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eUpdate

06/29/2023

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. Tar spot of corn has arrived in Kansas this season

Tar spot of corn, a disease caused by the fungus *Phyllachora maydis*, was confirmed in several fields in Doniphan County, Kansas on June 26, 2023 (Figure 1). Now is the time to intensify scouting efforts. If you wait until there is significant disease in the upper canopy then a fungicide application may be too late.

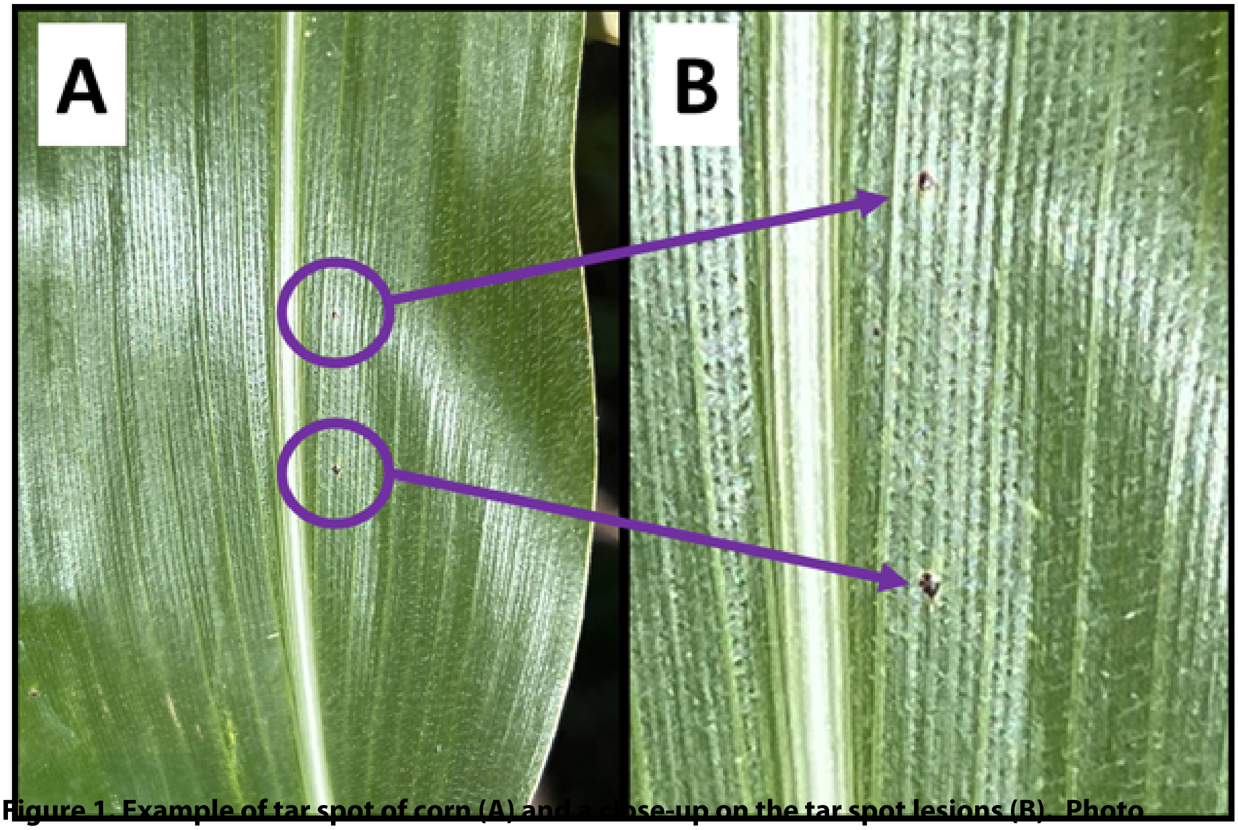

Figure 1. Example of tar spot of corn (A) and a close-up on the tar spot lesions (B). Photo courtesy of Rodrigo Onofre, K-State Research and Extension

The early disease onset that we're observing this year raises concern for yield loss. Although it is important to keep in mind that we are still learning about this disease in Kansas. However, we can look to neighboring states who have battled tar spot for multiple years now. Generally, early observations of tar spot have corresponded with high yield loss. Fields scouted this week were between V-8 to V14 growth stage, which adds a higher risk for disease spread and development. In some of the fields, we were able to find low levels of tar spot on the second leaf below the ear leaf (Figure 2A and 2B) and at higher levels in the lower leaves (Figure 2C and 2D). There is a good chance that the disease will spread to the ear leaf and neighboring fields, as multiple cycles of the disease can occur during the growing season. The recent rains likely helped to promote tar spot development. Additionally, irrigated corn may be at particularly high risk for yield or silage loss.

