Issue 860

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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. Herbicide applications and high temperatures

Summer temperatures have arrived, with high temperatures over 100°F in parts of Kansas. If you are planning herbicide applications, here are some things to consider when applying herbicides during hot weather.

- **Heat or drought stress slows plant growth processes.** This is especially important for systemic herbicides such as glyphosate and grass-killing herbicides like clethodim (Select) or quizalofop (Assure). As temperatures increase above 85°F, many plants begin to slow or stop metabolic processes that move herbicides throughout the plant. Notable exceptions to this rule are HPPD-inhibiting herbicides like Callisto or Balance Flexx. Palmer amaranth plants are able to overcome applications of these herbicides when applied at high temperatures (90°F and greater).

Management: In general, applying systemic herbicides early in the morning, after plants have had a chance to recover from heat stress, will give the best chance for the herbicide to reach the active site and effectively kill weeds.

- **Leaves change in response to heat**. In order to prevent water loss, plant cuticles become waxier in response to heat or drought stress. The greater wax content makes it more difficult for water-based spray solutions to penetrate the plant. In addition, the leaf angle of many plants changes in response to heat or drought stress (Figure 1). Often, this results in less herbicide contacting the leaf surface to enter the plant.

Management: Using maximum labeled rates of herbicides and surfactants can help get more spray solution into the plant, increasing effectiveness. Spraying during the cooler parts of the day will reduce the impact of altered leaf angle.

Figure 1. Velvetleaf usually changes leaf angles at night, but the leaves on these plants are vertical in response to high temperatures. Photo by Sarah Lancaster, K-State Research and Extension.

- **Crop response to foliar applied, non-translocated herbicides is greater in hot temperatures.** When applied in hot, humid conditions, contact herbicides, such as Cobra, Liberty, or Reflex will likely result in greater foliar injury to crops, but also greater weed control (Figure 2).

Management: If possible, postpone application of these herbicides if temperatures are over 90°F. If weed size requires immediate herbicide application, reduce the rate of herbicide and adjuvant, and apply later in the day, when the air temperature will decrease after application.

Figure 2. Contact herbicides such can cause bronzing of soybean leaves when applied post-emergence. Photo taken 1 week after an application that included flumiclorac (Resource, Perpetuo, others). Photo by Sarah Lancaster, K-State Research and Extension.

- **Herbicide volatility increases with high temperatures and low humidity**. Herbicides in group four, such as dicamba and 2,4-D are prone to volatility, which means the herbicide becomes a vapor and can move long distances with slight breezes. Volatility of these herbicides increases as temperature rise above 60°F and is greatest at temperatures above 90°F.

Management: Avoid applying these herbicides when temperatures are over 90°F. This may occur during morning or late afternoon hours, when temperature inversions are likely to occur. Herbicides should not be sprayed during inversions. Use larger spray droplets to reduce evaporation, which can be accomplished by reducing spray pressure or increasing nozzle orifice size.

Sarah Lancaster, Extension Weed Science Specialist
slancaster@ksu.edu

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.

2. Herbicide carryover considerations when planting after wheat

Growers considering re-cropping wheat fields need to consider the herbicide program that was used in the wheat crop. Many wheat herbicides have fairly long crop rotation restrictions. Selected herbicides and rotation intervals to certain crops are listed in Table 1.

Herbicide break down is affected by many factors such as soil pH so be sure to check herbicide labels for specific information for your fields, particularly for the intervals marked with an asterisk in Table 1. Additionally, some labels allow shorter intervals in the case of catastrophic crop failure, as long as the producer is willing to accept the risk of crop injury. If you are in doubt about your decision, consider conducting a *field bioassay* to determine if it is safe to plant the crop you are considering. A field bioassay is simply a short strip of crop planted across the direction of the herbicide application. Plants in the strip are monitored for herbicide injury as they emerge.

Table 1. Minimum rotation intervals for key summer crops following application of selected wheat herbicides in Kansas.

