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

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1. Effect of standing water and saturated soils on corn growth

If corn has been planted, standing water or saturated soil conditions in areas of a field can produce impacts now or later for corn. Periods of early-season water saturation can cause immediate problems for small corn plants, and can have season-long implications as well. Hopefully, the affected areas are small and confined to spots that are low-lying or poorly drained.

Saturated soils after corn emergence

After corn emerges, saturated soils inhibit root growth, leaf area expansion, and photosynthesis because of the lack of oxygen and cooler soil temperatures. Yellow leaves indicate a slowing of photosynthesis and plant growth. Leaves and sheaths may turn purple from accumulation of sugars if photosynthesis continues but growth is slowed. Corn plants can recover with minimal impact on yield if the plants stay alive and conditions return to normal fairly quickly.

Figure 1. Young corn plants affected by water standing and soil erosion. Photo by Ignacio Ciampitti, K-State Research and Extension.

Although root growth can compensate to some extent later in the season, a saturated profile early in the season can confine the root system to the top several inches of soil, setting up problems later in the season if the root system remains shallow. Corn plants in this situation tend to be prone to late-season root rot if wetness continues throughout the summer, and stalk rots if the plants undergo mid- to late-season drought stress. Plants with shallow root systems also become more susceptible to standability problems during periods of high winds.

Tolerance of young corn plants to full submersion

Young corn plants can tolerate only a few days of full submersion. In some cases, symptoms and stand problems seen late in the season may trace back to flooding when the plants were young.

Before V6, when the growing point is at or below the soil surface, corn can survive only 2-4 days of flooding. Chances of plant survival increase dramatically if the growing point was not completely submerged or if it was submerged for less than 48 hours. After 48 hours of soil saturation, soil oxygen is depleted and critical plant functions (photosynthesis, water and nutrient uptake) are impaired.

Thus, young corn plants are more susceptible than corn beyond the V6 stage, when the plants are taller and the growing point is above the surface. Research has demonstrated yield reductions from early-season flooding ranging from 5% to 32% depending on soil nitrogen status and duration of flooding.

Complicating factors

Temperatures can influence the extent of damage from flooding or saturated soils. Cool, cloudy weather limits damage from flooding because growth is slowed and because cool water contains more oxygen than warm water. Luckily, much of the flooded areas in the last couple weeks have stayed relatively cool. Warm temperatures, on the other hand, can increase the chances of long-term damage.

Silt deposition in the whorls of vegetative corn plants can inhibit recovery of flooded corn plants. Enough soil can be deposited in the whorl that emergence of later leaves is inhibited. A heavy layer of silt on leaf surfaces can potentially inhibit photosynthesis or damage the waxy surface layer of the leaf (cuticle), making the leaves subject to drying out. New leaves should not be affected if they can emerge normally. Ironically, what is often best for the silt covered plants is to receive a small shower to help wash off the leaves.

In some instances, the soil in the whorl may contain certain soft-rotting bacteria. These bacteria can cause the top of the plant to rot. The whorl can easily be pulled out of a plant infected with these soft-rotting bacteria. In addition, a rather putrid odor will be present. These plants will not recover.

Disease considerations

Flooding can increase the incidence of moisture-loving diseases like crazy top downy mildew. Saturation for 24 to 48 hours allows the crazy top fungus spores found in the soil to germinate and infect flooded plants. The fungus grows systemically in the plant, often not causing visual symptoms for some time. Symptom expression depends on the timing of infection and amount of fungal growth in the plant. Symptoms include excessive tillering, rolling and twisting of upper leaves, and proliferation of the tassel. Eventually, the both the tassel and ear can resemble a disorganized mass of small leaves, hence the name "crazy top."

Figure 2. Crazy top in corn. Photo by Doug Jardine, K-State Research and Extension.

Other concerns: Denitrification, cold weather crown stress, green snap, and root lodging

Saturated soils can also cause loss of N fertilizer by either denitrification (loss of N to the atmosphere, mainly as nitrous oxide gas) or leaching (movement of N beyond the rooting zone). For any of these losses to occur, N should be present in the mobile nitrate (NO_3) form. Depending on the fertilizer application time and source, most of the N may still be in the stable ammonium (NH_4) form. However, the conversion to nitrate happens quickly as soil temperature continues to increase. Under wet spring planting conditions, corn may respond to in-season N applications if a large portion of early-applied N is lost to these processes. If corn remains N deficient later in the season, expect considerably higher levels of stalk rot.

Another condition associated with extended periods of cool, wet soils is commonly referred to as *cold weather crown stress*. Internal stalk cells in the crown nodes can become "leaky" when cell membranes become chilled and oxygen is limited because of the saturated soils. Hybrids with "southern" genetics are more susceptible to this problem than are northern types. Plants may recover from this damage, but they will be much more susceptible to stalk rot later in the season if hot, dry temperatures occur since water and nutrients cannot be efficiently moved through the damaged crown.

Figure 3. Corn plant showing symptoms of cold weather crown stress. Photo by Doug Jardine, K-State Research and Extension.

The best advice is to scout your corn after water drains from the fields. Check the appearance of new leaves and the standability of the corn.

Ignacio Ciampitti, Farming Systems
ciampitti@ksu.edu

Dorivar Ruiz Diaz, Nutrient Management Specialist
ruizdiaz@ksu.edu

Stu Duncan, Northeast Area Crops and Soils Specialist
sduncan@ksu.edu

2. Soybean response to standing water and saturated soils

Soybean planting is already under way in Kansas (51% planted), based on the USDA-NASS Crop Progress and Condition Report from May 24, 2021. However, in many parts of the state beans have gotten off to a very slow start, constrained by rain events and wet soil conditions (mainly in the eastern side of the state).

Figure 1. Soybean slowly emerging and showing lack of uniformity. Photo by Ignacio Ciampitti, K-State Research and Extension.

Wet soil conditions will slow emergence, make the soil more susceptible to compaction (limiting root growth), and cause poor plant-to-plant uniformity after emergence. Sidewall compaction occurs when soybeans are planted when the soil is too wet, immediately followed by dry weather. Soil surface crusting is another potential challenge for soybean emergence.

After emergence, how will soybeans respond to standing water and saturated soil conditions?

If soybean plants are submerged for less than 48 hours, there is a good chance they will survive. Plants can survive under water longer under cool than warm temperatures. Submerged soybean plants can survive for up to 7 days when temperatures are less than 80 degrees F.

Figure 2. Soybean seedlings under water. Photo by D. Shoup, K-State Research and Extension.

To find out whether the soybeans are damaged after the water recedes, split the stem at the tip and examine the growing point. A healthy growing point will be firm and white or cream colored. A soft, dark growing point indicates injury. In some cases, the silt coating the plant after short-term flooding can cause more injury and plant death than the water itself.

Even if the fields did not have standing water and plants were not totally submerged, waterlogged soils can cause problems if the waterlogging lasts too long. When soils are saturated for a prolonged period of time, a lack of oxygen in the roots can lead to the accumulation of lactic acid and other products of anaerobic respiration. This is the underlying cause of damage to plants in waterlogged soils where only the roots are flooded.

Injury can depend on variety, growth stage, duration of waterlogging, soil texture, fertility levels, and diseases present. Interactions of these factors make it hard to predict how a given soybean field will react to waterlogged soils.

Figure 3. Soybean seedlings under full submersion. Photo by Ignacio Ciampitti, K-State Research and Extension.

Variety differences have been reported and researchers have identified possible genes associated with tolerance to waterlogged conditions. Scientists in Missouri have screened a number of soybean varieties, subjecting them to two periods of flooding, each two weeks in duration. The average yield reduction for all varieties was 61%. Yields were reduced by 39% for the most tolerant varieties and 77% for the least tolerant. Producers should check with their seed supplier regarding information about a particular variety.