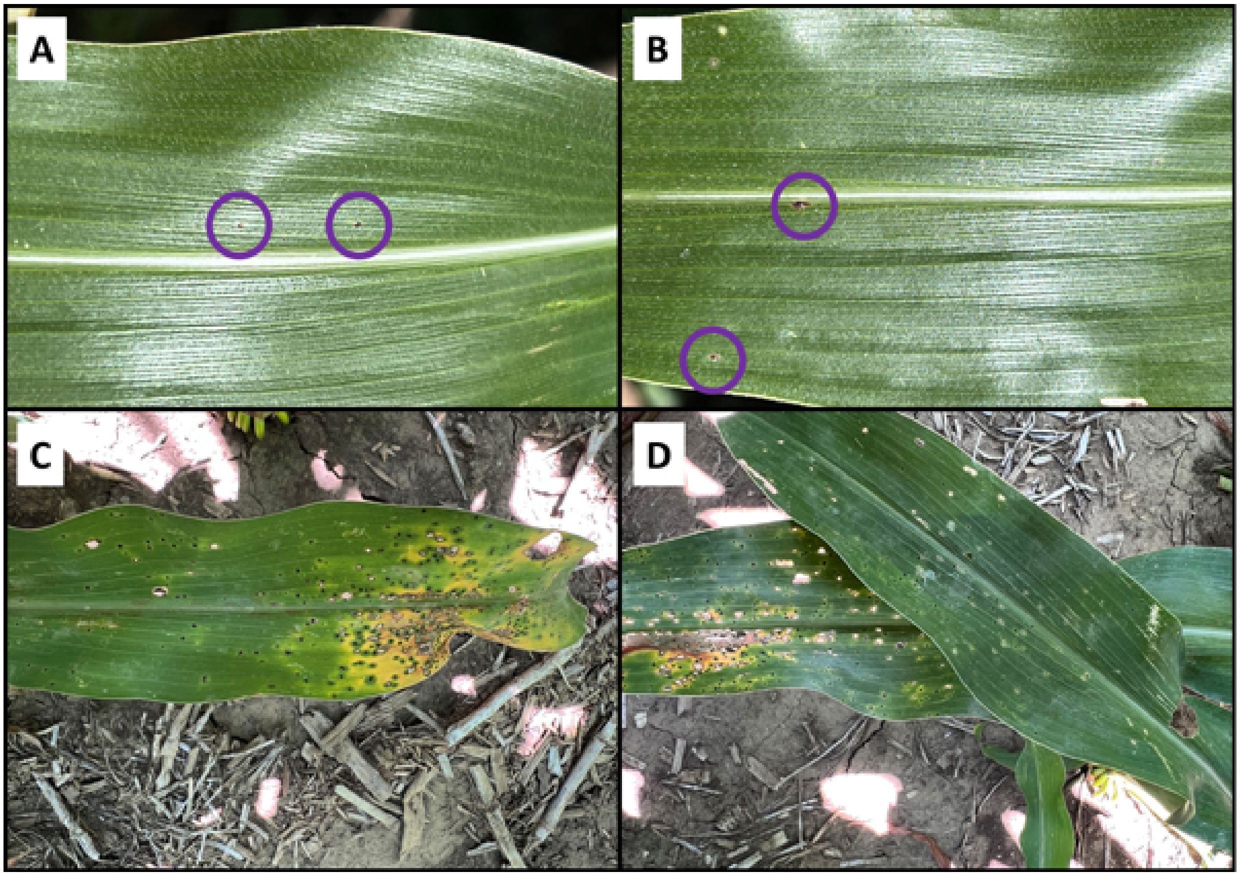

Figure 2. Tar spot lesions on the mid-canopy (A and B) and lower leaves (C and D). Photos courtesy of Rodrigo Onofre, K-State Research and Extension

Frequently Asked Questions about Tar Spot

What am I scouting for?

Tar spot develops as small, black, raised spots (circular or oval) that develop on infected plants, and may appear on one or both sides of the leaves, leaf sheaths, and husks. Spots may be found on both healthy (green) and dying (brown) tissue. Tar spot can be easily confused with insect poop, which can appear as black spots on the surface of the leaf. If you would like assistance in confirming tar spot you can contact your local county extension office or the K-State plant diagnostic clinic (https://www.plantpath.k-state.edu/extension/plant-disease-diagnostic-lab/).

Is there a history of disease in this field or neighboring fields?

Tar spot overwinters on infested corn residue on the soil surface, which serves as a source of inoculum for the subsequent growing season. Spores can be dispersed by wind and rain splash and can move to nearby fields if conditions are favorable.

What growth stage is the field?

Research has shown that making an application just after first detection and at or after VT is effective if lesions are detected early. If you wait until there is significant disease in the upper canopy then a fungicide application may be too late. Here you can find a guide for growth stages in corn: https://bookstore.ksre.ksu.edu/pubs/MF3305.pdf

How does moisture influence disease development?

The recent rains likely helped to promote tar spot development. Additionally, irrigated corn may be at particularly high risk for yield or silage loss. Forecasted rainfall and high humidity will favor tar spot development and spread.

Should I apply a fungicide?

Fungicides are an effective tool for controlling tar spot if they are timed well. Research has shown the best return on investment from a fungicide application on corn occurs when **fungal diseases are active** in the corn canopy. A **well-timed, informed fungicide application** will be important to reduce disease severity when it is needed, and we recommend holding off until the disease is active in your field and corn is at least nearing VT/R1 (tassel/silk) or even R2 (blister). Scouting will be especially important if wet weather continues. There are several fungicides that are highly effective at controlling tar spot when applied from tassel (VT) to R2 (milk). I would recommend picking a product with multiple modes of action. The National Corn Disease Working Group has put together efficacy ratings for fungicides labeled for the control of tar spot can be found at the Crop Protection Network website at https://cropprotectionnetwork.org/publications/fungicide-efficacy-for-control-of-corn-diseases.

If there is high disease pressure early in the season, a second application may be warranted. Fields should be scouted 14-21 days after the first application to see if tar spot has become active again. Fungicides will not provide benefits after R5. Always consult fungicide labels for any use restrictions prior to application.

Where has tar spot been reported in the 2023 season?

Tar spot has been detected in 8 counties in Illinois, 2 counties in Missouri, and 1 county (Doniphan) in Kansas (Figure 3).

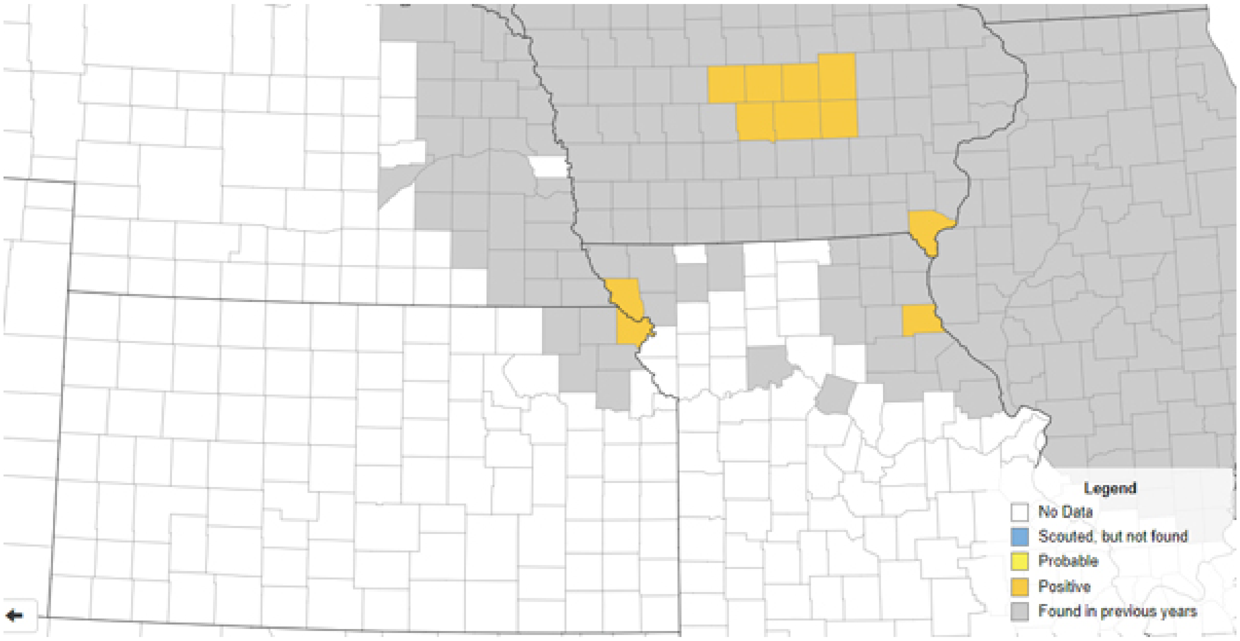

Figure 3. Tar Spot of Corn (Phyllachora maydis**) in Kansas and surrounding states in 2023. Source:** https://corn.ipmpipe.org/tarspot/

Please help us track tar spot! You can contact Rodrigo Onofre directly at 785-477-0171 if you suspect a field has tar spot and/or submit a sample to the K-State Plant Disease Diagnostic Lab at https://www.plantpath.k-state.edu/extension/diagnostic-lab/documents/2021_PP_DiseaseLabChecksheet.pdf.pdf. This will help us monitor the situation in the state.

