolt the next year in May and June. Winter annual plants will germinate with moisture and warm temperatures in the fall, live through the winter, and bolt the following year.

Most people recognize musk thistle during the early summer when the plants are actively blooming (Figure 2, top photo). However, musk thistle control is easiest as a rosette (Figure 2, bottom photo).

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Figure 2. Musk thistle in flowering and rosette stages of growth. Photos courtesy of Walt Fick, K-State Research and Extension.

Fall is an excellent time to spray musk thistle as all are in the rosette stage of growth. Another advantage for treatment in the fall is reduced risk of off-target drift. Waiting until most deciduous trees have lost their leaves and most crops are harvested will greatly reduce the likelihood of damage from herbicide drift. A wider window of opportunity for treating musk thistle also exists in the fall. The spraying window in the fall probably extends until the ground is frozen and the musk thistle plants have shut down activity until warmer temperatures in the spring. Freezing temperatures will start to damage musk thistle plants, with some yellowing and curling of leaves. However, the plants are susceptible to herbicides as long as green tissue exists.

Dry conditions in the fall can reduce control of musk thistle with certain herbicides, but studies in Kansas indicated that a fall application of 2,4-D LVE at 2 lbs per acre was more effective (80% control) than a similar rate of 2,4-D amine (49% control). Dicamba + 2,4-D amine at 0.25 + 0.75 lbs per acre and picloram at 0.125 lbs per acre were also effective (>90% control) on musk thistle treated in the fall. Other herbicides that have proven effective include 3-5 fl oz/acre aminopyralid (Milestone) and aminopyralid + metsulfuron (Chaparral at 1.5 oz/acre). Products containing picloram and aminopyralid will not only control rosettes treated in the fall, but will have enough carryover to control emerging seedlings the following spring.

If you need to treat musk thistle this fall, select the proper herbicide for the job. If possible, select a warm, sunny day to spray. Scattered rosettes can be mechanically removed by digging below the crown.

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6. Drought progression in Kansas during the 2022 growing season

The 2022 growing season began on April 1. We are now into early October, and in the next few weeks, frost and freezing conditions will put an end to the growing season. One fact has been a constant this growing season: much of Kansas has been in drought status. The state is in worse shape now than it was six months ago. How did we get to this point?

Spring 2022

At the beginning of the growing season, most of eastern Kansas was drought free, while western Kansas was in severe drought, with the worst category, D4, present in the far southwest (Fig. 1a). The Drought Severity Composite Index (DSCI) was 194, well above the long-term average DSCI of 105 (based on all available DSCI data from 2000-2022) and indicated that Kansas was drier than average. Precipitation during the first three months of the growing season was near to slightly above normal in the eastern two-thirds of Kansas, but below normal in the west (Fig. 2), and temperatures were slightly above normal in all areas except for northeast Kansas (Fig. 3). As a result, by the end of June, the DSCI had fallen 46 points to 148, and 43% of the state was drought-free (Fig. 1b), up from 28% at the start of the growing season. While eastern and central Kanas were in better shape than three months prior, most of western Kansas was in worse shape.

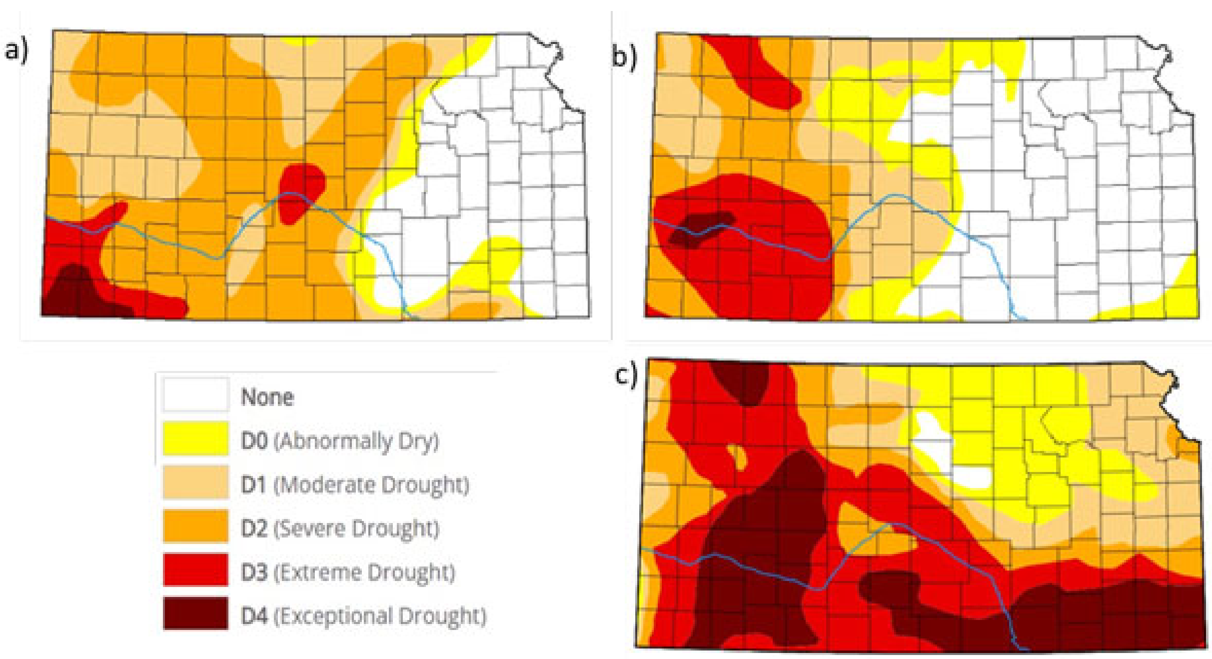

Figure 1. Drought conditions across Kansas on a) March 29, b) June 28 and c) September 27, 2022. Source: National Drought Mitigation Center.