Growth stage factors

Research examining the influence of growth stage on the degree of injury from waterlogged soils has provided mixed results.

- Germination. Saturated conditions during germination can reduce successful germination by up to 40% and can inhibit seedling growth. Seeds that are further along in the germination process at the time of saturation sustain more injury.
- Vegetative growth stages. Excess water during vegetative stages usually causes less injury than waterlogging during the reproductive and grain filling stages. Short-term waterlogging (2 to 3 days) at V2 to V4 can cause yield reductions of 0% to 50%, depending on soil texture, variety, and subsequent weather. Yield reductions from waterlogging during the early vegetative stages have been attributed to reduced plant population and shorter plants with reduced branching and fewer pods per plant.
- We are a long way from the reproductive stages at the moment, but for the record, waterlogging for 2 to 3 days at R2 usually causes greater yield reductions than if it occurs during the vegetative stages. Waterlogging at R1 reduced the number of pods per node. At

R5, yield reductions have been attributed to reduced seed size.

Duration of soil saturation

The longer the soil is saturated, the greater the injury, mortality, and consequent yield reductions. During germination, saturated conditions for 48 hours can decrease germination by 30% to 70% depending on the timing of the saturation, nearly twice the yield decrease resulting from durations of 24 hours or less. For plants that have emerged, a waterlogged condition that lasts for less than two days often causes little or no noticeable yield reduction. Intolerant varieties begin to show yield reductions after 2 days of saturation, but tolerant varieties can withstand up to 4 days of waterlogging with little reduction in yield. As the duration of soil saturation increases, researchers have documented greater reductions in population, height, pods per plant, yield, and leaf tissue nitrogen.

Other factors

Soil conditions play a role in the severity of injury from waterlogging as well. Coarser textured soils will drain more quickly, minimizing the duration of oxygen deprivation to the roots. Fine textured soils maintain saturation longer, increasing the chances of injury.

Fields that are flooded, or are at or above the water-holding capacity of the soil, will be more likely to develop root rot problems. Flooding accompanied by cooler temperatures would be favorable to *Pythium* root rot whereas warmer temperatures would favor *Phytophthora* and *Rhizoctonia* root rots. Whether *Phytophthora* root rot develops often depends on the tolerance or resistance of the variety used. If the flooding occurs beyond the first week or two after emergence, any seed treatment fungicides that may have been used will no longer be effective.

Figure 4. Stand loss in a wet area due to Phytophthora root rot. Photo by Doug Jardine, K-State Research and Extension.

Need help with a seedling problem?

Contact your local K-State Extension Office. They will work with you to send photos of the problem (close-up, seedling, field shot) and plant samples to the K-State Plant Disease Diagnostic Lab. Here are guidelines that can help get a good sample to the lab:

Use this link for the sample submission form:

https://www.plantpath.k-state.edu/extension/diagnostic-lab/documents/DiseaseLabChecksheet.pdf

- Fill out the accompanying Plant Diagnostic Lab Form (PDF) as completely as possible.
- Send a plentiful amount of fresh plant material (including roots). Shake off most of the soil.
- Send a sample characteristic of the problem that exhibits a range of symptoms.
- Dig (do not pull) up the seedling, so the roots remain intact.
- Do not add water or wet paper towels to the sample!
- Seal the plant material in an appropriately sized plastic bag and pack in a crush-proof container.
- Put the accompanying information sheet in a separate plastic bag to keep it dry.
- Bring your sample to the local K-State Extension Office for shipping or you can ship it overnight or early in the week.

Shipping address:

K-State Plant Disease Diagnostic Lab
4032 Throckmorton PSC
1712 Claflin Road
Manhattan, KS 66506

Ignacio Ciampitti, Farming Systems
ciampitti@ksu.edu

Rodrigo Onofre, Plant Pathology
onofre@ksu.edu

3. Updated - 2021 Kansas wheat plot tours

After over a year of virtual events, the Department of Agronomy and K-State Research and Extension will host several face-to-face winter wheat variety plot tours in different regions of the state, starting May 10 and going into April. Make plans to attend a plot tour near you to see and learn about the newest available and upcoming wheat varieties, their agronomics, and disease reactions. A preliminary list of plot tour locations, dates, times, and directions is provided below. Stay tuned to the eUpdate in the coming weeks as this list is updated.

Plot	Area	Agent	Date	Time	Main speaker	Directions
Walnut Creek - Rush	NW	Chris Long	5/27	8:00 AM	Haag	from LaCrosse, go 7 miles west on Hwy 4, then continue another 1 1/2 miles on Road L, on south side
Walnut Creek - Ness	NW	Chris Long	5/27	11:00 AM	Haag	from Ness City, go 7 miles south on Hwy 283 to 60 Rd, west 7 miles to L Rd, south 1 1/4 lines on east side
Walnut Creek - Lane	NW	Chris Long	5/27	5:00 PM	Haag	from Dighton, go west on 96 for about 7 miles, turn south, go 2 miles, turn west 1/4 mile, on south side of road
Solomon	C	Jay Wisbey	5/28	8:30 AM	Lollato-Stu	Tom and Pat Ryan Plot: Take old 40 highway West of Solomon then south on N Gypsum Valley Road 2.5 Miles just over the river bridge on the East side of the road.
Mentor	C	Jay Wisbey	5/28	11:00 AM	Lollato-Stu	Mentor Location just West of Town (Mentor) on the Northside of the road. 38.74031909188133, -97.60479299765356
Minneapolis	C	Jay Wisbey	5/28	2:30 PM	Lollato-Stu	From Minneapolis, take 106 Hwy south just past the Salt creek bridge and go west 2 miles to 90th road. North ¼ of a mile west of his irrigation circle.
Edwards Co.	SW	Marty Gleason	6/1	12:00 PM	Lollato	From Offerle, 9 1/2 miles north on 20th avenue. Plots are north of intersection

						with I road.
River Valley - Stunkle	NC	Rebecca Zach	6/1	3:30 PM	Stu-Onofre	From Palmer, 5 miles south on Liberty road, then 5 1/2 miles east on Parallel/County Line road, plots on the south side of the intersection of County line Rd and Quivira Rd.
River Valley - Ohlde	NC	Rebecca Zach	6/1	5:30 PM	Fritz-Stu-Onofre	From Linn, go northeast about 3.5 miles on 15 until intersection with 9, turn west on 10th road for a mile until Prairie Rd., go north about 1/2 mile. Plots on the west side of the road.
Pawnee	SW	Kyle Grant	6/1	6:00 PM	Lollato	From Larned go K-19 South to Zook Blacktop east 5 or 6 miles to 70 Ave than north 1 ¼ miles.
River Valley - Belleville	NC	Rebecca Zach	6/2	1:00 PM	Fritz-Stu-Onofre	2 miles west of Belleville, on the north side of the road at the KSU experiment field.
River Valley - Peyton Frybarger	NC	Rebecca Zach	6/2	4:00 PM	Stu-Onofre	2330 Elm Road, Munden, KS
River Valley - Polansky	NC	Rebecca Zach	6/2	6:00 PM	Fritz-Stu-Onofre	2 miles west of Belleville on 36, 1.25 miles south on 15. Plot is on the west side of the road.
Kingman	SW	Kallie Turner	6/3	9:00 AM	Lollato	7681 SW 80th Avenue, Kingman KS. Plot is on the north side.
Phillips-Rooks	NW	Cody Miller	6/3	TBD	Haag	From Phillipsburg- Travel North on HWY 183 to E. Osage, Turn East and travel about 1/16 of a mile. Plot is on the South side of the road
Phillips-Rooks	NW	Cody Miller	6/3	TBD	Haag	Spring wheat tour - Zurich
Phillips-Rooks	NW	Cody Miller	6/3	TBD	Haag	From Stockton- Travel North on HWY 183 to E. Road, Turn East and travel to 21 Road. The plot is on E. Road about ½ a mile East of 21 Road on the North Side of the Road. (If you get to Riffels mailbox you have gone too far.)
Wichita	NW	Rick Horton	6/9	4:30 PM	Lollato	Plot tour located just south

