KANSAS WHEAT

Kansas Wheat Farmer:

Wheat Streak Mosaic Virus and associated diseases have shown noticeable yield losses in Kansas. In an effort to provide more information to Kansas Wheat growers, we are providing the enclosed material. In this packet you will find timely information from Kansas State University as well as historical information from the 2017 crop year, which suffered devastating losses due to this disease.

Wheat Streak Mosaic Virus is a growing issue in Kansas. Tests show that the disease showed up not only in western Kansas, but also in central Kansas this year. The best way to stop the spread of WSMV is to control volunteer wheat at least two weeks prior to planting a new crop.

In 2017, this disease caused a conservative $76.8 million in direct losses to wheat farmers, a loss of 19.2 million bushels of wheat. The 2017 loss was 5.6% yield loss, up from an average 1.5% loss.

There are basically only three ways to control the spread of wheat streak mosaic virus:

1. Timely removal of volunteer wheat and other grassy weeds. **The best way to prevent the spread of the wheat streak mosaic virus is to remove volunteer wheat and other grassy weeds.** Volunteer wheat must be completely dead and dry for two weeks before planting a new wheat crop. Volunteer wheat and other grassy weeds can be removed with herbicides or tillage, but it's absolutely essential to allow time for herbicides to work. Even if last year's crop had good genetic resistance to WSMV (such as the variety Joe), it is still important to control volunteer so it doesn't serve as a green bridge.

2. **Avoid early planting**; plant after the hessian fly-free date. By avoiding early planting, Kansas wheat farmers are able to avoid times when wheat mite populations are the highest in late summer and to decrease the interval between planting and fall freeze events. "When we say avoid early planting, we're not talking about planting outside of the window for success of your wheat crop," said KSU Plant Pathologist Erick De Wolf. "We're encouraging you to **plant on the later side of the recommended planting dates**."

3. **Plant varieties with moderate or high levels of resistance to WSMV.** A number of wheat varieties have resistance to the virus, and others have resistance to the wheat curl mite which carries the virus. Check for resistance when choosing potential wheat varieties suited for your area.

At this point in time, there are **no chemical options** such as insecticides or pesticides that are effective at controlling the wheat curl mite.

Please review the enclosed information and contact our office if you have any additional questions.

Sincerely,
Kansas Wheat

Agronomy eUpdates | July 22nd, 2021 : Issue 865

Wheat streak mosaic virus: It is critical to stay on top of volunteer wheat this year

This past season was a bad one for wheat streak mosaic virus (and other viruses vectored by the wheat curl mite) in parts of Kansas. Late summer rainfall in 2020 was favorable for volunteer wheat establishment in some areas. One of the best preventative measures for wheat streak is the control of volunteer wheat early and often after harvest. If volunteer wheat is allowed to stand, it creates a "green bridge", allowing wheat streak mosaic and wheat curl mites to survive locally. Volunteer wheat should be terminated at least two weeks prior to planting to allow sufficient time for mites to die off.

Challenges faced in 2020-21

This year, the wheat crop faced several challenges that might have increased the amount of seed left behind after harvest, which could also increase the amount of volunteer wheat (Figure 1). These problems included:

- Excessive rainfall delayed wheat harvest in many parts of the state
- Freeze damage during late boot and early heading (which caused many delayed wheat heads to emerge), particularly in parts of south-central and southwest Kansas
- Hailed-out wheat
- A considerable amount of head scab (Fusarium head blight) even in western Kansas, where this disease is usually not a problem
- Waterlogged conditions in parts of central Kansas
- Drought-stressed wheat in southwest Kansas

Figure 1. Volunteer wheat that has emerged in wheat residue. Photo by Sarah Lancaster, K-State Research and Extension.

Breaking the "green bridge"

Wheat curl mites will move off growing wheat as the green tissue dries down and dies. After moving off the existing wheat at or near harvest time, the mites need to find green tissue of a suitable host soon or they will die (death of the whole population will take approximately 2 weeks).