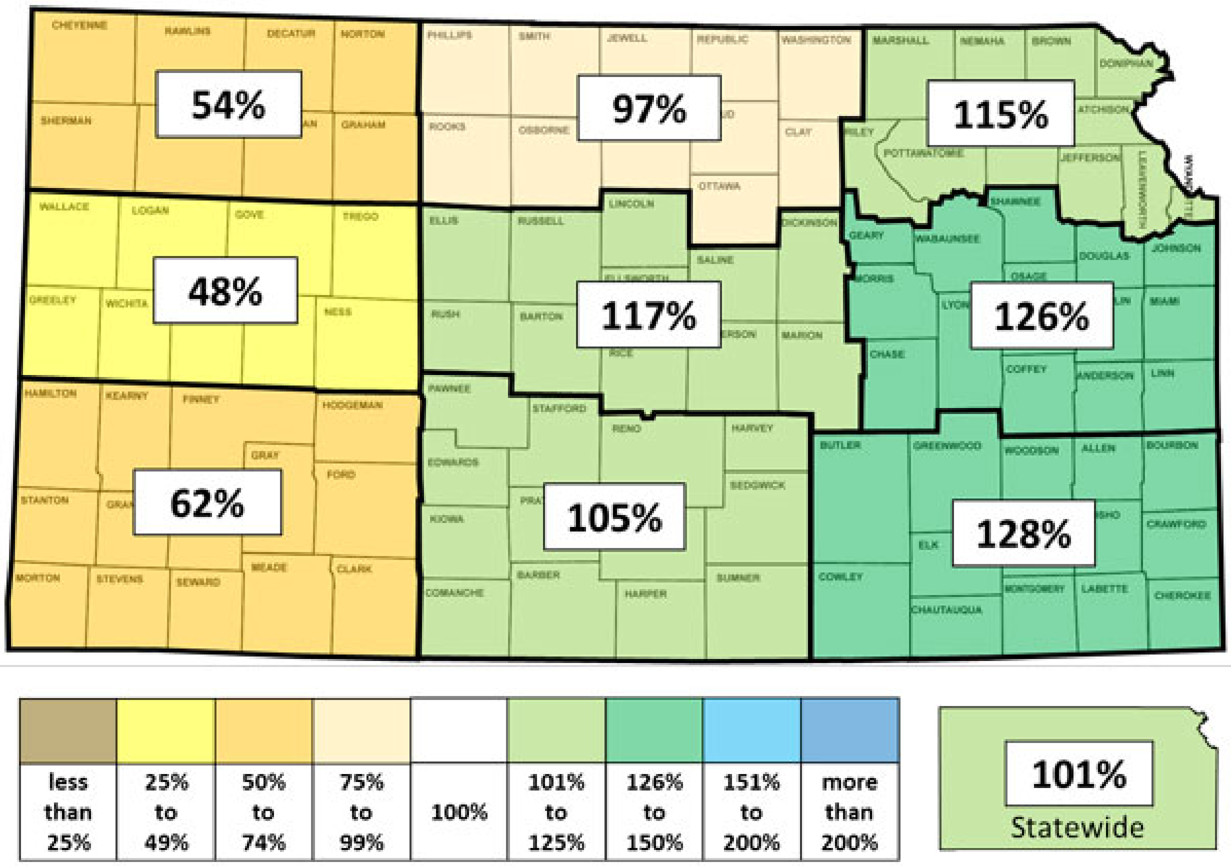

Figure 2. Percent of normal precipitation averaged by Kansas climate division, April 1-June 30, 2022.

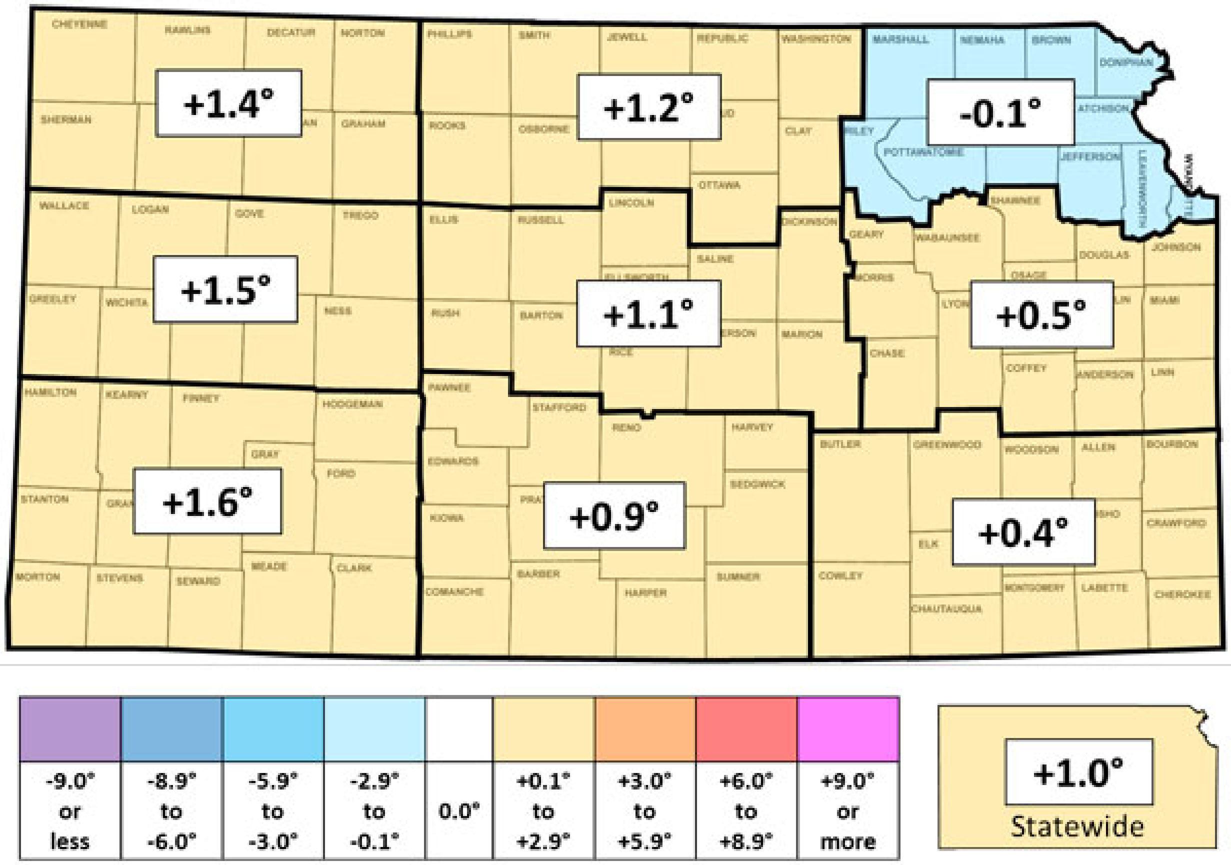

Figure 3. Departure from normal temperature averaged by climate division, April 1-June 30, 2022.

Summer 2022

The long, hot, dry summer kicked in, and all of Kansas was significantly affected. Below-normal precipitation was the rule statewide from July through September (Fig. 4); the state averaged only 60% of normal precipitation for this period. Above-normal temperatures accompanied the dry conditions (Fig. 5). As a result, drought conditions rapidly deteriorated (Fig. 1c). Parts of southeast Kansas went from being drought-free to D4 status in just three months. The third quarter of 2022 is the driest on record in southeast Kansas and the second driest on record in south central Kansas, dating back to 1895. Less than 2% of the state is currently drought-free. The DSCI more than doubled during this period (Fig. 6); the index was up to 326 as of September 27th. The last time the DSCI was 326 or higher was back in May 2014. Nearly 25% of the state is now in D4 status, and over half the state is in D3 or worse status. The last time both of these events happened was in 2013.