						of the Horton Seed Farms near Leoti, KS.
Twin Creeks	NW	Keith VanSkike	6/14	7:00 AM	Haag	Travel on HWY 36 west of Oberlin, KS about 2.5 miles. GPS coordinates: 39.828330, -100.584228
Twin Creeks	NW	Keith VanSkike	6/14	12:00 PM	Haag-Guorong-Lollato	Decatur (state line) plots - several trials - KYN, VPT, in furrow urea, KWC, etc
Twin Creeks	NW	Keith VanSkike	6/14	7:00 PM	Haag	From Dresden, KS travel South on 23 then at the #9 and 23 intersection go east on #9 to 2000th Road on the North side of the road. GPS: 39.568082, -100.36731
River Valley - LeClair	NC	Rebecca Zach	NA	NA	NA	From Clifton, 6 1/4 miles north on Eagle road, plots on the west side of the road north of 6th.
Wild West District	SW	Ron Honig	NA	NA	NA	SE 17-31-34. Go 6 miles NE of Hugoton on Hwy 56 to Rd V (County RD 16), then east 12 miles to Rd B, then 5 miles north and then 1/2 mile east on field road.
Ford Co. - Dodge City	SW	Andrea Burns	TBD	TBD	Local?	Highway 50 Bypass & 116 Road Across from Koch Nitrogen Plant, Dodge City
Thomas Co.	NW	Emily Bennigsdorf	6/7-6/12	TBD	Haag-Lollato	Solomon Creek Farms located 4 1/2 miles south of Levant/I-70 Interchange on County Road 11
Tribune	NW	Allan Schlegel	6/7-6/12	TBD	Haag	TBD
Sunflower	NW	Jeanne Falk Jones	6/7-6/12	TBD	Haag	TBD
Sunflower	NW	Jeanne Falk Jones	6/7-6/12	TBD	Haag	TBD
Sunflower	NW	Jeanne Falk Jones	6/7-6/12	TBD	Haag	TBD
Sunflower	NW	Jeanne Falk Jones	6/7-6/12	TBD	Haag	TBD
Barber Co. (Isabel)	SW	Justin Goodno	Virtual	Virtual	NA	Intersection of Main St and Hwy 42 on Isabel.
Barber Co. (Kiowa)	SW	Justin Goodno	Virtual	Virtual	NA	HYW 281 / HWY 2 intersection on the north side of Molz shop and grain bins.

Romulo Lollato, Extension Wheat Specialist
lollato@ksu.edu

4. Plan now for volunteer corn control in soybeans

We can debate whether or not volunteer corn is truly a "weed", but it is definitely a problem for soybean farmers (Figure 1). Soybean yield loss was 8 to 9% when volunteer corn density was about 1 plant per 10 square feet and yield loss increased to 71% at volunteer corn densities of about one plant per square foot, according to research conducted in South Dakota.

One of the factors that makes volunteer corn management difficult in soybeans is that this corn is typically resistant to glyphosate and/or glufosinate, and dicamba and 2,4-D do not control it. In addition, tank mixes with dicamba or 2,4-D may reduce the effectiveness of glyphosate and Group 2 herbicides like clethodim (Select Max, others) or quizalofop (Assure II, others). However, there are some steps farmers can take early in the growing season to manage volunteer corn in soybean crops.

Figure 1. Volunteer corn emerging with soybeans. Photo by Sarah Lancaster, K-State Research and Extension.

Burndown options

As mentioned above, glyphosate will not control glyphosate-resistant corn. Paraquat (Gramoxone, others) will control volunteer corn that has emerged prior to soybean planting. Glufosinate (Liberty, others) will also control volunteer corn – assuming the corn is not glufosinate-resistant (LibertyLink). One thing to remember with burndown herbicide applications is that they must come in contact with the growing point to ensure the corn plant will not regrow.

At planting options

In research conducted at the University of Nebraska, pre-emergence applications of sulfentrazone in combination with imazethapyr, cloransulam, metribuzin, or chlorimuron (Authority Assist, Authority First, Authority MTZ, or Authority XL) reduced volunteer corn growth compared to non-treated controls. Other treatments, including flumioxazin (Valor, others) alone or in combination with chlorimuron (Valor XLT) or cloransulam (Gangster), or fomesafen + metolachlor (Prefix) or saflufenacil + imazethapyr (Optill) did not reduce volunteer corn growth.

Over-the-top options

Group 2 herbicides (Select Max, Assure II, Fusilade, Poast, and others) are typically very effective on volunteer corn. However, research from Indiana suggest that volunteer corn control by clethodim formulations without 'fully loaded' surfactants can be reduced up to about 60% when applied with glyphosate or glyphosate plus 2,4-D and up to about 75% when applied with glyphosate plus dicamba. Reduced control in tank mixes can be overcome by increasing the rate of the Group 2 herbicide to the maximum labeled rate. The loss of control can also be minimized by using a clethodim formulation with a more aggressive surfactant package. In addition, research from North Dakota suggests that adding a high surfactant oil concentrate (HSOC) can improve volunteer corn control by tank mixtures of clethodim plus glyphosate, but neither NIS nor AMS improve control.

Sarah Lancaster, Weed Management Specialist
slancaster@ksu.edu

References

Alms et al. 2016; Chahal et al. 2014; Harre et al. 2020; Underwood et al. 2016; Zollinger and Ries, 2004

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.

5. 2021 Wheat Quality Tour - Summary of Kansas wheat crop conditions

The 2021 Wheat Quality Tour took place from May 17 through May 20, around 2-3 weeks later than in past years. The majority of the fields evaluated were between boot and anthesis stages. For this reason, the "late-season formula" was used to calculate grain yields in these fields, which accounts for the number of heads present at the time of sampling rather than estimating the potential tiller loss across the season. Approximately 45 people from 13 states actively scouted 350 Kansas wheat fields in 15 groups and six routes (Figure 1). The groups left Manhattan and headed to Colby on the first day, from Colby to Wichita on day 2, and finally from Wichita to Manhattan on day 3.