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2. Update: Pre-harvest weed control in wheat

This year's short, thin wheat crop, coupled with late-season rains has resulted in a lot of questions about the best approach to managing large weeds in mature wheat. We did address this topic previously this year, but with the extended wheat harvest, it seems timely to share this information again. The weather will greatly affect how quickly the weeds will dry down to facilitate harvest. Because of the large size of some of the targeted weeds, there may not be complete control of the weeds and that can result in regrowth after harvest. In addition, there have been questions regarding the effect of some products, especially saflufenacil (Sharpen) on weed seed germination. We need to clarify that BASF data suggest that Sharpen does **not** negatively affect seed wheat and **can** be used on wheat that will be saved for seed.

Herbicides labeled for use as harvest aids in wheat are listed in Table 1. There are differences in how quickly they act to control the weeds, the interval requirement between application and grain harvest, and the level or length of control achieved. All of them will require thorough spray coverage to be the most effective. Paraquat is sometimes mentioned as a possible herbicide for pre-harvest application but is **not** labeled for pre-harvest treatment in wheat**.** Application of paraquat to wheat is an illegal treatment and can result in quarantine and destruction of the harvested grain, along with severe fines.

Figure 1. Weeds in wheat near harvest time. Photo by Dallas Peterson, K-State Research and Extension.

Table 1. Herbicides for use as pre-harvest weed control options in wheat.

Herbicide and rate	Weeds controlled	Application timing	PHI* (days)	Comments
Metsulfuron (Ally, others) 0.1 oz	Some broadleaf weeds	Hard dough stage	10	Kochia, pigweeds, and marestail may be resistant Apply in combination with glyphosate or 2,4-D Use 0.25 to 0.5 % v/v nonionic surfactant) Do not use on soils with a pH greater than 7.9 12- to 34-month rotation interval for soybeans
2,4-D LVE 1 pt of 4lb/gal product or 2/3 pt 6 lb/gal product	Broadleaf weeds	Hard dough stage	14	Weak on kochia and wild buckwheat
Dicamba 0.5 pt	Broadleaf weeds	Hard dough stage and green color is gone from nodes	7	Do not use treated wheat for seed unless a germination test results in 95% or greater seed germination
Glyphosate 1 qt of 3 lb ae/gal product, 22 fl oz of 4.5 lb ae/gal product	Grasses and broadleaf weeds	Hard dough stage (30% or less grain moisture)	7	Kochia, pigweeds, and marestail may be resistant Consult label for recommended adjuvants Not recommended for wheat harvested for use as seed
Carfentrazone (Aim EC, others) 1 to 2 fl oz	Pigweeds, kochia, lambsquarters, Russian thistle, wild buckwheat		7	Acts quickly, usually within 3 days Regrowth of weeds may occur Use 1% v/v crop oil concentrate
Flumioxazin (Valor) 1.5 to 2 fl oz	Broadleaf weeds	after wheat reaches the hard dough stage and g 30% or less grain moisture	10	Acts quickly, usually within 3 days Regrowth of weeds may occur Some residual activity Use 1 qt/A MSO May use UAN Tank mix with glyphosate recommended Rotation interval depends on rate and soil
Saflufenacil	Broadleaf	Hard dough	3	Acts quickly, usually within 3 days

(Sharpen) **1 to 2 fl oz**	weeds	stage 30% or less grain moisture		Regrowth of weeds may occur Some residual activity Use 1% v/v methylated seed oil + 1 to 2% w/v AMS or 1.25-2.5% v/v UAN Rotation interval depends on rate and soil

*PHI = Pre-harvest interval, or days required between application and harvest.

For more detailed information, the "2023 Chemical Weed Control for Field Crops, Pastures, and Noncropland" guide is available online at https://www.bookstore.ksre.ksu.edu/pubs/CHEMWEEDGUIDE.pdf or check with your local K-State Research and Extension office for a paper copy.

The use of trade names is for clarity to readers and does not imply endorsement of a particular product, nor does exclusion imply non-approval. Always consult the herbicide label for the most current use requirements.

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3. Controlling weeds after wheat harvest

This growing season has resulted in more than the usual discussion regarding weed management in wheat. That conversation continues, as we think about what happens when we remove the crop canopy. Weeds that have been suppressed by the canopy will grow rapidly once crop competition is removed. In addition, weeds that have emerged through the wheat canopy will be damaged during harvest and will quickly begin regrowth. Delaying control can result in lost soil moisture that could be used for crop production, as well as weed seed production which will cause difficulties in the future.

When thinking about weed control in wheat stubble, there are two priorities – controlling already emerged weeds and preventing later flushes. Making applications before weeds exceed 4 to 6 inches is necessary for good control of already emerged weeds (Figure 1). Residual herbicides are needed to reduce the number of herbicide applications needed to control multiple flushes of weeds.

Figure 1. This large Palmer amaranth is regrowing after being sprayed with paraquat. Photo by Sarah Lancaster, K-State Research and Extension.

Despite a growing number of herbicide-resistant weeds, glyphosate plus 2,4-D LVE and/or dicamba continue to be important for weed control in wheat stubble. However, these herbicides alone are not likely to provide adequate control of pigweeds or kochia, especially when applied in the hot, dry conditions that are common after wheat harvest. The following paragraphs will list some herbicide options commonly used to control weeds after wheat harvest.

Paraquat (Gramoxone, others) is one herbicide that can work well in place of glyphosate to control emerged pigweed and kochia. Paraquat is a contact herbicide, so spray coverage is critical. Spray volumes of 20 gallons/acre or higher are preferred, especially on larger weeds or denser stands. Paraquat needs to be applied with a non-ionic surfactant or oil concentrate to enhance the surface coverage of the plant foliage. Also, remember there is a requirement for handlers and applicators to be certified to use paraquat (training information is included at the end of this article).