	Minimum rotation interval (conventional varieties/hybrids)			
Herbicide (active ingredient**)**	Grain sorghum	Corn	Soybean	Sunflower
Agility (*dicamba, thifensulfuron, tribenuron, metsulfuron*)	4 m*	4-12 m*	4-34 m*	10-22 m*
Ally, others (*metsulfuron*)	4-10 m*	12 m*	4-34 m*	22 m*
Beyond (*imazamox*)	9 m	0-8.5 m*	None	0-9 m*
Everest 3.0 (*flucarbazone*)	9-18 m*	9-18 m*	4-12 m*	4-9 m*
Glean (*chlorsulfuron*)	4-48 m*	Bioassay	4 m*	Bioassay
Harmony (*thifensulfuron*)	None	None	None	45 d
Huskie (*pyrasulfotole, bromoxynil*)	7 d	4 m	4 m	9 m
Outrider (*sulfosulfuron*)	3 m	3 m	3 m	3 m
Peak (*prosulfuron*)	1 m*	1 m*	10 m*	22 m*
PowerFlex HL (*pyroxsulam*)	3-9 m*	9 m	3-5 m*	3-9 m*
Quelex (*haluxifen, florasulam*)	45 d-3 m*	45 d-3 m*	45 d-3 m*	3 m
Rave (*triasulfuron, dicamba*)	14-24 m*	14-36 m*	11-36 m*	24 m*
WideMatch (*fluroxypyr, clopyralid*)	10.5 m	None	10.5 m	10.5 m

Abbreviations: d=day, m=month

*Consult herbicide label for geographic, soil, precipitation, application rate, or other conditions associated with this crop rotation interval.

Many of the herbicides listed in Table 1 are ALS-inhibiting herbicides that are associated with resistance in certain varieties or hybrids. Some examples are Clearfield sunflowers, which can be planted following Beyond, or Bolt soybeans which have a shorter rotation interval following sulfonylurea herbicides such as Ally.

Sarah Lancaster, Extension Weed Science Specialist
slancaster@ksu.edu

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3. Plant analysis for testing nutrient levels in corn

Plant analysis is an excellent in-season "quality control" tool. It can be especially valuable for managing secondary and micronutrients that do not have high-quality, reliable soil tests available, and for providing insight into how efficiently you are using applied nutrients.

Plant analysis can be used by Kansas farmers in two basic ways: for diagnostic purposes, and for monitoring nutrient levels at a common growth stage. Diagnostics can be done any time and is especially valuable early in the season when corrective actions can easily be taken. Monitoring is generally done at the beginning of reproductive growth.

General sampling guidelines:

- Plants are less than 12 inches tall: Collect the whole plant; cut the plant off at ground level.
- Plants more than 12 inches tall and until reproductive growth begins: Collect the top fully developed leaves (those which show leaf collars).
- After reproductive growth starts: Collect the ear leaves (below the uppermost developing ear), samples should be collected at random from the field at silk emergence.

Figure 1. Corn sampling during different growth stage. Photos by Dorivar Ruiz Diaz, K-State Research and Extension.

Plant analysis for diagnostic sampling

When sampling for diagnostic purposes, collecting specific plant parts is less important than obtaining comparison samples from good and bad areas of the field.

Plant analysis is an excellent diagnostic tool to help understand some of the variation among corn plants in the field. When using plant analysis to diagnose field problems, try to take comparison samples from both good/normal areas of the field, and problem spots. This can be done at any growth stage.

Along with taking plant tissue samples, it is also helpful to collect a soil sample from both good and bad areas when doing diagnostics. Define your areas, and collect both soil and plant tissue from areas that represent good and bad areas of plant growth. Soil samples can help define why a problem may be occurring. The soil sample may find certain nutrient levels are very low in the soil, helping to explain why a deficiency is occurring. However, other factors can also cause nutrient problems. Soil compaction, or saturation of soils for example, often limits the uptake of nutrients, especially potassium, which are otherwise present in adequate amounts in the soil.

Plant analysis for nutrient monitoring

For general monitoring or quality control purposes, plant leaves should be collected as the plant enters reproductive growth. Sampling under stress conditions for monitoring purposes can give misleading results, and is not recommended. Stresses such as drought or saturated soils will generally limit nutrient uptake, and result in a general reduction in nutrient content in the plant.

How should you handle samples and where should you send the samples?

The collected leaves should be allowed to wilt over night to remove excess moisture, placed in a paper bag or mailing envelope, and shipped to a lab for analysis. Do not place the leaves in a plastic bag or other tightly sealed container, as the leaves will begin to rot and decompose during transport, and the sample won't be usable. Most of the soil testing labs working in the region provide plant analysis services, including the K-State testing lab.

What nutrients should be included in the plant analysis?