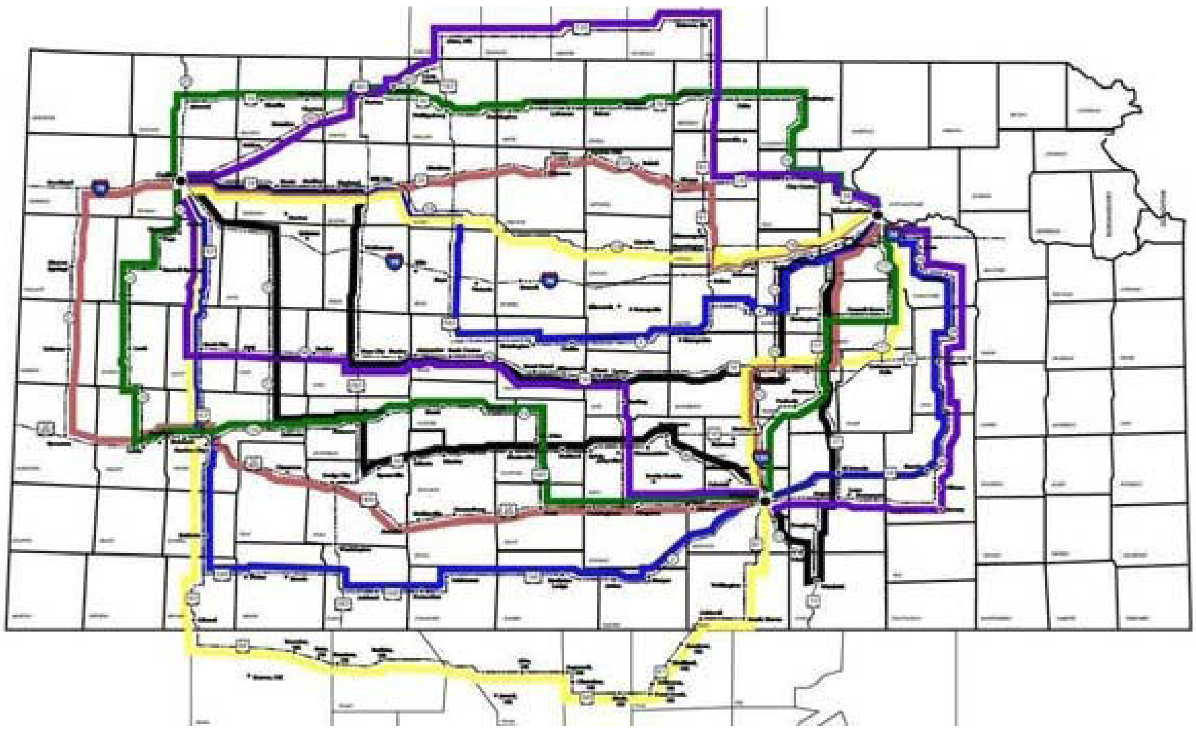

Figure 1. Representation of the six routes (purple, green, pink, yellow, blue, and black) explored during the wheat quality tour. Image courtesy of the Wheat Quality Council.

The tour estimated the 2021 wheat production for Kansas at 365 million bushels of wheat, compared to 284 million bushels in 2020 and 306 million bushels in 2019. An estimated 7.3 million acres of wheat were planted in the fall, with a 95% estimated area to be harvested. Yield average calculated was 58.1 bushels per acre by the end of the third day, and 52.8 bushels per acre yield was the final report based on estimated production and harvested area.

Variability in wheat stage development within field

Precipitation around the sowing time varied considerably across the state, leading to large variability between and within fields according to the different sowing dates in Kansas. Around the state, wheat fields planted mid- to late-September had sufficient rainfall to emerge on time and attain good stand. However, fields planted in October and early in November – usually planted after corn in western Kansas and after soybeans in central Kansas – had minimal soil moisture at sowing, which resulted in uneven emergence and stand establishment. In many cases, fields sown in October did not emerge altogether until November, or parts of the field that reached moisture emerged earlier than dryer portions of the field. This led to high within-field variability, which was even more apparent in fields with different corn residue distribution: plants had lower stand and slower emergence in spots where residue was concentrated, resulting in a considerably less developed crop in these areas (Figure 2).

Figure 2. Wheat field planted after corn shows different development stages and uneven stand establishment within field, based on corn residue distribution and soil moisture at sowing. Photo taken in Norton County, KS, by Romulo Lollato, K-State Research and Extension.

Especially in the central and north part of the state, plants were anywhere between booting and heading stage within the same field, making them a few days apart in terms of maturity. Drought stress was also observed across fields, and it was more evident in the southern part of the state. Recent precipitation events in late March and early May were received timely and might be used efficiently for grain filling, but uneven developing stages in northern Kansas might be a problem at harvest. As the tour moved into eastern southwest Kansas and south central Kansas, the fields were more even and showed less within field variability, likely due to a higher rainfall amount during October as compared to central and north-central Kansas.

Barley yellow dwarf, stripe rust, and wheat streak mosaic

The most often mentioned diseases in the wheat quality tour were barley yellow dwarf virus, stripe rust, and wheat streak mosaic, followed by tan spot and loose smut. Saved seeds not treated with fungicide seed treatment promote a high risk of loose smut and potential rejection at the elevator (Figure 3). Stripe rust in the upper canopy was seen throughout the state, although some fields were possibly sprayed with fungicide and thus only the lesions were present. Wheat streak mosaic caused considerable damage in many parts of the state, including many of central and south-central Kansas counties where it is usually not a common concern. Possibly, wheat scab might appear later in the season as wet conditions were dominant across the state close to heading and flowering stages (Figure 4). Fields sown with varieties susceptible to scab and especially after corn need to be scouted in the following weeks and could likely benefit from a fungicide application to help control head scab.

Figure 3. Wheat head damaged by loose smut. Lack of fungicide in the seed treatment and saved seeds with previous infection considerably increases the risk of smut appearance. Photo taken in Ford County, KS, by Romulo Lollato, K-State Research and Extension.

Figure 4. Extended wheat canopy moisture at heading stage can lead to scab appearance, especially in susceptible varieties sown after corn. Photo taken in Washington County, KS, by Romulo Lollato, K-State Research and Extension.

Nitrogen and sulfur deficiencies

Although nutrient deficiency was not as common of a theme in 2021 Wheat Quality Tour as in some previous years of the tour, some fields were showing visual symptoms of nitrogen and sulfur deficiencies, sometimes associated with drought stress (Figure 5). In this case, the wheat canopy was thin and the lower leaves and stems were dried back, which is not ideal for grain filling since the leaves are the primary source to produce sugars and translocate them to the grain. Fields with uneven topography showed nutrient deficiency in the lower parts, likely due to water accumulation which may cause nutrients leaching in the deeper of the soil. Also, cooler temperatures earlier in the spring might slow organic matter mineralization, but warmer weather and moisture may release N and S in the following weeks. When symptoms were even across the field, fertilizer application rates less than the crop nutrient demand were likely the cause for nutrient deficiency.

Figure 5. Wheat field showing a combination of drought stress and N deficiency. Drought stress is noticed by the dried back bottom leaves and N deficiency by the pale green canopy. Photo taken in Norton County, KS, by Romulo Lollato, K-State Research and Extension.

The factors above were the major challenging factors mentioned in the 2021 Wheat Quality Tour. Drought stress around sowing in some instances and in the early spring might decrease yield potential, but timely precipitation during grain filling may overcome some damages caused by drought. Although nutrient deficiency was less seen this year, lack of N is still one of the biggest causes for yield gaps in Kansas. While some fields showed significant disease incidence up to the upper canopy, fields seemed to be sprayed with foliar fungicides in most instances either evidenced by recent tracks on the fields or the lack of active spores where a previous disease incidence was obvious. Cool and moist weather conditions are a perfect combination for stripe rust, and can also increase the risk for scab in the next weeks. However, the decision to perform fungicide applications should likely already have been taken in most of the state, especially as most fungicide products would already be off label at the current crop growth stages.

Luana Machado Simão, Agronomy Ph.D. student
lmsimão@ksu.edu

Romulo P. Lollato, Extension Wheat and Forage Specialist
lollato@ksu.edu

6. Estimating western corn rootworm egg hatch and adult emergence

Degree-day models are useful tools for estimating the development of many different insects, allowing us to predict when potential pests might begin to impact a crop. In the case of the Western Corn Rootworm (WCR), degree-day calculations can be used to determine the onset of egg hatch in an area, peak egg hatch and the timing of adult emergence.