If planning to plant corn or sorghum next spring, a tank mix of paraquat with atrazine will enhance the control of emerged weeds and provide some residual weed control. However, it is important to be aware of the total amount of atrazine you are applying to each field in a given year. M**etribuzin** can be used instead of atrazine if rotating to soybean to enhance control and provide some residual activity.

One final note regarding paraquat. Limited research out of Australia suggests applying paraquat 2 weeks after a glyphosate application will increase weed control. This is called a 'double knock' strategy. I include this information here not as a recommendation per se, but to encourage careful thought about when you want to utilize contact herbicides in your fallow weed management system.

Saflufenacil (Sharpen) applied at one to two fluid ounces per acre is an option to provide postemergence and short-term residual control of Palmer amaranth, kochia, and other broadleaf weeds. Sharpen should be applied with glyphosate for grass control, and can be applied with other products labeled for use in wheat stubble, but do not apply Sharpen with Valor. Sharpen works best with the addition of methylated seed oil and ammonium sulfate. Good spray coverage is needed, so using 15 to 20 gallons/acre spray solution is important. Be sure to note crop rotation intervals for your situation, especially if using more than one fluid ounce per acre or applying to sandy or low organic matter soils.

Flumioxazin (Valor, others) can be added to burndown treatments at rates of one to four fluid ounces per acre for activity on emerged broadleaf weeds and some residual activity on broadleaf and grass weeds in wheat stubble. Flumioxazin can be mixed with glyphosate or clethodim (Select Max) for enhanced grass control. It can also be mixed with 2,4-D, atrazine, metribuzin, or paraquat. Wheat can be planted 30 days after two fluid ounces per acre, or 60 days after three fluid ounces per acre if at least one inch of rain occurs between application and planting. Soybeans can be planted immediately after an application of three fluid ounces per acre. Corn, sorghum, cotton, sunflowers, or soybeans can be planted in the spring following the application of four fluid ounces per acre. Residual weed control with flumioxazin will depend on rainfall (0.25 inch) for activation, just as with pre-plant treatment in soybeans.

Flumioxazin has longer residual activity than saflufenacil (Sharpen), however, saflufenacil provides greater control of kochia than flumioxazin. A third Group 14 product that could be used is **tiafenacil (Reviton).** Similar to saflufenacil, it requires both MSO and AMS as adjuvants and should be applied with glyphosate for grass control.

For more detailed information, see the "2023 Chemical Weed Control for Field Crops, Pastures, and Noncropland" guide available online at https://www.bookstore.ksre.ksu.edu/pubs/CHEMWEEDGUIDE.pdf or check with your local K-State Research and Extension office for a paper copy.

Paraquat training

If you have not completed the certification for applying or handling paraquat, here is a link to the training: http://usparaquattraining.com/ Additional details in the January 12, 2023 eUpdate: https://eupdate.agronomy.ksu.edu/article_new/2023-kansas-training-information-for-paraquat-and-dicamba-526-1

The use of trade names is for clarity to readers and does not imply endorsement of a particular product, nor does exclusion imply non-approval. Always consult the herbicide label for the most current use requirements.

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4. Wheat harvest: Identifying disease problems and setting harvest priorities

As wheat harvest progresses in Kansas, we wanted to provide some reminders about diseases that may affect either grain quality or the viability of grain that is destined to be saved for seed. At this point in the season, most disease management decisions have been made, but there are some strategies for mitigating losses on heavily infected fields. Additionally, decisions can be made about variety selection and seed preparation for next season.

Harvest considerations for Fusarium head blight (scab)

Fusarium head blight (scab) has now been reported in several counties in northwest Kansas where wet weather was present during and after flowering. This disease (Figure 1) can lead to lightweight, damaged kernels (Figure 2) which may contain the mycotoxin deoxynivalanol (DON). DON is sometimes referred to as "vomitoxin" because it can lead to vomiting and feed refusal in animals and is strictly regulated in finished products destined for human consumption. Fields known to have high levels of Fusarium head blight should be harvested separately from fields that are unaffected when possible. It may be prudent to harvest infected fields as early as possible to avoid further accumulation of DON in grain. Producers should carefully consider if they want to blend seed from infected and uninfected fields, as this may result in reduced quality of uninfected grain. Research has indicated that adjusting combine fan speeds may help 'blow out' lightweight Fusarium damaged kernels. Fan speeds that are too high, however, may remove too much healthy grain. Additionally, blowing out scabby kernels may increase the abundance of volunteer wheat. If you are considering saving back seed from affected fields, the seed should be professionally cleaned. The pathogen that causes Fusarium head blight can result in a seedling disease and decreased emergence. If seed from fields with Fusarium head blight is saved, a seed treatment can improve emergence. Fusarium head blight is not seed transmitted, however, so infected seeds themselves will not result in head bight problems in the subsequent season.

Figure 1. Symptoms of Fusarium head blight (head scab) appear as bleached spikelets anywhere on the head and will spread through the head when conditions are favorable. When there is high humidity, orange-colored fungal structures can be seen in some infected heads. Photo by Kelsey Andersen Onofre, K-State Research and Extension.

Figure 2. Chalky wheat kernels resulting from a severe infection of Fusarium head blight. Photo by Erick DeWolf, K-State Research and Extension.

Common bunt (stinking smut)

Common bunt is typically only detected at harvest when grain appears to have a black, dusty appearance. Grain may also have a foul, "fishlike" odor. Infection actually occurs in the fall, when wheat seeds infested with spores germinate however, symptoms are not present until grain fill. Kernels infected by common bunt are dark and discolored and are filled with black spores called teliospores (Figure 3). Teliospores can be released when wheat is harvested and in severe cases may cause a black cloud behind the combine. Heavily infected fields can have reduced grain quality and yield. Very 'smutty' grain can be discounted. The best way to manage common bunt is to purchase certified, fungicide-treated seed or to have saved seed commercially cleaned and fungicide treated.

Figure 3. Wheat infected with common bunt. Photo by Kelsey Andersen Onofre, K-State Research and Extension.

Black point and sooty molds

With multiple rain delays slowing the progress of wheat harvest, some areas of the state are reporting sooty molds and grain with a discoloration known as black point. Both of these problems are caused by molds that grow on mature wheat.

These molds are normally not aggressive pathogens in wheat, but they can rapidly colonize mature plants. These diseases are most problematic when rain re-wets mature plants and causes harvest delays. The sooty molds are often a cosmetic problem because the mold growth is very superficial on the chaff and glumes (Figure 4). The sooty molds can make for a dusty harvest, however. If the timing of the rain coincides with the late stages of kernel development, the molds can begin to colonize the outer layers of the wheat kernel, resulting in a gray-black discoloration called black point (Figure 5). Commonly, the embryo end of the kernel is most discolored, but entire kernels can become gray or black as a result of the black point. There is no way to manage this disease as all fungicides are long past labeled application windows. Although not typically yield limiting, the fungi that cause black point can cause problems with germination and may reduce seedling vigor. Seed lots with symptoms of black point should be tested for germination. If black point is causing germination problems, fungicide seed treatments can often improve the germination and ensure good stand establishment.