In Kansas, nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), chloride (Cl), and iron (Fe) are the nutrients most likely to be found deficient. Recently, questions have been raised concerning copper (Cu), manganese (Mn), and molybdenum (Mo), though widespread deficiencies of those micronutrients have not been found in the state. Normally the best values are the "bundles" or "packages" of tests offered through many of the labs. They can be as simple as N, P and K, or can be all the mineral elements considered essential to plants. K-State offers a package which includes N, P, K, Ca, Mg, S, Fe, Cu, Zn, and Mn.

What will you get back from the lab?

The data returned from the lab will be reported as the concentration of nutrient elements, or potentially toxic elements, in the plants. Units reported will normally be in "percent" for the primary and secondary nutrients (N, P, K, Ca, Mg, S, and Cl) and "ppm" (parts per million) for most of the micronutrients (Zn, Cu, Fe, Mn, B, Mo, and Al).

Most labs/agronomists compare plant nutrient concentrations to published *sufficiency ranges*. A sufficiency range is simply the range of concentrations normally found in healthy, productive plants during surveys. It can be thought of as the range of values optimum for plant growth. The medical profession uses a similar range of normal values to evaluate blood work. The sufficiency ranges change with plant age (generally being higher in young plants), vary between plant parts, and can differ between hybrids. A value slightly below the sufficiency range does not always mean the plant is deficient in that nutrient. It is an indication that the nutrient is relatively low. Values on the low end of the range are common in extremely high-yielding crops. However, if that nutrient is significantly below the sufficiency range, you should ask some serious questions about the availability and supply of that nutrient.

Keep in mind that any plant stress (drought, heat, soil compaction, saturated soils, etc.) can have a serious impact on nutrient uptake and plant tissue nutrient concentrations. A low value of a nutrient in the plant does not always mean the nutrient is low in the soil and the plant will respond to fertilizer. It may be that the nutrient is present in adequate amounts in the soil, but is either not available or not being taken up by the plant for a variety of reasons. Two examples are drought, which can reduce plant uptake of nutrients and cause low nutrient values in the plant, and high-pH soils, which can cause low iron availability.

On the other extreme, levels above "sufficiency" can also indicate problems. High values might indicate over-fertilization and luxury consumption of nutrients. Plants will also sometimes try to compensate for a shortage of one nutrient by loading up on another. This occurs at times with nutrients such as iron, zinc, and manganese.

Table 1 gives the range of nutrient contents considered to be "normal" or "sufficient" for corn seedlings below 12 inches tall and for the ear leaf of corn at silking. Keep in mind that these are the ranges normally found in healthy, productive crops.

Table 1. Range of nutrient contents considered "normal" or "sufficient" at two growth stages in corn.

Nutrient	Unit	Whole Plant <12" tall	Corn Ear Leaf at Green Silk
Nitrogen (N)	%	3.5-5.0	2.75-3.50
Phosphorus (P)	%	0.3-0.5	0.25-0.45
Potassium (K)	%	2.5-4.0	1.75-2.25
Calcium (Ca)	%	0.3-0.7	0.25-0.50
Magnesium (Mg)	%	0.15-0.45	0.16-0.60
Sulfur (S)	%	0.20-0.50	0.15-0.50
Chloride (Cl)	%	Not established	0.18-0.60
Copper (Cu)	ppm	5-20	5-25
Iron (Fe)	ppm	50-250	20-200
Manganese (Mn)	ppm	20-150	20-150
Zinc (Zn)	ppm	20-60	15-70
Boron (B)	ppm	5-25	4-25
Molybdenum (Mo)	ppm	0.1-10	0.1-3.0
Aluminum (Al)	ppm	<400	<200

Summary

In summary, plant analysis is a good tool to monitor the effectiveness of your fertilizer and lime program and as a very effective diagnostic tool. Consider adding this to your toolbox.

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

4. Evaluating corn fields for nematode damage

There are many disease organisms that can result in the reduction of corn yields in Kansas. One of the stealthiest is the root-lesion nematode (RLN) because it operates below ground on the roots and often has no specific, identifiable symptoms other than yield loss. It is present, at some level, in nearly all corn fields in the state. Historically the largest yield losses, which can exceed 40 percent in individual fields, occur in western Kansas where irrigated, no-till, continuous corn production systems in sandy soils are common.

Like most nematode problems, visible symptoms, if any, may be limited to patchy areas of the field where growth is stunted. Sometimes yellowing may also occur (Figure 1). Occasionally, roots may have lesions on them or roots may appear to be pruned (Figure 2).

Figure 1. Yellowing of plants caused by root-lesion and other nematode injury. Yield in the center of these areas was as low as 30 bu/ac. Photo courtesy of Tamra Jackson-Ziems, University of Nebraska-Lincoln.