The most damaging stage of WCR is the larval stage. Freshly hatched larvae feed on root hairs and the surface of young roots. As they grow, feeding intensifies and the larvae start tunneling into larger roots and begin pruning developing tips of brace roots. Yield loss occurs when severe infestations weaken the root system, causing plants to lodge. Without adequate scouting, often times the problem is not apparent until it is too late. Having an estimate on when eggs are going to start hatching and peak in an area will ensure that scouting is done when root damage is fresh, easy to identify and, most importantly, before the damage becomes severe.

Growing degree days for WCR egg hatch

As with all degree-day models, the base temperature, or developmental threshold, will be important for predicting rootworm hatch and emergence. Western corn rootworm eggs are laid in summer and overwinter in the soil. The following spring, a threshold soil temperature of 52°F or higher will trigger eggs to begin developing. This base temperature along with daily 10cm high and low soil temperatures are used to monitor egg hatch using the formula below (Figure 1). It is important to note that degree day calculations for egg hatch should begin starting January 1 of the current year.

Calculating growing degree days for western corn rootworm egg hatch:

$$\left(\frac{\text{Max. Daily 10cm Soil Temp.} + \text{Min. Daily 10cm Soil Temp)}}{2}\right) - 52°\text{F}$$

For example:

$$\frac{(58°\text{F} + 54°\text{F})}{2} = \frac{112}{2} = 56 - 52 = 4 \text{ degree days accumulated that day}$$

Figure 1. Formula and example calculation for determining growing degree days for Western Corn Rootworm egg hatch.

Eggs should begin hatching after approximately 380 degree days have accumulated. Peak egg hatch occurs between 684-767 accumulated degree days. Examining corn roots for damage 10 to 14 days following peak hatch is recommended since feeding damage will be fresh and easier to detect.

Growing degree days for WCR adult emergence

As with egg hatch, knowing when adult rootworms might be emerging in the field will help make sure both scouting efforts and insecticide applications are timed correctly. Male and female corn rootworms emerge at different times. Peak male emergence is always prior to peak female emergence. This life strategy ensures that males will always have access to newly emerged females. If insecticide applications are to be made in order to reduce egg laying, spraying too soon when the field is predominantly occupied by male beetles will do nothing to reduce potential rootworm pressure the following season.

Using this method to estimate adult emergence is not meant to replace scouting, in fact this requires scouting to begin earlier than beetles should be emerging. The reason for this is to determine a "biofix". Rather than simply using January 1 of the current year, the biofix is the point in time when degree days begin to accumulate and, in this case, the biofix is the date that an adult rootworm is first observed or trapped in a field. Another important difference with the adult emergence model is that air temperature data is used instead of soil temperature.

Calculating growing degree days for WCR adult emergence:

$$\left(\frac{\text{Max. Daily Air Temp.} + \text{Min. Daily Air Temp}}{2}\right) - 53°\text{F}$$

For example:

$$\frac{(64°\text{F} + 60°\text{F})}{2} = \frac{124}{2} = 62 - 53 = 9 \text{ degree days accumulated that day}$$

Figure 2. Formula and example calculation for determining growing degree days for Western Corn Rootworm adult emergence.

While male rootworm emergence begins before female emergence, there is overlap. Peak male emergence can be expected at approximately 118 degree days and with 505 accumulated degree days male emergence should be concluded. Peak female emergence can be expected at approximately 245 degree days and concludes at 629 degree days. Scouting will require more effort and time; if the first beetle detected is a female, the window of opportunity to use this tool has already passed.

Anthony Zukoff, Extension Entomologist – Garden City
azukoff@ksu.edu

7. Summer weather outlook for Kansas - May 20, 2021

So far, May has featured cooler-than-normal temperatures across the entire state. The Climate Prediction Center's summer outlook favors a switch to warmer-than-normal conditions across all but the eastern edge of the state (Figure 1). Remember that this is the average for the three months, a cooler-than-normal June could be countered by a warmer-than-normal July or August.

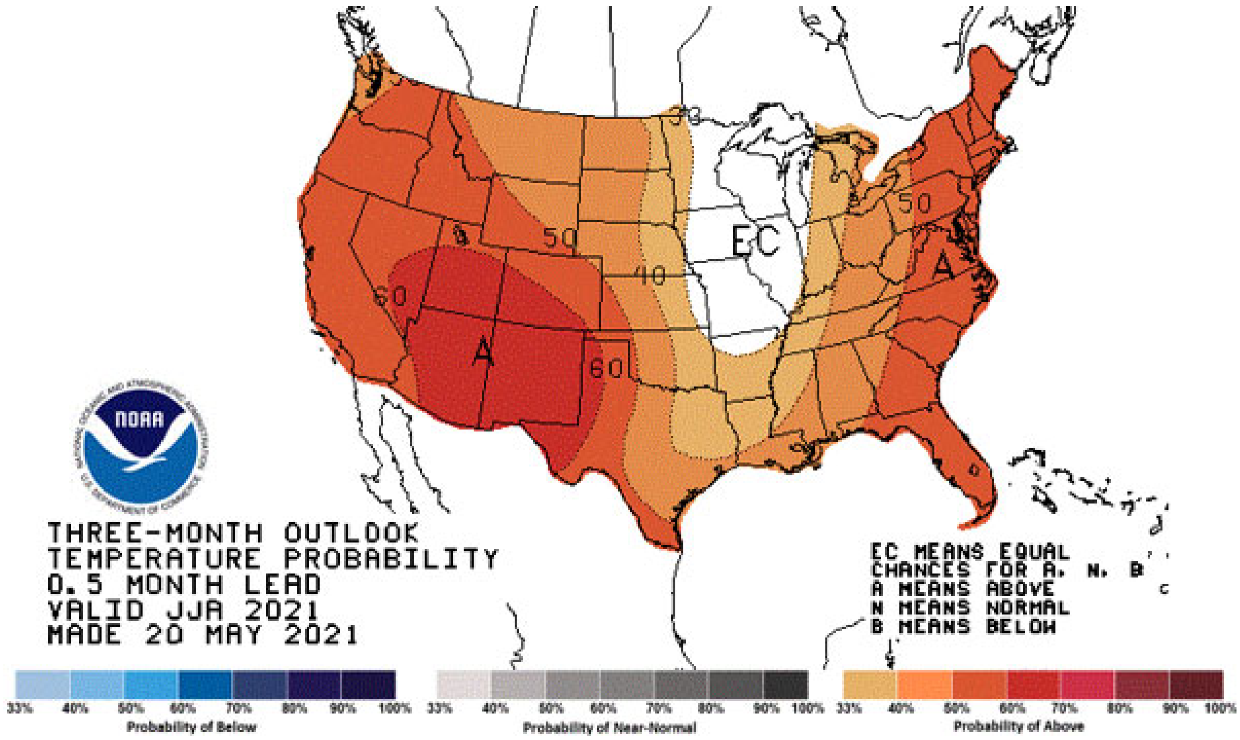

Figure 1. Summer temperature outlook (NOAA).

Antecedent conditions

Temperatures were cooler than normal in April (Figure 2), creating issues with planting and emergence of summer crops. Several freeze events, including events in early May, further stressed the winter wheat crop and resulted in emergence issues with early-planted corn. It also led to reduced evaporative demand in the atmosphere and helped retain surface moisture.