Producers often like to wait several weeks after harvest before making their first herbicide application to control volunteer wheat. This allows as much volunteer as possible to emerge before spraying it or tilling it the first time. Glyphosate and atrazine are two herbicides that are often used for this purpose. Additional information about controlling volunteer wheat can be found in a recent eUpdate article: "Considerations for weed control following wheat harvest". Often, a second application or tillage operation will be needed later in the summer to eliminate the green bridge to fall-planted wheat by making sure all volunteer is dead within ½ mile of wheat being planted in the fall. As we saw in 2020, wet weather through late summer often favors multiple flushes of volunteer wheat (Figure 2) and also favors the growth of other grassy weeds that can also support moderate populations of the curl mites and virus.

Figure 2. Thick stand of volunteer wheat after wheat harvest (left panel) and detail of volunteer wheat crop development (right panel). Photos taken in Edwards County, KS by Romulo Lollato, K-State Research and Extension.

Other hosts for the wheat curl mite

Volunteer wheat is not the only host of the wheat curl mite. Over the years, multiple research studies have evaluated the suitability of wild grasses as hosts for both the curl mite and the wheat streak virus. There is considerable range in the ability of a grassy weed species to host the mite and the virus. Barnyardgrass is among the more suitable hosts for both virus and mites, but fortunately it is not that common in wheat fields. In contrast, various foxtails, although a rather poor host, could be an important disease reservoir simply because of their abundance. These grasses may play an important role in allowing the mites and virus to survive during the summer months particularly in the absence of volunteer wheat.

The K-State Research and Extension publication, MF3383 - *Wheat Streak Mosaic*, includes information about grassy weed hosts of the mite and virus, and the contribution of these hosts to the risk of severe wheat streak mosaic infections. Take note of significant stands of these grasses in marginal areas and control them as you would volunteer wheat.

If volunteer wheat and other hosts are not controlled throughout the summer and are infested with wheat curl mites, the mites will survive until fall and could infest newly planted wheat. Wheat curl mite infestations of wheat often lead to wheat streak mosaic infections (Figures 2 and 3).

Figure 3. Close-up of wheat showing symptoms of a wheat streak mosaic virus infection in the fall. Photo by Kelsey Andersen Onofre, K-State Research and Extension.

Management with genetic resistance: One tool in the toolbox

Other than timely control of volunteer, genetic resistance is also an important tool for WSMV control. Genetic resistance to wheat streak mosaic can also reduce the risk of severe disease problems. There are currently a few varieties adapted to Kansas that have wheat streak mosaic resistance, including KS Dallas (red), KS Hamilton (red), Guardian (red), Oakley CL (red), Joe (white), and Clara CL (white). All of these varieties have the same resistance source (a wheat resistance gene named *WSM2*). The OSU variety Breakthrough has the *WSM1* resistance gene. These resistance genes help, but have some serious limitations. For example, they are effective against wheat streak mosaic virus but does not cover triticum mosaic or high plains viruses (two other viral diseases also spread by the wheat curl mites). The resistance conferred by WSM2 is also temperature sensitive and is much less effective at high temperatures, although the resistance in KS Dallas seem to endure greater temperatures before breaking down. If wheat is planted early for grazing or if high temperatures persist into October, the resistance is much less effective. KS Silverado (white) also has temperature sensitive resistance to wheat streak mosaic, although from a different source other than WSM2.

In addition, there are a handful of varieties with resistance to the wheat curl mite, including TAM 112, Byrd, Avery, Langin, KS Western Star, Whistler, Canvas, Guardian, Crescent AX, Incline AX, Fortify SF, TAM 115, TAM 204, and T158. These varieties are actually susceptible to the viral diseases, but they generally slow the development of the mite populations in the fall. This resistance can help reduce the risk of severe disease but will not provide enough protection if wheat is planted in close proximity to volunteer wheat or other hosts infested with large populations of the curl mites and virus.