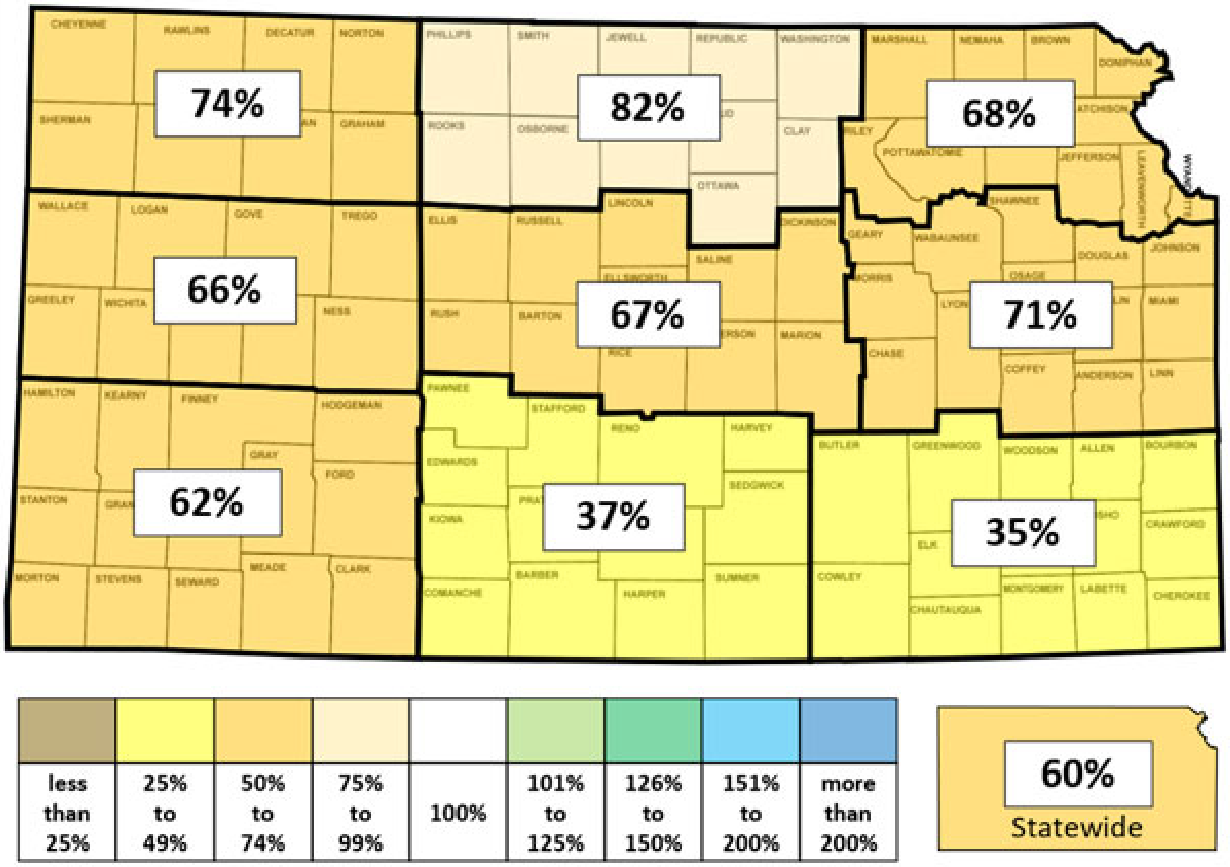

Figure 4. Percent of normal precipitation averaged by Kansas climate division, July 1-September 30, 2022.

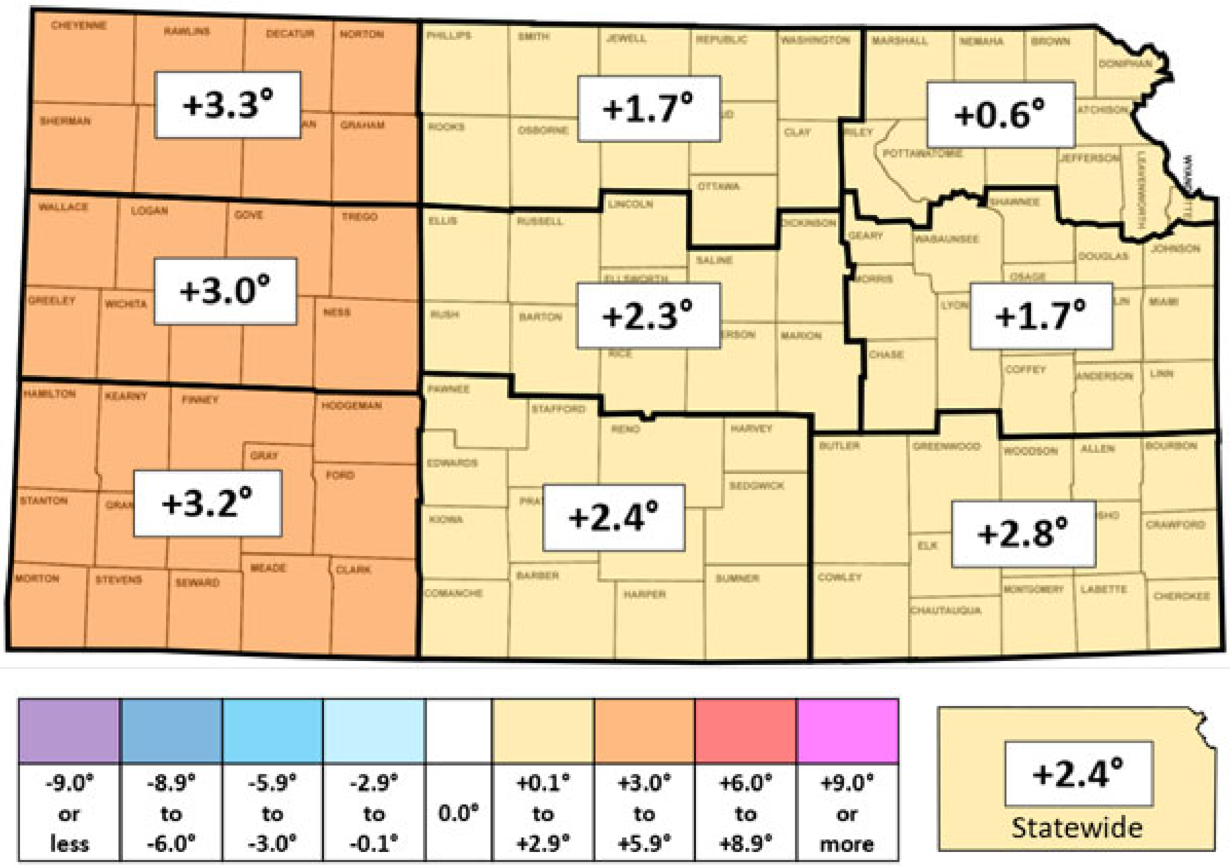

Figure 5. Departure from normal temperature averaged by climate division, July 1-September 30, 2022.