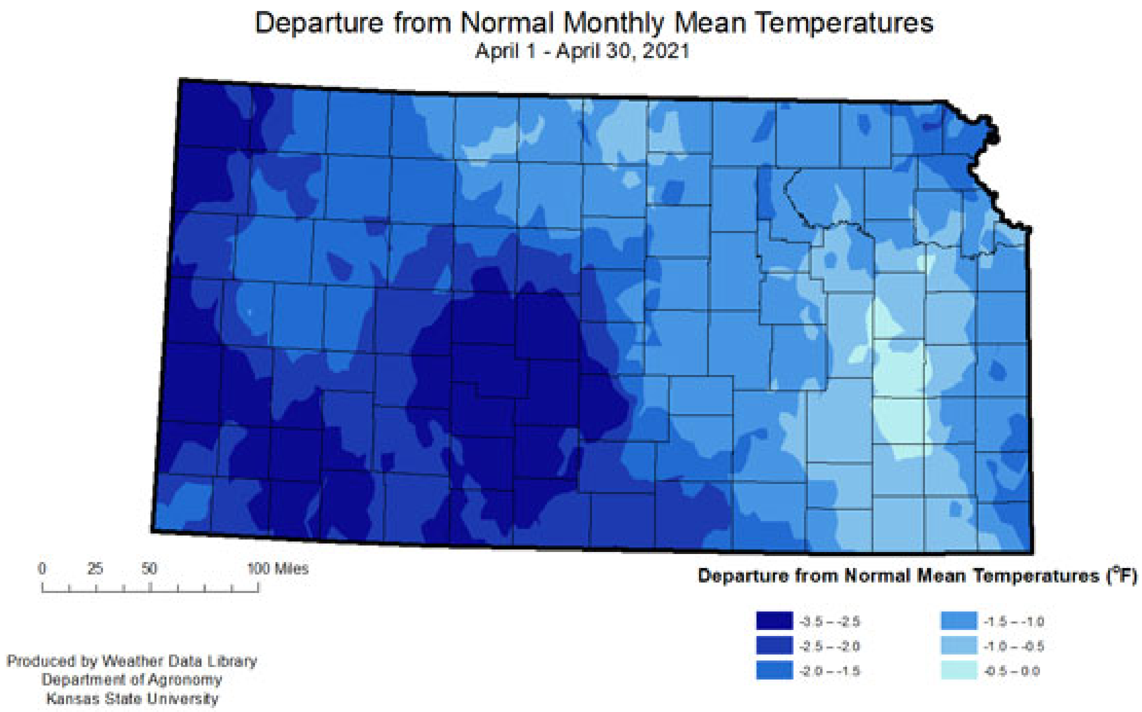

Figure 2. Departure from normal April average temperatures. Source: Weather Data Library

Aside from temperature, a major concern is precipitation. Summer precipitation constitutes the majority of the annual precipitation, particularly in the west. Timing and amounts are also critical. Despite some periods of very dry weather over the last few months, all divisions are currently above normal year-to-date except the South Central. Unfortunately, amounts have been excessive in parts of the state, creating flooding issues in isolated areas. Tribune 1W, received 5.66 inches on May 16. Current year-to-date total for Tribune is 12.98 inches compared to the normal of 4.96 inches. In contrast, Wellington, Cherokee County has recorded 9.35 inches compared to the normal of 11.04 inches.

The persistent cool weather and slow to change weather has been the result of split flow across the United States (Figure 3). Split flow means there are two active jet streams that often segregate the momentum across the region. In addition, they lead to more stagnant weather patterns with cut off lows and longer periods of warm/dry or wet/cool. This also typically results in less severe weather, which has been noted across the Central Plains.

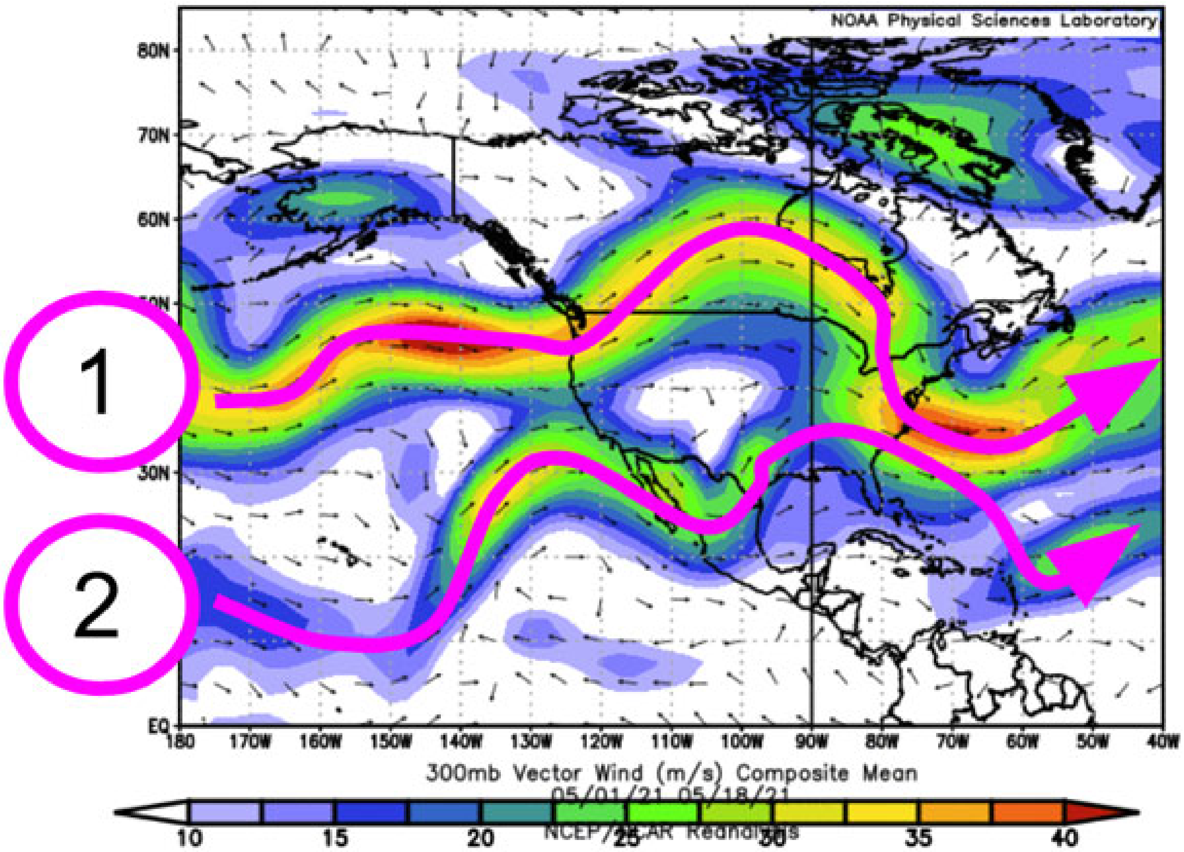

Figure 3. Average upper level wind flow across the United States from May 1-18, 2020 (Source: NOAA Physical Sciences Laboratory).

Precipitation outlooks

The precipitation outlook for summer is neutral, meaning equally likely to be above or below normal for most of the state with low chances of below normal for western Kansas (Figure 4). Distribution of that moisture will be critical and is often highly localized during the summer, dependent on persistent storm complex tracks.