Figure 4. Wheat head with symptoms of sooty mold. Photo by Erick DeWolf, K-State Research and Extension.

Figure 5. Wheat kernels showing symptoms of black point. In severe cases, the entire kernel may appear darkened. Photo by Kelsey Andersen Onofre, K-State Research and Extension.

Loose smut

Loose smut can be easily identified after heading by masses of black spores that appear on heads in place of spikelets (Figure 6). By harvest, most of the black, powdery spores have been blown away by wind, leaving only the central stem of the head (rachis). Individual heads with loose smut will not produce any grain. Earlier in the growing season, spores from infected heads may have spread to neighboring plants and infect developing seed. Cool, wet weather during the flowering period favors disease spread. Although this disease will not affect grain quality in the current season, the disease can persist within the infected kernels if the grain is saved for seed. The best option for control in infected seed is the use of a fungicide seed treatment. Coverage is key to ensuring the success of the treatment. More information about wheat seed treatment options can be found in this K-State wheat seed treatment publication: https://bookstore.ksre.ksu.edu/pubs/MF2955.pdf.

Figure 6. Loose smut symptoms caused by the fungus Ustilago tritici**. Photo by Kelsey Andersen Onofre, K-State Research and Extension.**

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5. 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 stages. Photos by Dorivar Ruiz Diaz, K-State Research and Extension.

Plant analysis for diagnostic sampling

Collecting specific plant parts is less important when sampling for diagnostic purposes 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, collecting a soil sample from both good and bad areas is also helpful 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 overnight 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. For questions about the plant tissue testing services at the K-State Testing Lab, email soiltesting@ksu.edu or call 785-532-7897.

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 that 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. The 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 is a very effective diagnostic tool. Consider adding this to your toolbox.

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6. Identifying nutrient deficiency symptoms in soybeans

As the soybean-growing season progresses, the plants may begin showing signs of chlorosis or other leaf discoloration in all or parts of the field. There may be many causes of this discoloration. Nutrient deficiencies are one possibility.

General considerations

The relative mobility of the nutrient within the plant will determine if the deficiency symptom will first be noticeable on the lower leaves or upper leaves.

Mobile Nutrients: These nutrients can be transferred from older tissues to the youngest tissues within the plant. Deficiency symptoms are first noticeable on the lower, oldest leaves.

- Nitrogen (N)
- Phosphorus (P)
- Potassium (K)
- Magnesium (Mg)

Immobile Nutrients: These nutrients are not easily transferred within the plant. Therefore, symptoms occur first on the upper, youngest leaves.

- Boron (B)
- Calcium (Ca)
- Copper (Cu)
- Iron (Fe)
- Manganese (Mn)
- Molybdenum (Mo)
- Sulfur (S)
- Zinc (Zn)

Possible causes of nutrient deficiencies:

1. Low soil levels of the nutrient
2. Poor inoculation (in the case of N deficiency)
3. Unusually low or high soil pH levels depending on the nutrient in question
4. Roots are unable to access sufficient amounts of nutrients - due to poor growing conditions, excessively wet or dry soils, cold weather, or soil compaction
5. Root injury due to mechanical, insect, disease, or herbicide injury
6. Genetics of the plant

The following briefly describes the symptoms of some of the most common nutrient deficiencies in soybeans.

Nutrient deficiency symptoms

Nitrogen. Chlorotic or pale green plants start with the lower leaf (Figure 1a). Within the plant, any available nitrogen (N) from the soil or nitrogen fixation within nodules on the roots first goes to the new growth. Soybeans prefer to take up N from the soil solution as much as possible since this requires less energy than the nitrogen fixation process. However, both sources of N are important for soybeans since they are a big user of N. Nitrogen deficiency can be associated with poor nodulation (Figure 1b).

Figure 1a. Soybean field showing signs of chlorosis. Photo by Dorivar Ruiz Diaz, K-State Research and Extension.

Figure 1b. Lack of nodulation on far right soybean plants. Photo by Dorivar Ruiz Diaz, K-State Research and Extension.

Iron. Iron chlorosis occurs in calcareous soils (contains calcium carbonates) with high soil pH. The classic symptom is chlorosis (yellowing) between the veins of young leaves since iron is not mobile within the plant (Figures 2 and 3). A side effect of iron deficiency can be N deficiency since iron is necessary for nodule formation and function. If iron is deficient, N fixation rates may be reduced. Iron deficiency occurs on calcareous soils, in addition to high pH, plant stress can favor the development of iron chlorosis, and therefore the severity can vary significantly from year to year in the same field.

Figure 2. Iron chlorosis in soybeans; the upper leaves become chlorotic. Photo by Dorivar Ruiz Diaz, K-State Research and Extension.

Figure 3. Close-up of iron chlorosis in soybeans. Photo by Dorivar Ruiz Diaz, K-State Research and Extension.

Magnesium. Lower leaves will be pale green, with yellow mottling between the veins. At later stages, leaves may appear to be speckled bronze. This deficiency may occur on very sandy soils.

Manganese. Stunted plants with interveinal chlorosis (Figure 4). Can be a problem in soils with high pH (>7.0), or on soils that are sandy or with a high organic matter content (>6.0% OM). Manganese activates enzymes that are important in photosynthesis, as well as nitrogen metabolism and synthesis. Symptoms are hard to distinguish from iron chlorosis.

Figure 4. Manganese deficiency symptoms are similar to symptoms of iron chlorosis in soybeans. Photo by Jim Camberato, Purdue University.

Phosphorus. Phosphorus deficiency may cause stunted growth, dark green coloration of the leaves, necrotic spots on the leaves, a purple color to the leaves, and leaf cupping. These symptoms occur first on older leaves. Phosphorus deficiency can also delay blooming and maturity. This deficiency may be noticeable when soils are cool and wet, due to a decrease in phosphorus uptake.

Potassium. Soybean typically requires large amounts of potassium. Like phosphorus deficiency, potassium deficiency occurs first on older leaves. Symptoms are chlorosis at the leaf margins and between the veins (Figure 5). In severe cases, all but the very youngest leaves may show symptoms.