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Considerations for weed control following wheat harvest

Post-harvest weed control in wheat stubble is very important to conserve soil moisture and prevent weeds from going to seed and adding to the weed seedbank that must be managed in future years. Weeds can grow quickly once the wheat canopy is removed and can easily become difficult to manage, especially in the hot, dry conditions of summer. The species that are often targeted with post-harvest herbicide applications are often Palmer amaranth and kochia; however, controlling volunteer wheat is also an important objective for these applications (Figure 1).

Figure 1. Palmer amaranth and volunteer wheat can quickly emerge once the wheat canopy is removed at harvest. Photo by Sarah Lancaster, K-State Research and Extension.

Historically, the key herbicides for weed control in wheat stubble were glyphosate plus 2,4-D and/or dicamba. However, the development of herbicide resistant weeds has reduced the effectiveness of these products. Higher rates of 2,4-D and dicamba may improve control, but it is important to consider other options, especially those with residual activity on key species like pigweeds and kochia. Some options are described in the next paragraphs of this article.

Gramoxone (paraquat) is a non-selective, contact herbicide that can be used in fallow fields. It should be applied at 0.5 to 1.0 pounds of paraquat/A, which is equal to 2 to 4 pints of GramoxoneSL 2.0 or 1.3 to 2.7 pints of GramoxoneSL 3.0. Thorough spray coverage is important for good control, which means medium to coarse droplet sizes and greater spray volumes (20 GPA or more). Gramoxone should be applied with NIS, COC, or MSO. Because paraquat is a contact herbicide regrowth is common, especially of large weeds (Figure 2). Adding a Group 5 herbicide, such as **atrazine** or **metribuzin** can enhance control of larger weeds and add some residual activity. Atrazine will also help control volunteer wheat. It's also important to remember that paraquat is a restricted use pesticide that requires additional training for handling.

Figure 2. This large Palmer amaranth is re-growing after being sprayed with paraquat. Photo by Sarah Lancaster, K-State Research and Extension.

Sharpen (saflufenacil) is a Group 14 herbicide that is a primarily a contact herbicide but also provides some residual activity. Use 2 to 3 oz/A for larger weeds and residual activity. Sharpen works best with the addition of methylated seed oil. Sharpen requires complete coverage so using 15 to 20 gallons/acre spray solution is important.

Valor (flumioxazin) can provide contact and residual activity of key species like pigweeds. Valor EZ can be applied at 2 to 4 fl oz/A. Crop rotation should be considered when selecting the application rate. The 4 fl oz rate has a 4-month rotation interval for corn, cotton, sorghum, soybean, sunflower, and wheat; but lower rates have fewer restrictions. If targeting emerged weeds, NIS or COC should be included in the application.

All herbicides are most effective when applied to weeds that are actively growing. This means it is necessary to wait for a at least 2-3 inches of regrowth if weeds were cut off by the combine. It may be tempting to wait further delay applications to wait for later weed flushes; however, consider including a product with residual activity, rather than waiting, in order to prevent poor control of large weeds.

Additional information can be found in the 2021 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, K-State publication SRP-1162.

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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K-STATE Research and Extension

Wheat Streak Mosaic

Department of Plant Pathology | MF3383 | Wheat Disease

Wheat streak mosaic is one of the most economically devastating wheat diseases in Kansas and the Great Plains. The disease is most common in the western portion of the state, with sporadic outbreaks in central and eastern Kansas.

Symptoms

Plants infected with the disease often have yellow leaves with contrasting green and yellow streaks extending toward the leaf base (figures 1 and 2).

Wheat streak mosaic develops most readily when temperatures are higher than 70 degrees Fahrenheit, and the severity of symptoms often increases as temperatures rise in the spring. The symptoms of infection may occur in warm periods during the fall. Wheat streak mosaic is often most severe on the edge of a field that is closest to the source of the disease. The intensity of the symptoms decreases with distance from the source. This gradient of disease within a field reflects the spread of disease and the timing of infection relative to the age of the plants.

The symptoms of wheat streak mosaic are similar to triticum mosaic and high plains wheat mosaic. Laboratory testing is often required to confirm which diseases are present within a field.