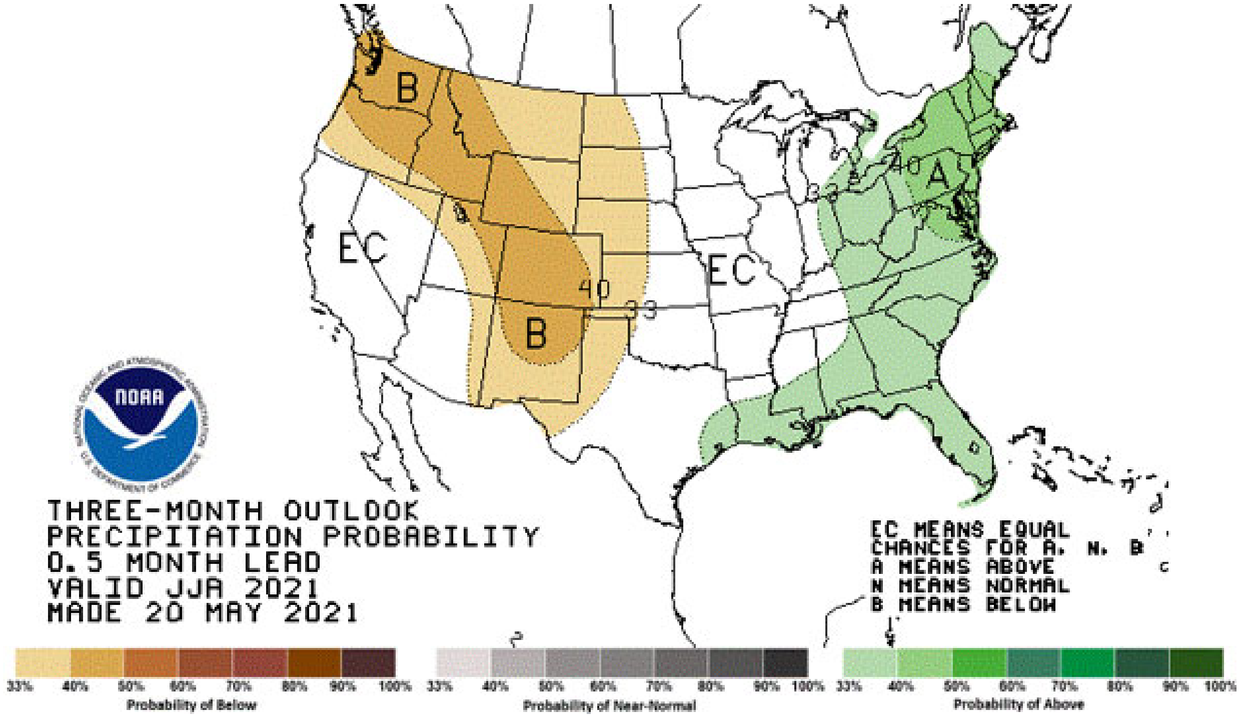

Figure 4. Summer precipitation outlook (NOAA)

Forecast models provide a wide variance in possible precipitation outcomes for the season and resulting drought impacts. While there are many models, one method is to blend the models together in what is called an "Ensemble Mean." This provides a quick glimpse in overall trends in all forecast models for the period. The result of the June through August model output is for overall slightly below normal moisture expected for Kansas and much of the west (Figure 5). However, it doesn't indicate the distribution patterns and doesn't provide further guidance on flood or drought impacts.

The US Drought Monitor favors redevelopment of drought conditions for western Kansas, where conditions have recently eased (Figure 6). Drought can develop rapidly in the summer with much warmer temperatures and actively growing vegetation. Overall storm track/patterns will be the ultimate driver of trends over the next few months. Despite a period of wet weather, the three-month period can be significantly drier should a stagnant weather pattern continue into summer.

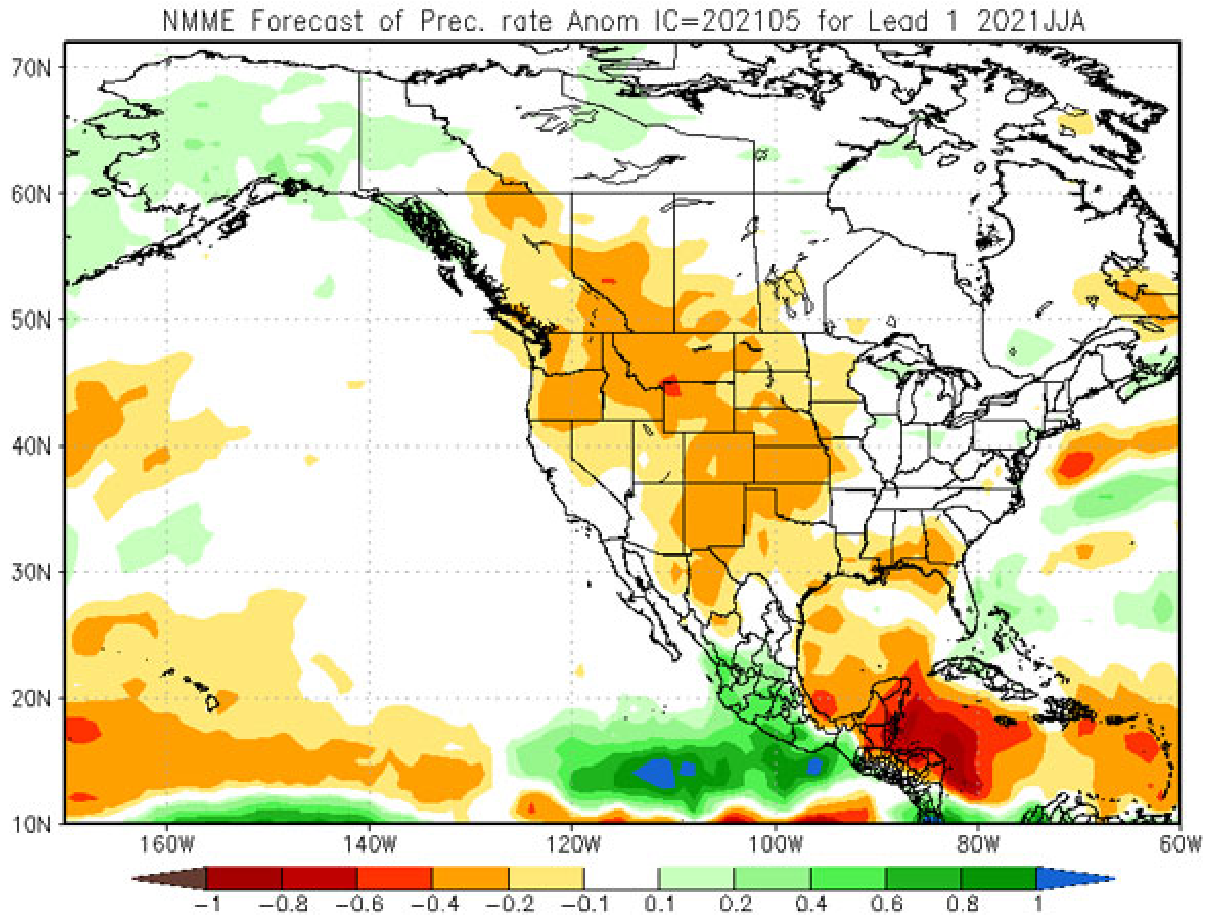

Figure 5. National Model Mean Ensemble forecast into August 2020. Source: Climate Prediction Center