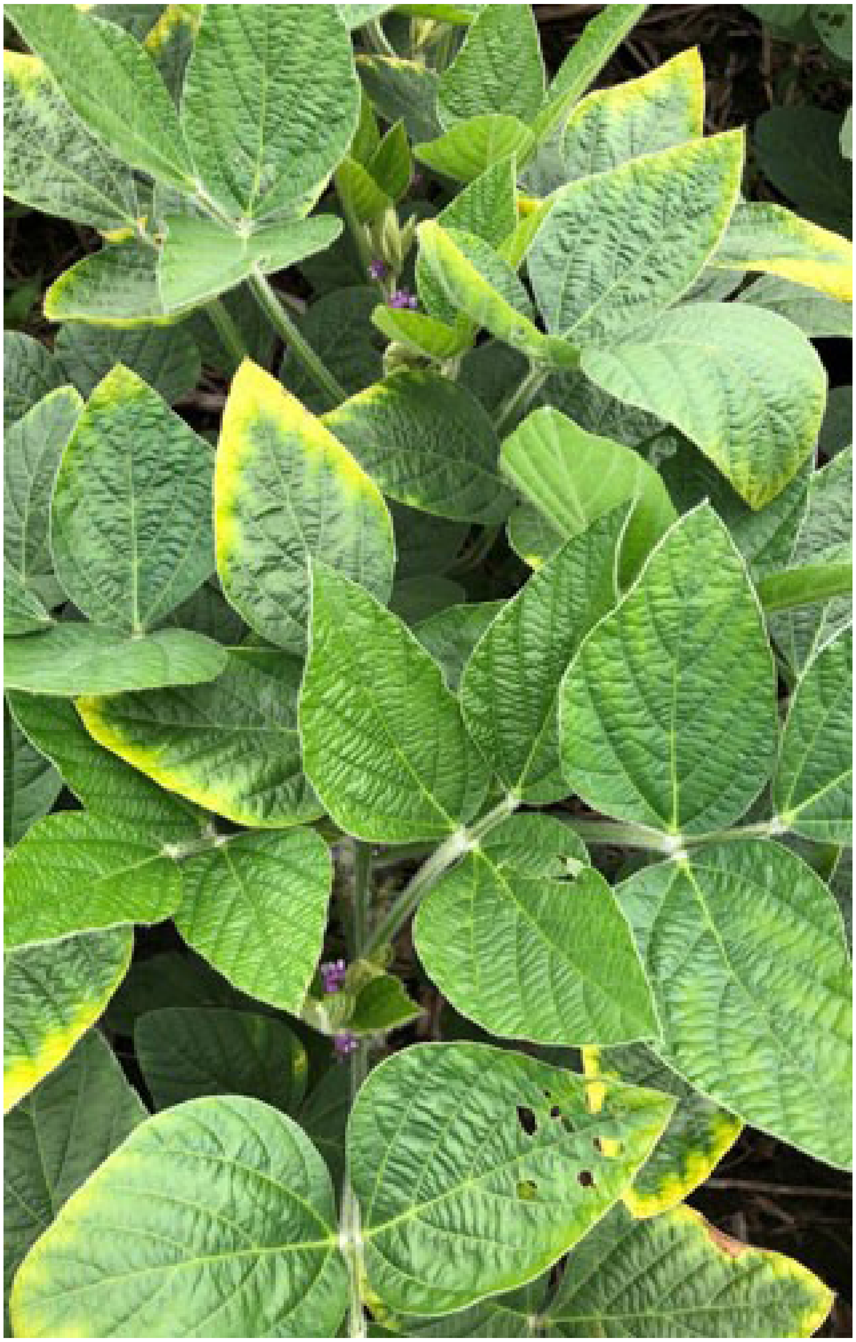

Figure 5. Potassium deficiency: chlorosis of the lower leaves. Photo by Dorivar Ruiz Diaz, K-State Research and Extension.

Sulfur. Stunted plants have a pale green color, similar to N deficiency except chlorosis may be more apparent on upper leaves. Plant-available sulfur is released from organic matter. Deficiency is most likely during cool, wet conditions or on sandy soils with low organic matter content.

For more information, see K-State Research and Extension publication MF-3028, *Diagnosing Nutrient Deficiencies in the Field* at: http://www.ksre.ksu.edu/bookstore/pubs/MF3028.pdf

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7. Diagnosing wheat production problems - Updated publication for 2023

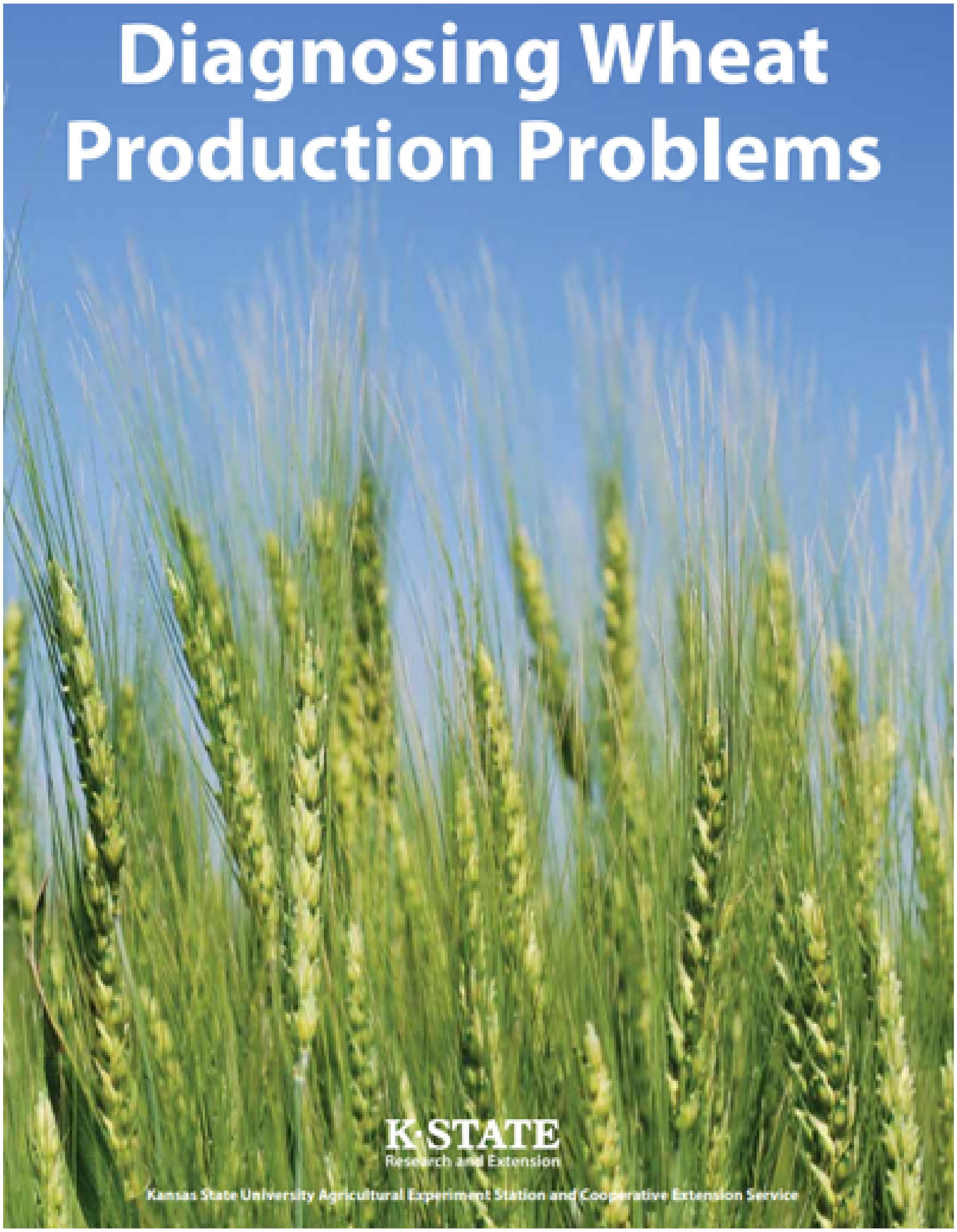
The K-State Research and Extension publication S84 "Diagnosing Wheat Production Problems" has been recently updated. This comprehensive update was a collaborative effort between three K-State departments: Plant Pathology, Agronomy, and Entomology. This 66-page full-color publication will help growers diagnose likely causes of slow growth, distorted appearance, off-colors, injury, and death of wheat plants from planting to harvest.