Figure 2. Badly damaged roots near the end of the season with lesions and root pruning. Photo courtesy of Tamra Jackson-Ziems, University of Nebraska-Lincoln.

The best way to identify a root lesion nematode problem is by a whole-root assay. Optimal time for sampling is when corn is between V5 to V7 growth stage. Suspect plants should be dug from the soil – try to keep some of the soil with the roots. Keep samples away from excessive heat.

You can also find more information about sampling for corn nematode on a recent YouTube video by K-State Plant Pathology at https://youtu.be/WWC23etxJYs.

There are several commercially available seed treatment nematicides currently marketed, but in university trials, results have been inconsistent. Although root lesion nematode has a wide host range, studies have shown that soybean and sorghum are effective rotation crops for controlling the most common species of RLN in Kansas. Other plant-parasitic nematodes that occasionally result in losses include the sting, stunt and stubby-root nematodes.

Need help with a corn nematode problem?

Contact your local K-State Extension Office. They will work with you to send photos of the problem (close-up, whole plant, roots, and field shot) and root and soil samples to the K-State Plant Disease Diagnostic Lab.

Rodrigo Borba Onofre, Postdoctoral Research & Extension Fellow
onofre@ksu.edu

Timothy Todd, Nematologist
nema@ksu.edu

Doug Jardine, Emeritus Extension Plant Pathologist

5. Start scouting corn for southern rust in Kansas

Southern rust is now active on corn in Texas, Louisiana, and Georgia (Figure 1). Although this disease has not yet been reported in Kansas, it is time to start actively monitoring corn fields. The first positive fields in 2019 and 2020 were on July 11 and July 15, but based on the age of the pustules, the disease arrived sometime in mid-June. The severity is dependent on the weather. The 10-day forecast indicates that weather will remain favorable for disease development. Southern rust likes 90-degree days, warm nights, and high humidity.

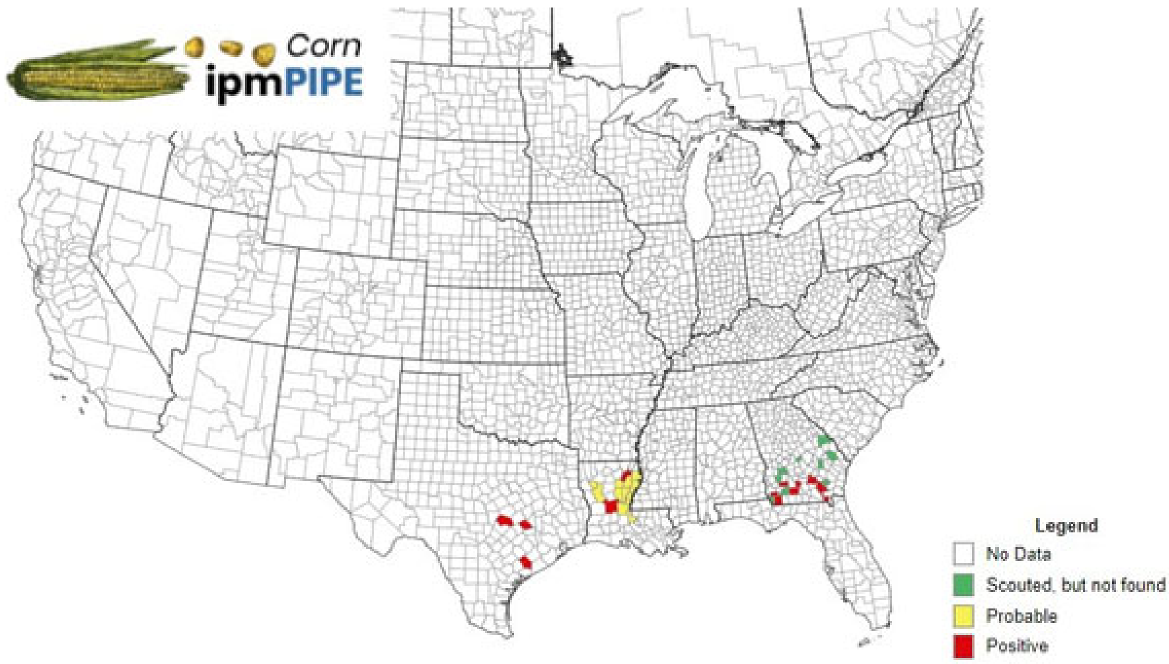

Figure 1. Southern corn rust (Puccinia polyspora**) has now been reported in Texas, Louisiana, and Georgia as of June 16, 2021. Source: https://corn.ipmpipe.org/southerncornrust/**

Here are some frequently asked questions related to managing southern rust in Kansas:

Q1. Should I apply a fungicide prior to observing southern rust?