Disease Cycle

Wheat streak mosaic is caused by the *Wheat streak mosaic virus*. The virus is spread by the wheat curl mite, *Aceria tosichella*, which feeds on wheat and other grasses. The wheat curl mite is tiny and can only be seen with considerable magnification (30-40×). Feeding by mites causes the edge of the affected leaf (Figure 3) to curl back over itself (Figure 4). When populations are high, the leaves may become so

Quick Facts

- Wheat streak mosaic causes a yellow discoloration of leaves. This discoloration is most intense near the leaf tip. Plants infected as seedlings are often stunted and have a reduced head size.
- Wheat streak mosaic can reduce yield by more than 80 percent when susceptible cultivars are infected with the disease as seedlings. Cultivars with intermediate levels of resistance are less damaged by the disease but may still experience up to 20 percent yield loss. Yield losses are reduced if plants are infected after the heading stages of growth.
- Destroying volunteer wheat and other grassy hosts of the virus is the best management strategy. Planting resistant varieties also may reduce losses. No pesticides provide control of the wheat curl mites that spread wheat streak mosaic.

Figure 1. Wheat with symptoms of wheat streak mosaic. Infected plants often have bright yellow discoloration and are often smaller than healthy wheat. The diseased plants also may have a prostrate growth habit.

Figure 2. Leaf of a plant infected with wheat streak mosaic. Notice the yellow discoloration is more intense near the leaf tip with streaks extending down toward the base of the leaf.

damaged that new leaves become trapped in the whorl of the plant (Figure 5). Even without the virus, high populations of wheat curl mites during grain fill and dry down can reduce grain yield and test weight.

Wheat curl mites and *Wheat streak mosaic virus* require a living host or "green bridge" to survive after wheat harvest. Volunteer wheat is the primary host for the wheat curl mite and the virus during the summer months (Figure 6). Other grassy weeds may serve as hosts, but these weeds are not nearly as suitable or prevalent as volunteer wheat. In Kansas and Nebraska, major outbreaks of wheat streak mosaic are often associated with wet summers that favor the germination and health of volunteer wheat and other grassy hosts. When a new wheat crop is planted, the wheat curl mites move from summer hosts to the newly emerging wheat crop. The mites and virus then survive the winter on the wheat crop.

Figure 4. Symptoms of wheat streak mosaic include whitish to yellow streaking, which will usually be more pronounced toward the leaf tip. Note the curled leaf is where a colony of mites live.

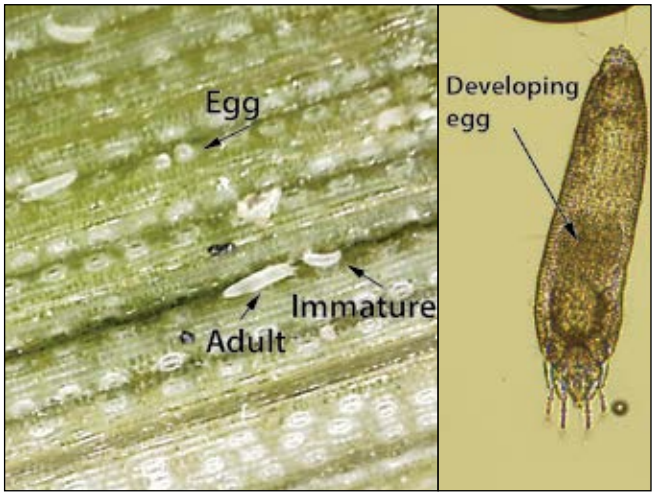

Figure 3. Wheat curl mites live in colonies on the upper surface of the leaf where the leaf's edges curl around them due to their feeding. Adult, immature, and egg stages magnified 220× (left). Close-up of a female wheat curl mite (smaller than 0.03 mm).

Figure 5. Wheat curl mite–infested leaves take on a rolled appearance, similar to an onion leaf. Leaves can be carefully unrolled to expose the mite colonies. These mites will be about the size of a grain of sand to the naked eye. Note, Russian wheat aphids also roll the leaves, but these will generally show a white striping instead of yellow streaking.

Table 1. Risk factors influencing the yield loss caused by wheat streak mosaic.