There are five sections organized by growth stage covering a myriad of wheat production problems. This is also an index to help users quickly find the appropriate section for their topic of interest. The sections, accompanied by color photos, are:

- Early Season Problems: Emergence to Tillering
- Middle Season Problems: Tillering to Heading
- Late Season Problems: Heading to Maturity
- Post-Harvest Problems
- Rare Problems

Copies can be ordered from the KSRE Bookstore at
https://bookstore.ksre.ksu.edu/Item.aspx?catId=299&pubId=1757

The online version can be viewed at https://bookstore.ksre.ksu.edu/pubs/S84.pdf



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8. Soybean gall midge detected in Kansas - Be on the lookout

This past week, soybean gall midge was found infesting soybean and sweet clover in Marshall and Nemaha counties.

The Soybean Gall Midge (*Resseliella maxima*) was first observed in Nebraska in 2011 but was not officially described as a new species until 2018 when this tiny fly established itself as an emerging pest of soybeans in South Dakota, Nebraska, Minnesota, and Iowa. New infestations have been documented every year since and its range has expanded into Missouri. Soybean gall midge has been documented in Nebraska along the Kansas border as recently as 2021. This pest should be actively scouted for during the growing season, especially in counties along the Nebraska border.

Losses from soybean gall midge infestation are due to plant death and lodging (Figure 1). Heavily infested fields have shown the potential for complete yield losses from the edge of the field up to 100 feet into the field and a 20% yield loss from 200 to 400 feet into the field.

Figure 1. Soybean field with damage by soybean gall midge. Photo by Justin McMechan, Univ. of Nebraska.

Identification and Lifecycle

Adults: tiny (2-3mm), delicate flies with an orange abdomen, slender bodies, and mottled wings.

Long legs are banded with alternating light and dark markings (Figure 2).

Figure 2. Adult soybean gall midge. Photo by Mitchell Helton, Iowa State Univ.

Larvae: small, legless, maggots that are clear to white-colored when young but turn bright orange when mature (Figure 3).

Figure 3. Soybean gall midge larvae. Photo by Justin McMechan, Univ. of Nebraska.

Soybean gall midge overwinters as larvae in the first few inches of soil. After pupation in the early spring, adult midges emerge and lay their eggs on the lower portions of stems or at the base of soybean plants. The eggs hatch and the larvae feed within the stems. Infestation does not occur until the V2 stage when natural fissures and cracks appear in stems allowing entry by larvae. Infestation can continue into the reproductive growth stages. So far, there appear to be at least two generations per growing season. The adult soybean gall midges do not feed on soybeans.

Scouting

Begin scouting soybean plants at the V2 growth stage. Symptoms of infestation include:

1. wilting or dead soybeans along field edges with decreasing damage into the center of the field (Figure 4),
2. darkening and swelling at the base of stems (Figure 5),
3. brittle stems that break easily near their base, and
4. small orange larvae present in split open stems.

Figure 4. Wilting soybean plant from gall midge infestation. Photo by Justin McMechan, Univ. of Nebraska.

Figure 5. Darkening and swelling of the stem. Photo by Adam Varenhorst, South Dakota State Univ.

Management

As such a new pest, no published research-based management recommendations are currently available. On-farm studies in impacted states are examining the effects of cultural practices and insecticides on preventing losses. Seed treatments have not been shown to be effective.

Please report any occurrence of soybean gall midge to your local extension professional or contact the K-State Entomology Department. The Soybean Gall Midge Alert Network, https://soybeangallmidge.org/, can be used to track developments regarding this new pest.

Anthony Zukoff, Extension Entomology, Southwest Research and Extension Center
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9. Soybean insect activity - Dectes stem borers

In the last week, we scouted many soybean fields around north central Kansas and found no significant infestations of early-season defoliators. Of course, that can change relatively quickly once/if defoliators get started.

However, a relatively large number of adult Dectes (soybean) stem borers were sampled (Figure 1). The holes in the leaves were made by adult bean leaf beetles and are of no consequence, nor were the numbers of adult bean leaf beetles sampled. However, the Dectes stem borer adults were observed in relatively large numbers, but still only around the edges of the fields. This is where they usually aggregate for a week or two after emerging as adults, mate (note the 2 beetles at the top of the leaf in Figure 1), then disburse to deposit eggs in stems throughout the field for the next few weeks. The numbers revealed in sampling this past week were higher than usual. Thus, growers throughout the western two-thirds of Kansas need to be monitoring their fields that have high infestation levels in August/September and try to harvest those fields as soon as possible to try to prevent lodging due to soybean stem borer girdling.

Figure 1. Dectes stem borer adults from one sweep sample. The holes in the leaves were made by adult bean leaf beetles. Photo by the Department of Entomology, K-State Research and Extension.

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10. Registration is open for the 2023 K-State/KARA Summer Field School

Kansas State University and the Kansas Agribusiness Retailers Association (KARA) will be hosting two, 2-day field schools on July 11-12 and July 13-14 at the K-State Agronomy North Farm (2200 Kimball Ave) located just north of the football stadium. This year's program will focus on soybean production and fertility. In addition, there will be comprehensive hands-on training in herbicide symptomology and deposition, weed identification, summer annual forages, soil and water management, crop diseases, and insects.