A1. It is not recommended to apply a fungicide to control southern rust unless disease has been observed in the canopy. Now that southern rust has been reported in the Texas, Louisiana, and Georgia, it is time to be out scouting corn fields. Once pustules are observed, the pathogen can reproduce rapidly if temperature and humidity are high.

Q2. What factors should I consider when making the decision to spray for southern rust?

A2. It is important to consider hybrid susceptibility, disease incidence (how many plants are affected), and the growth stage of the crop. Infection early in the season on a susceptible hybrid, coupled with conducive weather conditions, pose the highest risk for yield loss.

Q3. If I apply a foliar fungicide at tasseling (VT) or silking (R1) to control gray leaf spot, will this application have efficacy against southern rust?

A3. Yes. Most fungicides that are labeled for gray leaf spot are also effective for southern rust and will have residual activity for approximately three weeks after application, depending on the product. Fields should be carefully monitored for disease development. Research has suggested that applications can be effective at preserving yield up until dent (R5) when dealing with a susceptible hybrid and high disease pressure.

Q4. What fungicides are best to control southern rust?

A4. Efficacy ratings for corn fungicide management of southern rust have been compiled by a working group of corn researchers and can be found here:

https://crop-protection-network.s3.amazonaws.com/publications/fungicide-efficacy-for-control-of-corn-diseases-filename-2021-03-09-163332.pdf

Q5. How do I know if what I'm seeing is southern rust?

A5. Southern rust produces characteristic orange pustules of spores, primarily on the upper side of the leaf (Figure 2). If you run your finger across the pustules, the orange spores will be visible on your hand. The Kansas State Plant Diagnostic Lab can also confirm southern rust by observing spores under the microscope. Additional information about sending in a sample can be found here: https://www.plantpath.k-state.edu/extension/diagnostic-lab/.

Figure 2. Corn southern rust. Photo courtesy of Rodrigo Borba Onofre, K-State Plant Pathology.

For more information on identifying corn rusts, see K-State Research and Extension Bulletin MF3016, Corn Rust Identification and Management in Kansas.

Rodrigo Onofre, Plant Pathology
onofre@ksu.edu

6. Updated K-State publication on cleaning field sprayers

Sprayer cleaning is a critical component of maintenance that prolongs the life of the sprayer, prevents unnecessary repairs and downtime, and prevents crop injury caused by equipment contamination. Thorough sprayer cleanout is important following all pesticide applications but is even more critical after use of certain herbicides. Serious crop injury can result from small amounts of herbicides. Without proper cleanup, crop injury from sprayer contamination can occur several months after using the sprayer and following several subsequent applications.

A K-State Research and Extension publication, MF1089 – Cleaning Field Sprayers, has been recently updated and is available online at https://bookstore.ksre.ksu.edu/pubs/MF1089.pdf.

This helpful resource guides readers through a common procedure for cleaning sprayer equipment, outlines the best cleaning agents for different herbicides, and discusses crop injury caused by sprayer contamination.


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Cleaning Field Sprayers

Department of Agronomy | MF1089 | Sprayer Cleaning

Sarah Lancaster, Extension Weed Science Specialist
slancaster@ksu.edu

7. 2021 Kansas Corn Yield Contest

Corn harvest in Kansas will be here before you know it. Corn producers in the state are encouraged to keep in mind the Kansas Corn Yield Contest before they fire up the combines this year.

Kansas Corn, in conjunction with K-State Research and Extension, are conducting the 2021 Kansas Corn Yield Contest. New this year, the Kansas Corn Yield Contest has joined the National Corn Yield Contest (NCYC). To participate in the Kansas Contest, growers must enter the NCYC. This will the simplify entry process while building Kansas participation in both contests. Many seed companies will cover the cost of entry. For more details in this voucher program, go to https://www.ncga.com/get-involved/national-corn-yield-contest/profile/voucher-program.