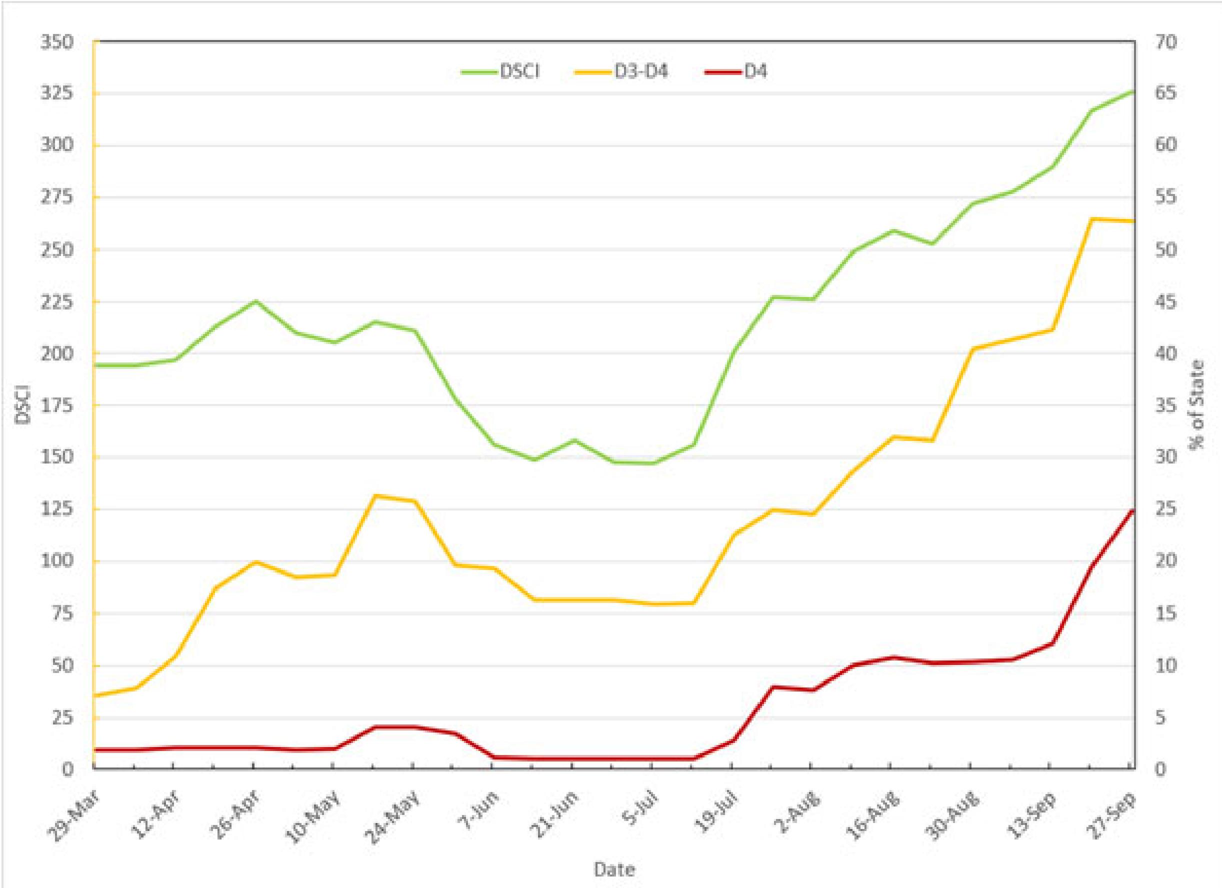

Figure 6. Drought Severity Coverage Index (DSCI) and the percent of Kansas in D3 and/or D4 status during the 2022 growing season.

A closer look at western Kansas

If we look only at the western third of Kansas, the high temperatures and lack of significant moisture are far more unusual than a once-in-a-decade event as suggested by the magnitude of the DSCI (Table 1). All three of the western climate divisions' average temperature and total precipitation values rank in the top 12 of both the warmest and driest growing seasons on record, dating back to the start of archived climate divisional data in 1895.

This is Garden City's driest growing season in 130 years of record keeping; only 4.86 inches of precipitation has been recorded as of September 30. This is 9.92 inches below normal, and 0.03 inches lower than the current record set in 1934, during the Dust Bowl era. Liberal (7.21", departure -8.01"), Goodland (8.42", -6.58"), Dodge City (9.69", -7.96") and Hill City (9.95", -6.82") have all had less than 10 inches of precipitation since April 1; these amounts rank between 11th and 16th driest at all four locations. Thanks to 101 days with highs of 90° F or more, one less than the record set in 2011, Dodge City's average temperature since April 1 ranks as the 4th warmest out of 148 years of climate data. Other locations where the counts of 90°-days rank in the top 10 of most days on record include Wichita (94 days; ranks 4th out of 134 years), Concordia (78 days; 6th out of 138 years), and Hill City (89 days; 9th of 96 years). Ashland (Clark County) has the highest count of 90° days anywhere in Kansas: 112 days, which ranks as tied 3rd out of 123 years at that location. Of those 112, 43 of the days had highs of 100° or more, only 4 off the highest count in the state: 47, in Healy (Lane County).

Table 1. Average temperature and precipitation, departures from normal and rankings of the 2022 growing season (through September 30th) against the full period of record for climate divisional data (1895-2022). Departures are based on 30-year normals for the period 1991-2020.

#: Division	Average Temperature (Departure)	Rank - Warmest	Total Precipitation (Departure)	Rank - Driest
1: Northwest	68.6° (+1.7°)	12th	10.12″ (-6.04″)	7th
4: West Central	69.8° (+1.7°)	10th	8.77″ (-6.66″)	6th
7: Southwest	71.7° (+2.0°)	10th	9.18″ (-5.69″)	7th