Risk Factor	Influence on wheat streak mosaic
Time of Infection	The yield loss caused by wheat streak mosaic is rarely uniform throughout a field and reflects the gradient of disease symptoms within a field. This gradient of symptoms results from the timing of infection relative to plant growth and development. Plants infected as seedlings are most at risk. Plants infected after heading may show leaf discoloration but are less at risk for severe yield loss.
Additional Viruses	Plants infected with multiple viruses often experience greater yield losses. The presence of triticum mosaic or high plains wheat mosaic along with wheat streak mosaic increases the risk of severe yield loss.
Variety	Susceptible varieties are most at risk for severe yield losses. The risk is reduced by varieties with high or moderate levels of resistance to wheat streak mosaic.
Weather	Plants infected with wheat streak mosaic are more vulnerable to environmental stress. High temperatures, drought, and other stresses often increase the yield losses caused by the disease.

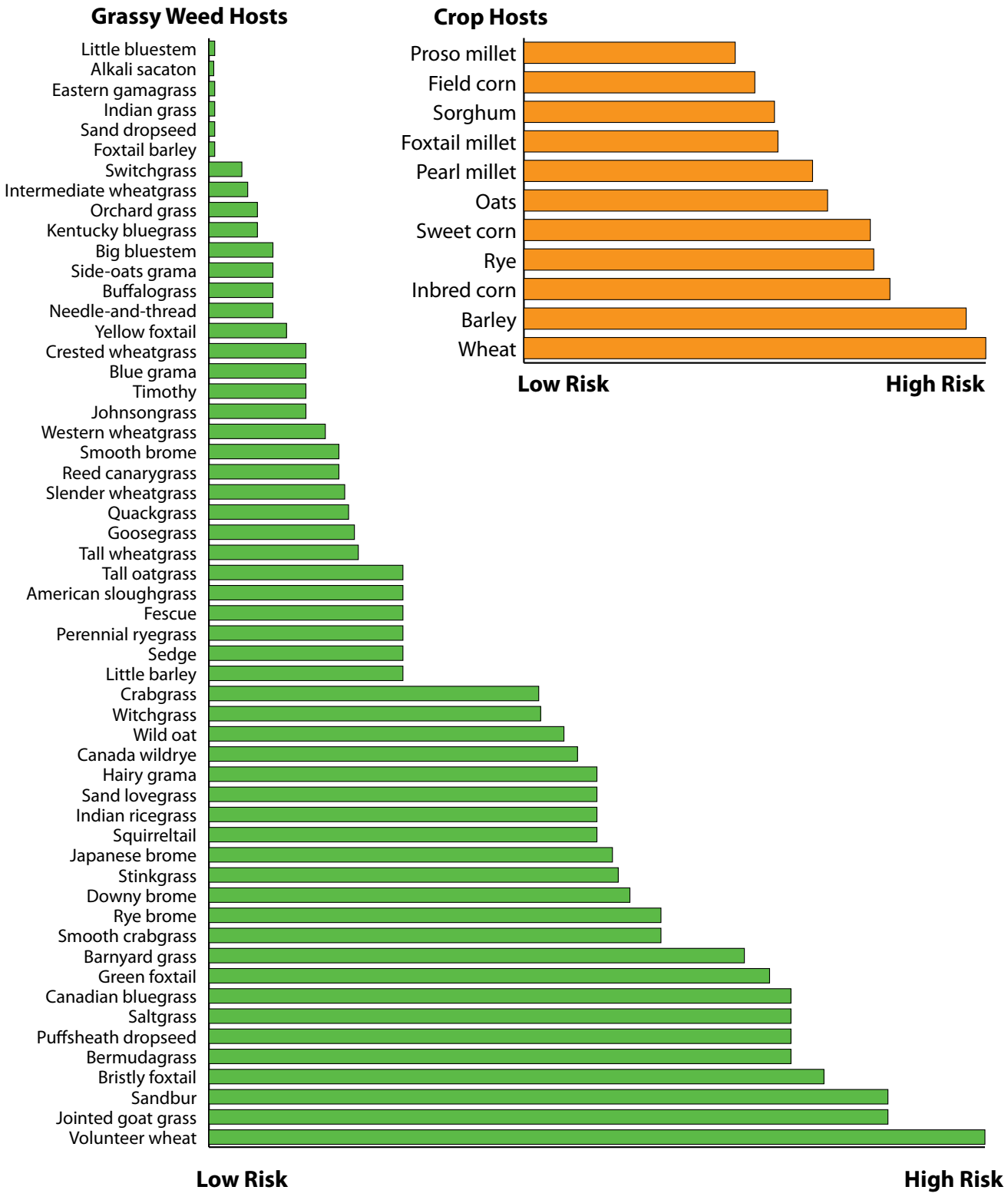

Figure 6. Relative risk that various crops and grassy weeds will serve as reservoir of wheat streak mosaic virus and the wheat curl mite. This figure summarizes the results of multiple research articles and reports. Risk is a function of suitability of a weedy grass or crop to serve as a host of wheat streak mosaic and the wheat curl mite.

Other grasses with only partial information were not included in the figure, but preliminary results indicate that windmillgrass, bearded sprangletop, prairie threeawn, shattercane, and yellow nutgrass are a low risk for becoming a reservoir of either wheat streak mosaic virus or wheat curl mite. Annual bluegrass and fall panicum are a moderate risk. Giant foxtail is a high risk for becoming a reservoir of the disease or mite.

Potential Yield Losses

In severe cases, wheat streak mosaic causes yield losses of more than 80 percent. The disease also may result in lower test weight and reduced grain quality. The time of infection, variety, planting date, environmental conditions and other viral diseases influence the losses caused by wheat streak mosaic (Table 1).

Control

- *Timely removal of volunteer wheat and other grassy weeds.* Volunteer wheat and other grassy weeds can be killed with herbicides or tillage operations. The weeds and volunteer wheat should be dead and dry for 2 weeks before planting the new wheat crop.