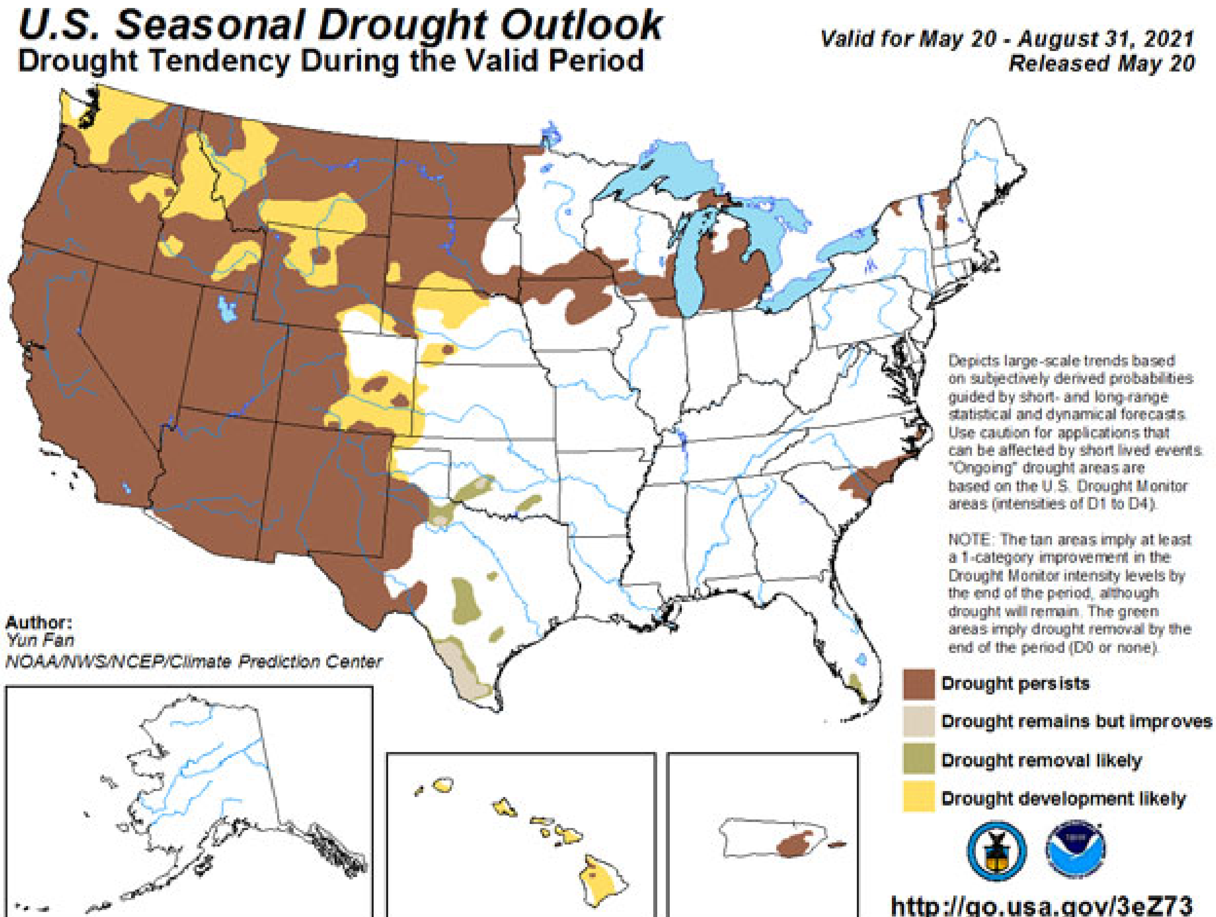

Figure 6. U.S. Drought Outlook. Source: Climate Prediction Center

The science behind the outlook

Historically, the ENSO (El Niño Southern Oscillation) in the equatorial Pacific has little impact on summer conditions in Kansas. This year a moderate La Niña to start the year has officially faded to neutral conditions as of this week (Figure 6). The previously mentioned antecedent conditions in Kansas and in the dry southwest often have a higher influence than ENSO.

Another concern is the Pacific Ocean off the west coast of the United States. Temperatures are much warmer than normal already and expected to continue (Figure 6). This often develops negative EPO (East Pacific Oscillation) which incurs another ridge of high pressure across the western United States, driving the Jetstream northward. On the opposite coast, warmer temperatures currently exist in the Atlantic Ocean with forecasts for above normal tropical activity once again in 2021. Tropical systems in the Atlantic form under high pressure which would infer ridging (high pressure) to our east.

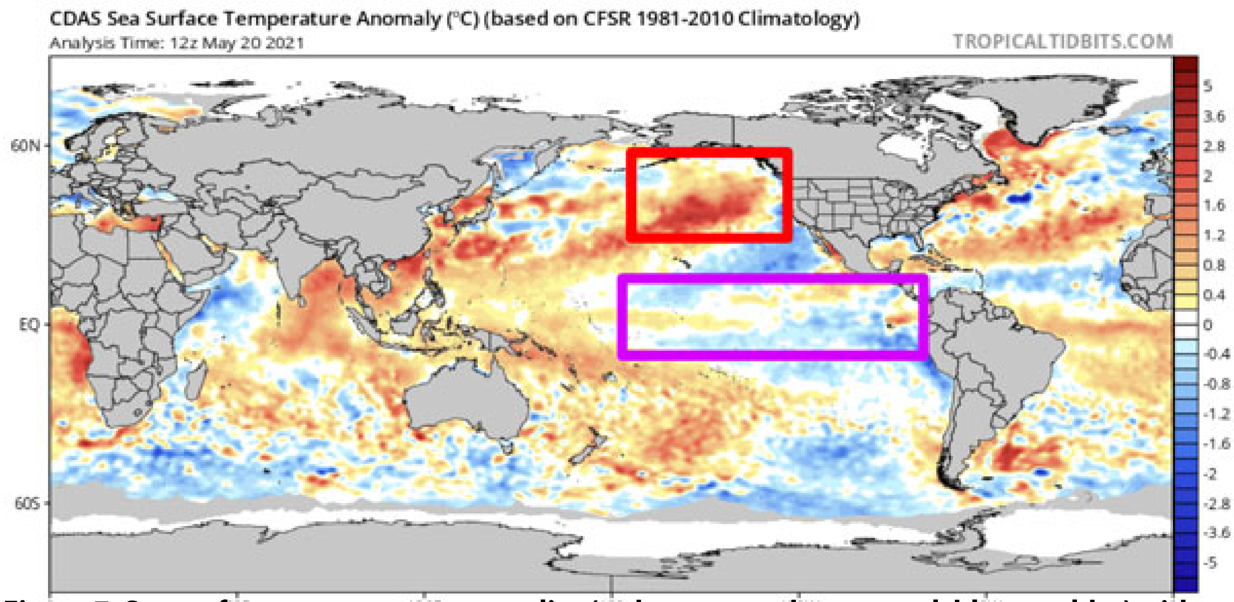

Figure 7. Sea surface temperature anomalies (red = warmer than normal, blue = colder) with Eastern Pacific Oscillation (red box) and the El Nino Southern Oscillation (purple box) highlighted (Source: Tropicaltidbits.com).

With high pressure often to the west and east, two things can happen. First, we could spend much time in the transition area on either side of the high pressures. This would typically mean impacts from ridge-riding troughs (weak low pressure systems) providing increased amounts of moisture and normal to slightly below-normal temperatures. Another possibility, which would align with our overall stagnant weather pattern we have observed thus far in 2021, would be a large scale ridge/high pressure across the entire US. This would likely mean above-normal temperatures and drier conditions. This scenario would have southwest monsoonal influences and rely on its location for any moisture. Should it persistently set up over one location, it would have a resulting impact on temperatures (and increased precipitation).

Often, summers get remembered for a short term period that has a high impact (significant rain event or week-long heat wave). This summer (as usual) will feature them, but the impacts will be determined by the persistent pattern averaged over the next three months.

Summary

- Temperature outlook is warm for the entire state.
- Precipitation is favored to be below normal in the west with equal chances of above/below normal in the east.
- Drought is likely to redevelop in the west this summer.

Mary Knapp, Assistant State Climatologist
mknapp@ksu.edu

Christopher “Chip” Redmond, Kansas Mesonet Manager christopherredmond@k-state.edu