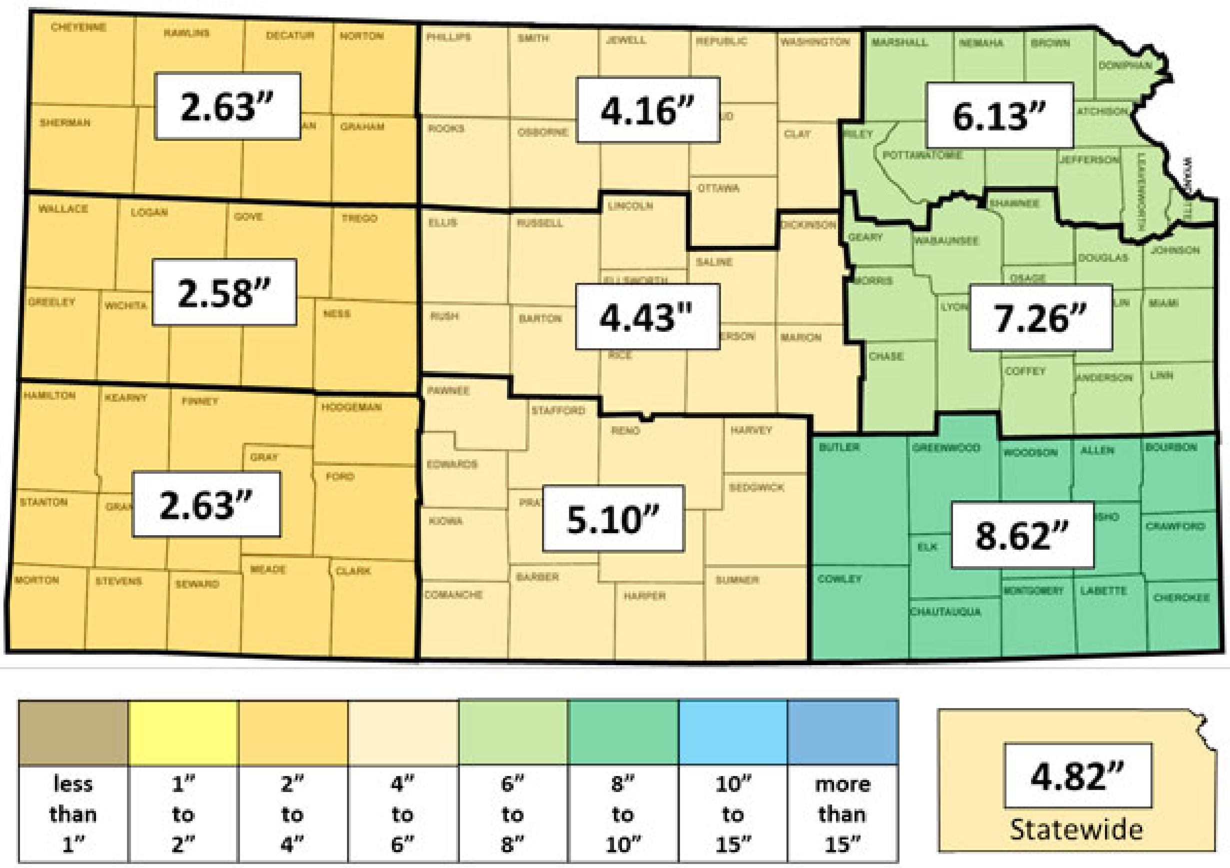

Figure 7. Average precipitation by climate division, October 1-December 31.

Looking ahead for fall and early winter

The problem with the fourth quarter of the year, climatologically speaking, is that normal precipitation is much lower than in summer (Fig. 7). The average precipitation in southwest Kansas, for example, is just 2.63 inches for the last three months of the year. Even if southwest Kansas averaged 8 inches of rain in the last three months of year (which has only happened once in 127 years: 8.04" in 1946), it would still not be enough to completely erase the precipitation deficit, since 8 inches would only be 5.37 inches above normal, and the current average deficit in southwest Kansas as of September 30 is 5.63 inches. It would take an unprecedented fourth quarter for southwest Kansas to finish the year at normal precipitation.

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7. 2022 fall weather outlook for Kansas

Current conditions

Kansas continues to see prolonged drought and warm temperatures through fall. Moisture has been limited to primarily one late-September event in the northwest and north central Kansas. Otherwise, very dry conditions have persisted statewide. Many locations across the state have gone 30-50 days without a half inch of moisture (in one day) (Figure 1). While this has helped harvest, it has generally led to poor wheat planting conditions. Drought is also leading to water quantity concerns, especially in the southeast portion of the state. If you have a drought impact, be sure to report it here: go.unl.edu/CMOR.

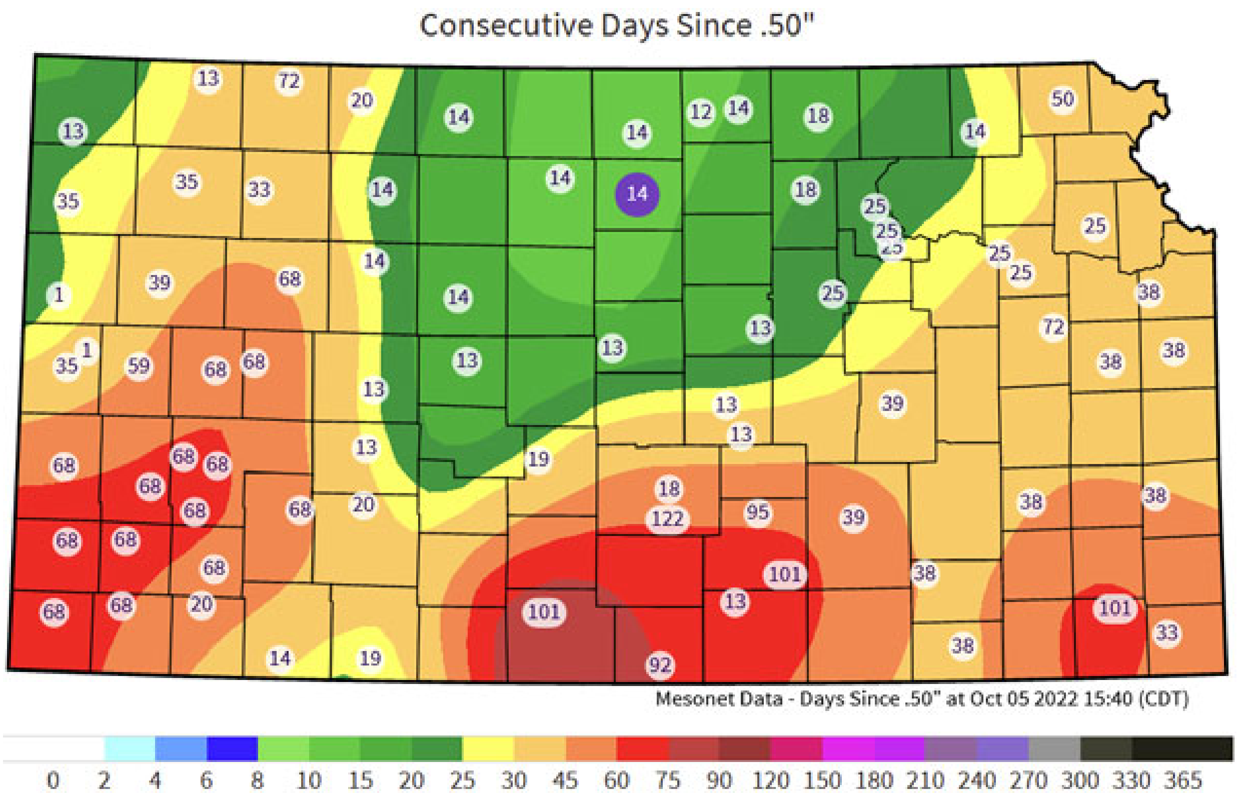

Figure 1. Days since 0.5 inch of rainfall was recorded at a time as of October 5, 2022. Data from the Kansas Mesonet, http://mesonet.k-state.edu/precip/consecutive/#mtIndex=2&tab=chart-tab

The central Plains have been one of the driest regions of the United States over the last few months (Figure 2, left). Meanwhile, to the west/southwest, abundant monsoons brought normal to above-normal precipitation. The southwest US moisture continues even up with monsoons persisting later than normal. A similar trend of increased moisture in Arizona and Utah occurred in 2021 (Figure 2, right). However, widespread drought had hold of most of the western US outside that region (Figure 3, right). This year, drought conditions have actually been improved (while not completely removed) for most of the same regions in the west (Figure 3, left). It is apparent that much of the Rockies drought conditions have migrated somewhat into the Central US and taken hold over Kansas and neighboring states. The upstream wetter conditions in the west, and resulting higher soil moistures, will be something to watch. They may play a small role in how systems successfully make it across the west.