All corn producers are eligible to enter the contest, but must be members of the Kansas Corn Growers Association (KCGA). A KCGA membership includes one to the NCGA. Information regarding entry deadlines can be found at: https://kscorn.com/yieldcontest/

Benefits of contest participation

The contest is a fun way for producers to showcase and compare their high yielding and high quality corn with other growers in their districts and state, and provide motivation to producers to improve productivity. The contest also serves as a vehicle to improve farming practices and increase awareness of best management practices (BMPs) to improve and sustain corn yields.

In addition to grower recognition, cash awards will be awarded at the district and state levels. The districts align with crop reporting districts, plus a NNE district which includes Doniphan and parts of Brown and Atchison counties (Figure 1). In addition, one statewide dryland winner and one statewide irrigated winner will be announced. District winners will receive $300 and a plaque. Second place entries will receive a $200 prize and third place will receive a $100 prize. The highest yielding dryland and irrigated entries statewide will receive an additional $500 prize. National Corn Yield Contest winners will be announced December 15, 2021. Kansas Corn Yield winners will be recognized at the Kansas Corn Symposium in January 2022.

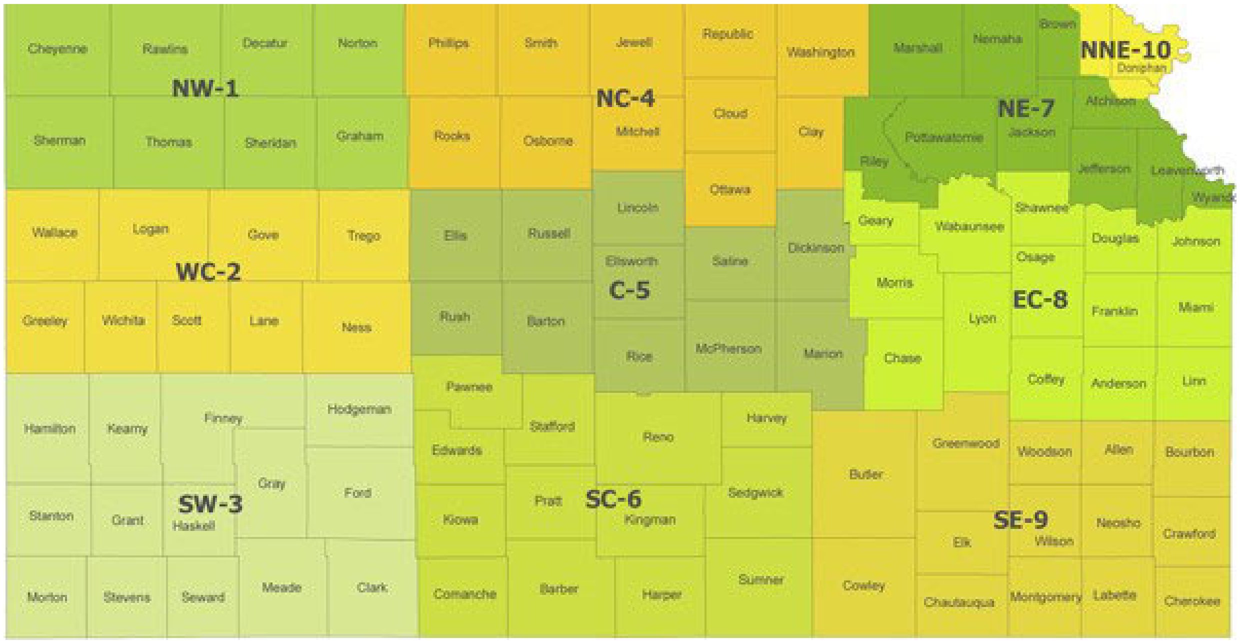

Figure 1. Dryland and irrigated contest districts. Note: NNE includes only those fields north and/or east of KS Hwy 73 in Brown, Doniphan, and Atchison counties.

A publication summarizing the results from the 2019 Kansas Corn Yield Contest can be viewed at:

https://bookstore.ksre.ksu.edu/pubs/MF3463.pdf. The 2020 contest results will be summarized in a similar publication that will be soon be available to view online. A list of the 2020 Kansas Corn Yield Contest winners is available at: https://kscorn.com/yieldcontest/#2020Winners.

For complete contest information, visit https://kscorn.com/yieldcontest/.

For questions, call Kansas Corn at 785-410-5009 or email dohlde@ksgrains.com

Deb Ohlde, Director of Grower Services, Kansas Corn
dohlde@ksgrains.com

Ignacio A. Ciampitti, Cropping Systems Specialist, K-State Department of Agronomy
ciampitti@ksu.edu