Agendas for both sessions are included at the end of this article.

The complete program and registration link can be found at https://www.ksagretailers.org/events-training/ksu-field-days/. The program costs $210 for the 2-day program or $125 for 1 day. The registration fee includes lunch (both days are included for the 2-day program rate) and the opportunity to earn multiple CCA and 1A credits (final number is pending).

Lodging information and other program details can be found at the above link or using the QR code in the graphic below.

REGISTER

DATES: Session I: July 11 - 12 | Session II: July 13 - 14

TIME: 8:30 a.m. - 3:30 p.m.

CITY: Manhattan

PRICE: $210 or $125

To register, fill out and return the bottom portion via fax 785-234-2930, or via email to lisa@kansasag.org. To pay by check or be billed please return this form and payment to Lisa Anschutz, 816 SW Tyler, Topeka, KS 66612. Cancellations must be made 72 hours in advance for a full refund.

Please note: KSRE agents should register via the registration link that was recently distributed over the Ag Agent email listserv.

Peter Tomlinson, Environmental Quality Specialist
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Kansas State University/KARA Summer Field School (Session 1)
North Agronomy Farm, Manhattan, July 11-12, 2023

K·STATE Research and Extension

	Tuesday 7/11/2023		
8:00 AM	Registration – **North Agronomy Farm**		
8:30 AM	Welcome, Instructions		
	Group A	**Group B**	**Group C**
8:45 AM	**Herbicide Symptomology** (Lancaster)	**Weed ID** (Dille & Veenstra)	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)
9:35 AM	**Herbicide Deposition** (Lancaster)	**Weed ID** (Dille & Veenstra)	**Soybean production issues** (Ciampitti, Correndo, Caredo)
10:25 AM	**Break**		
10:40 AM	**Weed ID** (Dille & Veenstra)	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)	**Crop Insect Pests** (Whitworth)
11:30 AM	**Weed ID** (Dille & Veenstra)	**Soybean production issues** (Ciampitti, Correndo, Caredo)	**Crop Diseases** (Onofre)
12:20 PM	**Lunch – North Agronomy Farm**		
1:10 PM	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)	**Crop Insect Pests** (Whitworth)	**Weed ID** (Dille & Veenstra)
2:00 PM	**Soybean production issues** (Ciampitti, Correndo, Caredo)	**Crop Diseases** (Onofre)	**Weed ID** (Dille & Veenstra)
2:50 PM	**Adjourn**		
	Wednesday 7/12/2023		
7:00 AM	Registration – **North Agronomy Farm**		
	Group A	**Group B**	**Group C**
7:30 AM	**Soybean Fertility** (Ruiz Diaz)	**Herbicide Symptomology** (Lancaster)	**Soil Management** (Presley)
8:20 AM	**Summer Annual Forages** (Roozeboom & Detter)	**Herbicide Deposition** (Lancaster)	**Water Quality** (Tomlinson)
9:10 AM	**Break**		
9:25 AM	**Soil Management** (Presley)	**Soybean Fertility** (Ruiz Diaz)	**Herbicide Symptomology** (Lancaster)
10:15 AM	**Water Quality** (Tomlinson)	**Summer Annual Forages** (Roozeboom & Detter)	**Herbicide Deposition** (Lancaster)
11:05 AM	**Lunch – North Agronomy Farm**		
11:55 AM	**Crop Insect Pests** (Whitworth)	**Soil Management** (Presley)	**Soybean Fertility** (Ruiz Diaz)
12:45 PM	**Crop Diseases** (Onofre)	**Water Quality** (Tomlinson)	**Summer Annual Forages** (Roozeboom & Detter)
1:35 PM	**Break**		
1:50 PM	**Core Hour**		
2:40 PM	**Adjourn**		

Kansas State University/KARA Summer Field School (Session 2)

North Agronomy Farm, Manhattan, July 13-14, 2023

K-STATE Research and Extension

	Thursday 7/13/2023		
8:00 AM	Registration – **North Agronomy Farm**		
8:30 AM	Welcome, Instructions		
	Group A	**Group B**	**Group C**
8:45 AM	**Soybean Fertility** (Ruiz Diaz)	**Herbicide Symptomology** (Lancaster)	**Soil Management** (Presley)
9:35 AM	**Summer Annual Forages** (Roozeboom & Detter)	**Herbicide Deposition** (Lancaster)	**Water Quality** (Tomlinson)
10:25 AM	**Break**		
10:40 AM	**Soil Management** (Presley)	**Soybean Fertility** (Ruiz Diaz)	**Herbicide Symptomology** (Lancaster)
11:30 AM	**Water Quality** (Tomlinson)	**Summer Annual Forages** (Roozeboom & Detter)	**Herbicide Deposition** (Lancaster)
12:20 PM	**Lunch – North Agronomy Farm**		
1:10 PM	**Crop Insect Pests** (Whitworth)	**Soil Management** (Presley)	**Soybean Fertility** (Ruiz Diaz)
2:00 PM	**Crop Diseases** (Onofre)	**Water Quality** (Tomlinson)	**Summer Annual Forages** (Roozeboom & Detter)
2:50 PM	**Adjourn**		
	Friday 7/14/2023		
7:00 AM	Registration – **North Agronomy Farm**		
	Group A	**Group B**	**Group C**
7:30 AM	**Herbicide Symptomology** (Lancaster)	**Weed ID** (Dille & Veenstra)	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)
8:20 AM	**Herbicide Deposition** (Lancaster)	**Weed ID** (Dille & Veenstra)	**Soybean production issues** (Ciampitti, Correndo, Caredo)
9:10 AM	**Break**		
9:25 AM	**Weed ID** (Dille & Veenstra)	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)	**Crop Insect Pests** (Whitworth)
10:15 AM	**Weed ID** (Dille & Veenstra)	**Soybean production issues** (Ciampitti, Correndo, Caredo)	**Crop Diseases** (Onofre)
11:05 AM	**Lunch – North Agronomy Farm**		
11:55 AM	**Soybean Growth & Development** (Ciampitti, Correndo, Carcedo)	**Crop Insect Pests** (Whitworth)	**Weed ID** (Dille & Veenstra)
12:45 PM	**Soybean production issues** (Ciampitti, Correndo, Caredo)	**Crop Diseases** (Onofre)	**Weed ID** (Dille & Veenstra)
1:35 PM	**Break**		
1:50 PM	**Core Hour**		
2:40 PM	**Adjourn**		