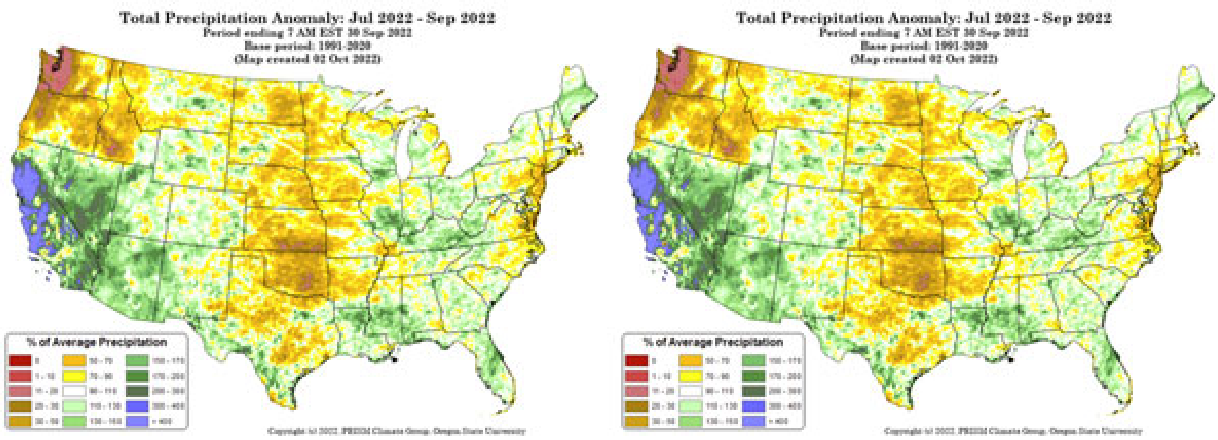

Figure 2. Precipitation anomalies for the United States from July to September 2022 (left) compared to last July to September 2021 (right). Data from PRISM Climate Group.

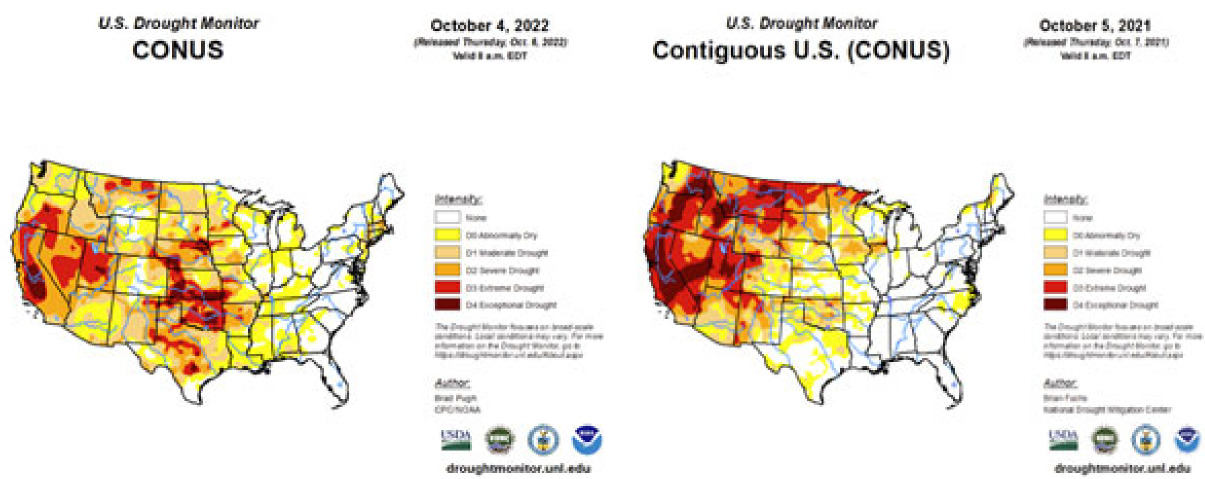

Figure 3. Drought monitor for the contiguous U.S. (CONUS) for October 4, 2022 (left) compared to October 5, 2021 (right). Data from the US Drought Monitor.

Temperature-wise, conditions for the Central Plains and westward are very similar to last year. July through September anomalies were 1-3°F above normal for all but the southeast. This year, temperature anomalies were slightly warmer and covered all but the Midwest to the Gulf states. Warmer temperatures become more impactful as we get into the fall and winter because seasonally, winds increase. This enhances potential evaporation of remaining surface moisture and can more efficiently dry out soils and/or reduce the positive impact of any recent moisture.

The Forecast – Third La Niña in a row

The big headline for the third fall/winter in a row continues to be the La Niña state of the eastern Pacific along the Equator. While some La Niñas aren't overly influential to the US weather pattern, this event has been quite impactful. It has helped drive drought expansion across the region with continued blocking/high pressure to our west. Additionally, La Niña has worked with the negative Pacific Decadal Oscillation to help be "deconstructive," preventing a significant pattern change and the shunting influence of other oscillations. The good news is that as we get into winter, our weather becomes more influenced by these other oscillations and the likelihood increase for a change. Unfortunately, until the overall background changes, it is likely that any change would be short lived. Kansas typically sees an increase in warm/dry extremes over the winter with La Niña in place. Last year fit the bill with the warmest December on record for Kansas.