- *Avoid early planting.* Planting wheat after the "hessian fly free date" reduces the risk that the new wheat crop will emerge when the populations of wheat curl mites are large and more likely to move to new locations.
- *Plant wheat varieties with moderate or high levels of resistance to wheat streak mosaic.* Varieties such as Oakley CL, Clara CL, and Joe have resistance that is highly effective against wheat streak mosaic. This resistance is not perfect and these plants may still be susceptible to triticum mosaic or high plains mosaic. The resistance to wheat streak mosaic is less effective at temperatures above 75 degrees Fahrenheit. Therefore, planting these varieties early for grazing can place fields at risk for disease-related yield losses. For more information on plant resistance, refer to the K-State Research and Extension publication *Wheat Variety Disease and Insect Ratings*, MF991.
- *Chemical controls are not effective in controlling the wheat curl mite*. Testing has indicated that the currently labeled insecticides and miticides do not provide effective control of the wheat curl mite.

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MF3383 May 2017

Western Kansas hit by Wheat Streak Mosaic Virus

May 17, 2017

by Jordan Hildebrand, Kansas Wheat Program Assistant

While grazing cattle on volunteer wheat may seem like a cost-effective option in a tough farm economy, not controlling volunteer may cost you, and your neighbors, down the line. Volunteer wheat is a host for the wheat curl mite, the transmitter of Wheat Streak Mosaic Virus (WSMV), the disease that is crippling the western Kansas wheat crop.

In addition to WSMV affecting wheat, it's common for plants infected with WSMV to also be infected with High Plains mosaic and triticum mosaic viruses. The symptoms of these diseases are nearly identical, but disease severity is greater when plants are infected by more than one virus. According to K-State Research and Extension Agronomy, six west-central Kansas counties (Greeley, Wichita, Lane, Hamilton, Kearny and Finney) are experiencing extreme distribution of wheat streak mosaic, triticum mosaic and high plains mosaic virus. Many fields in this area are severely diseased and could experience more than 70 percent yield loss, if not a complete loss. The rest of western Kansas is dealing with high distributions of these diseases while the central region is also seeing high and moderate infection levels.