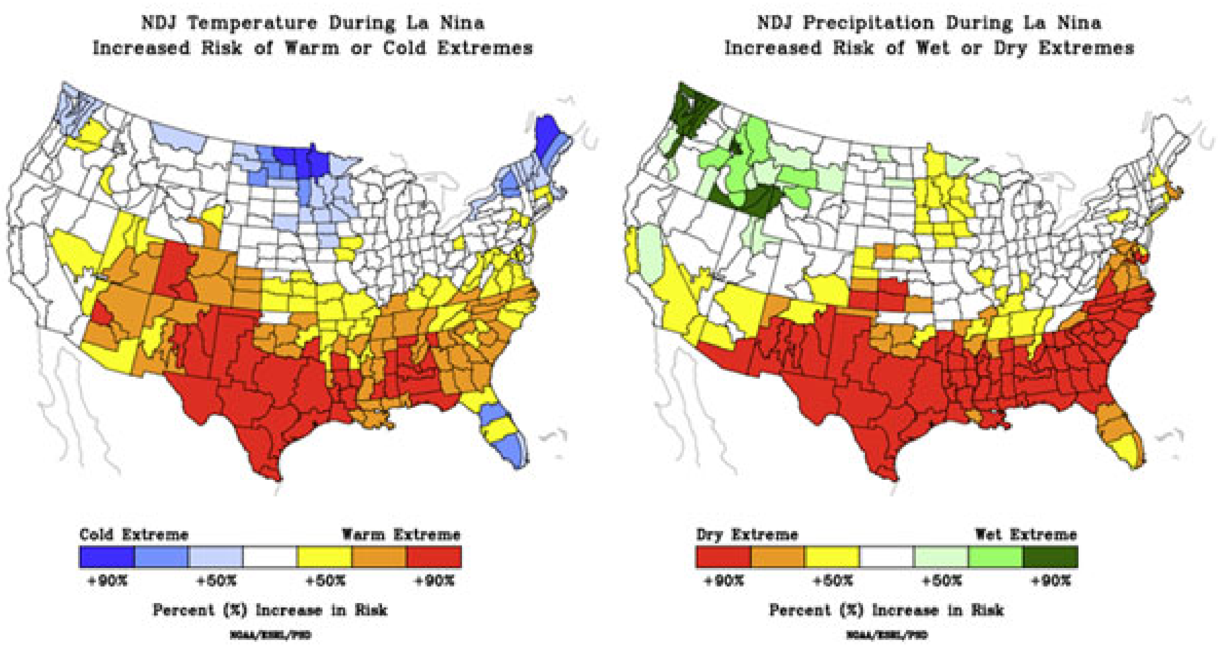

Figure 4. Probability of warm/cold extremes (left) and wet/dry extremes (right) with La Niña conditions during December through February. Data from NOAA Physical Science Library.

Since forecast models keep La Niña in place this winter for the third straight year, we refer to it as a "triple dip" La Niña. This will be only the third time it has ever occurred since records began in 1950. The previous years were centered around 1974 and 1999. That doesn't provide us with a very good historical analog since it is a rare event. However, the summer of 2000 was so much like 2022 that it is hard to ignore since it too was the third year in a triple dip La Niña. Precipitation wise, 2000 was the 7th driest on record from July to September (5.31" statewide). Similarly, 2022 is preliminarily the 10th driest (5.66"). Very similar temperatures occurred as well. The July to September 2000 period is tied for 10th warmest on record with a statewide average of 77.7°. This summer had an average of 77.1°, good enough to tie for 16th warmest.

Since 2000 would be a rough analog for the summer of 2022 (July through September), it is worth looking into what happened with the winter into 2001. While that year featured moderated weather for the fall period (already unlike what appears likely for 2022), it did feature a change over the winter. After a warm and dry December 2000, it flipped and became quite cool and wet. In fact the December through February 2001 period was the 16th coldest and 8th wettest on record. It also featured above normal snowfall! I think Kansans would take that!

Unfortunately, there is a lot more that goes into an outlook aside from a simple analog. Several factors need to be considered as we enter the cold season. First, sticking with La Niña, the forecast a transition to moderate (between -1° and -1.5°) event before trending towards neutral later in the winter (Figure 5). While this was forecasted to occur last winter, odds are increased for verification this year since there has never been a period of four straight winters with La Nina. Granted, we only have about 70 years of data.

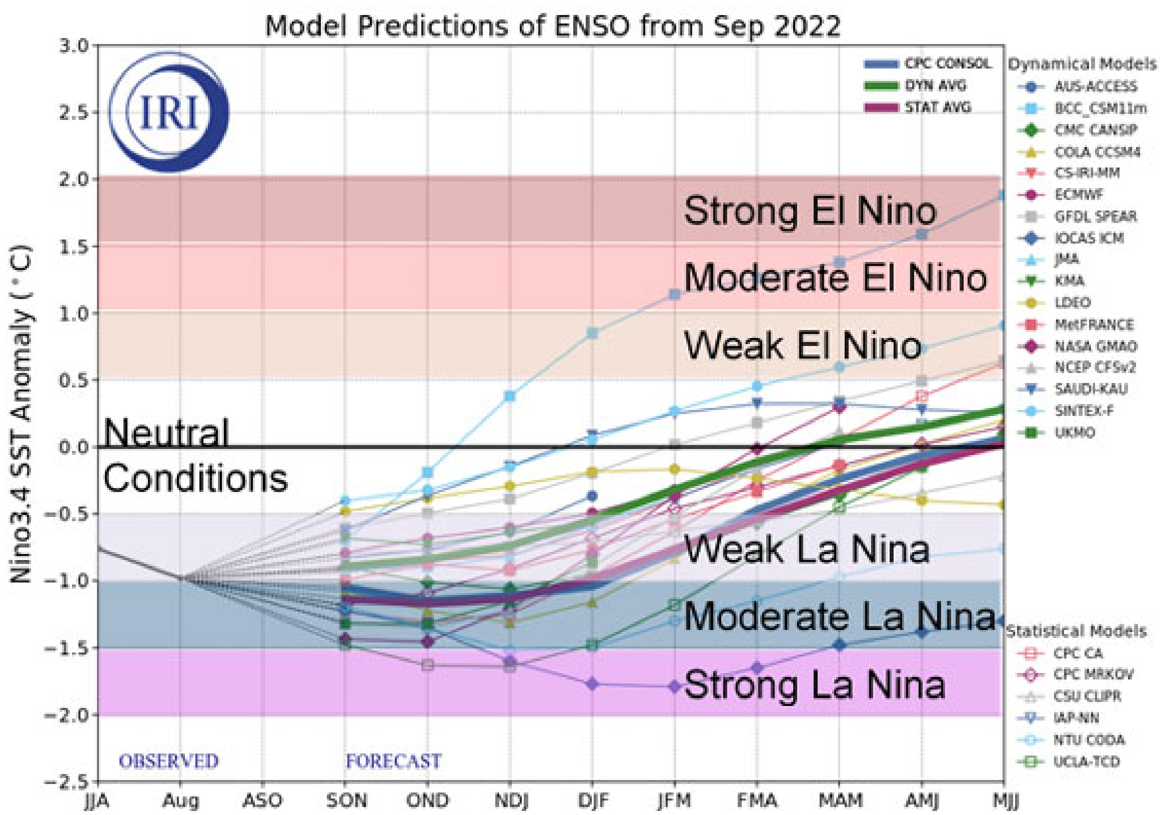

Figure 5. Forecast model predictions of ENSO showing a strengthening La Nina becoming more neutral later in winter . Data from IRI, annotations by author.

La Nina conditions typically favor a dipole of conditions north to south across the US. The northern US is favored for below normal temperatures and above normal precipitation while the southern is the opposite, split by the jet stream (Figure 6, left). The location of the mean jet stream flow will help determine where the greatest impacts will be felt. Additionally, common terminology these days often brings up the "Polar Vortex" during the winter months. This is basically the northern jet stream that follows the Arctic Oscillation (AO). When it is positive, the vortex is stable with cold air and the jet stream mostly confined to our north. When the vortex breaks down and weakens, the AO typically becomes negative and significant bursts of cold air could potentially drop into the mid-latitudes (Figure 6, right). This is exactly what happened in February 2021.

The AO/polar vortex changes on a much quicker scale than the ENSO. As a result, it is a bit harder to predict far out. However, with La Niña in place, it does provide a favorable background for negative AO to be more impactful for the Central Plains. Additionally, some preliminary research shows that the resulting cooling of the stratosphere in the southern hemisphere as a result of the Wunga Tonga eruption could potentially lead to a more negative AO and weaker vortex in the northern hemisphere's following winter. This would increase confidence in additional cold air outbreaks and general storminess come mid-winter. Unfortunately, with residing La Niña, the overall northwest flow may still result in dry air masses that don't provide beneficial moisture long term during these colder periods. Remember, winter is still the driest time of year in Kansas.

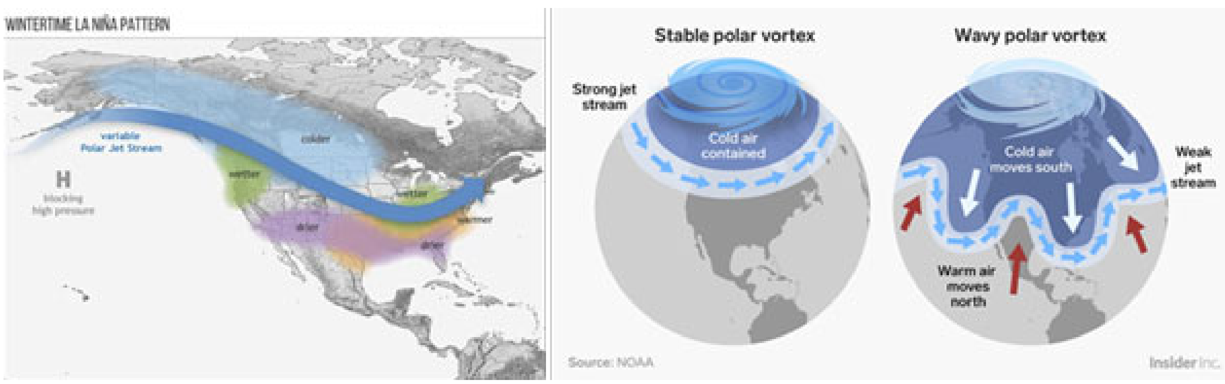

Figure 6. Typically La Nina patterns across the Northern Hemisphere (left) and typical negative Arctic Oscillation pattern of stable/unstable Polar Vortex (right). Data from NOAA Climate Prediction Center.

In Summary

So what does all that mean? In the short term, La Niña is going to continue to dominate our weather pattern. Though there are some signs that the Madden Julian Oscillation (MJO) may bring some hints of Central Plains moisture mid-to-late October into early November, the overall forecast is expected to align with persistent warmer than normal and drier than normal through the end of the year (Figure 7). There is optimism however, as the negative AO/vortex becomes more favorable early 2023, we have equal chances of above/at/below normal temperature and precipitation in Kansas. Though it doesn't favor the above normal precipitation we hope to see, we will take a less chance at below normal for once!

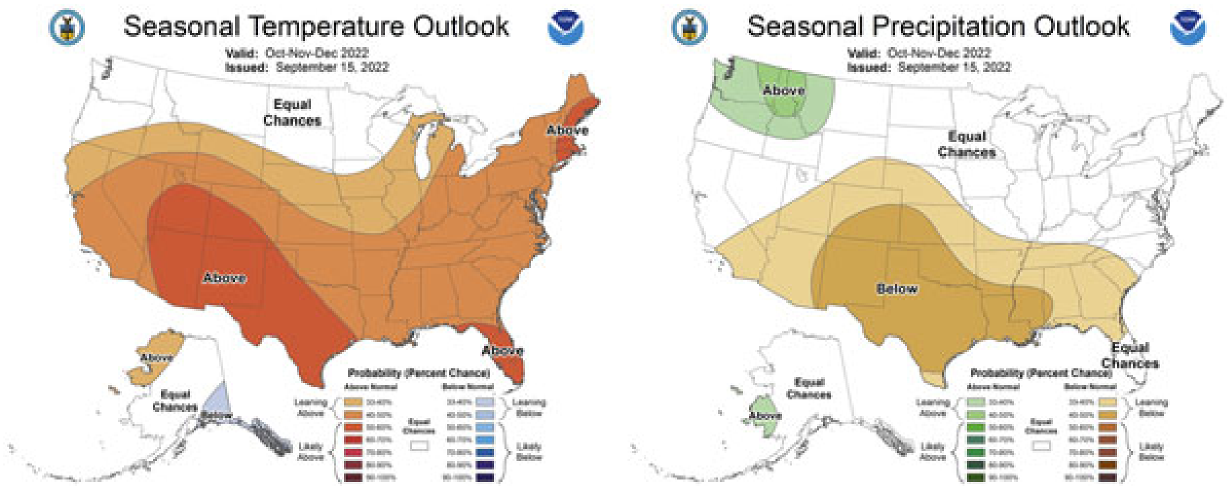

Figure 7. Climate Prediction Center outlooks for October through December 2022. Data from NOAA Climate Prediction Center.

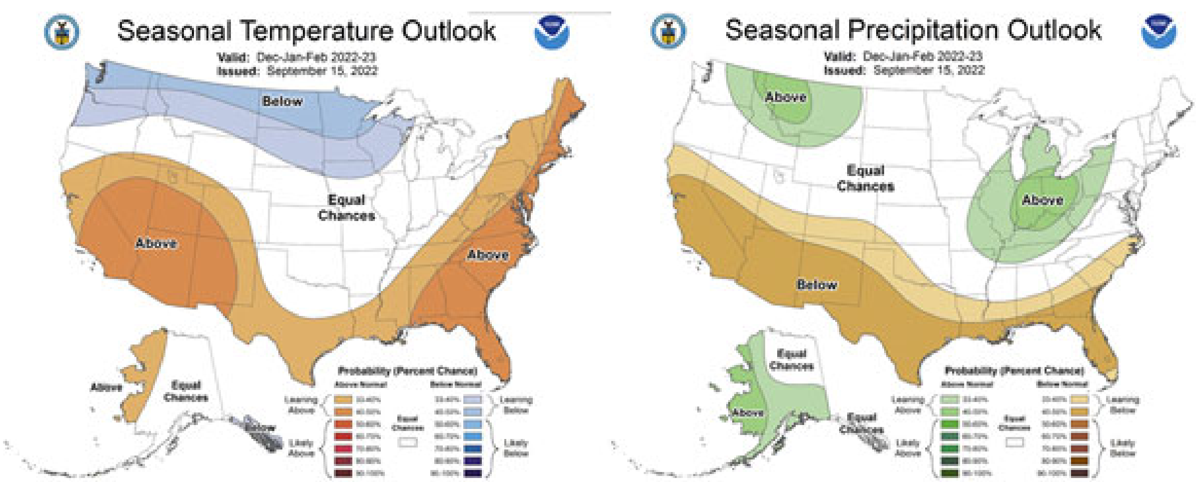

Figure 8. Climate Prediction Center outlooks for December 2022 through February 2023. Data from NOAA Climate Prediction Center.

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