Losses due to WSMV depend on variety, weather, percent of plants infected and the time of infection. Infections that occur in the fall are the most damaging, with yield losses of 50 percent or more. Spring infections may cause losses closer to 20 percent. The first visible symptoms usually pop up in April on the edges of fields near volunteer wheat. Yellow streaking and mosaic patterns on young leaves and stunted tillers are some of the first signs. Symptoms worsen as the weather warms. Leaves on the infected plants turn yellow from the tip down, but usually the leaf veins remain green the longest. This gives the appearance of a striped yellow and green leaf, if the leaf is able to unfurl completely at all.

While there is no chemical treatment for WSMV, there are management options to limit your risk. Controlling volunteer wheat is essential, both for yourself and your neighbors. Volunteer wheat provides a "green bridge" through the summer between successive wheat crops, and that green bridge is the perfect home for wheat curl mites, the only known vector of WSMV. The volunteer wheat must be thoroughly destroyed for no fewer than two weeks in order to eliminate the wheat curl mites. Kansas winds are the preferred mode of transportation for wheat curl mites, so volunteer must be killed within ¼ to ½ mile of a newly planted field.

Another control option is to avoid early planting. It's recommended to wait until after the "fly-free" date for WSMV control. Plant varieties with resistance to the virus or the curl mite. While no variety currently has high resistance to WSMV, many varieties do have a partial resistance. In

addition, the Kansas Wheat Commission funded research into developing a trait, WSM3, that is highly resistant to both wheat streak mosaic and triticum mosaic viruses.

Undoubtedly, the best method to control WSMV is controlling the volunteer wheat. Be a good steward, and a good neighbor, when making these management decisions, and you might just be rewarded with a boost of bushels on your next wheat crop.

Wheat Streak Mosaic Virus infection in Wichita County, Kansas.
Photo by Alec Horton, Horton Seed Services.

https://kswheat.com/news/western-kansas-hit-by-wheat-streak-mosaic-virus

How to Submit a Field Crop Sample to the K-State Plant Disease Diagnostic Lab

It is important to send the KSU Plant Diagnostic Lab an excellent sample so as to provide you with the best service possible concerning your valuable crop. Following are some guidelines to help you in selecting and preparing your sample.

1) Fill out the sample submission form

The more information you can provide on the sheet, the better. If you are not sure what an item means, feel free to give us a call and we can help you fill it out over the phone. It is especially important to know:

- When the problem first occurred.
- How widespread it is – are there other plants that are also declining in the area? Do they share the same symptoms? Are they the same species? Include crop variety whenever possible.
- Describe the symptoms as the sample's appearance may change in shipment.
- What has the weather been like lately?
- How often the crop is irrigated.
- Properties of the soil or media the crop is being grown in, such as drainage and pH.
- Summarize any applications of pesticides or fertilizers during the current season.

Please do not send payment with your sample as you will receive an invoice later.

2) Choose the right sample. Try to send the entire plant when possible, including roots and soil contained around the root ball. Carefully dig up the sample rather than pulling the plants out of the ground. Choose plants that are declining, rather than ones that are already completely dead. Try to pick from the leading edge (where the disease is spreading out).

3) Take a large enough sample. A single plant is not adequate to represent an entire field. Send in as many whole plants are you can. It may be beneficial to send both a 'Good' and a 'Bad' sample for comparison. Sending in as much plant material as possible is going to result in a higher quality diagnosis. Photos showing field patterns can be sent with a sample or emailed to clinic@ksu.edu. Please specify on your submission sheet and within your email that the photos are linked with your sample.

4) Pack it up nicely. Put the sample into a plastic bag as soon as it is collected to prevent the leaves from drying out. Take note not to place the submission form or any other stationary in the bag with the sample as it may be damaged in the shipping process. Staple it to the outside of the bag so that it arrives in good shape.

5) Send it promptly. Expedited shipment is recommended. Do not send your samples on a Friday. It is recommended that they be sent between Monday and Wednesday. Samples sent later than Wednesday will often sit in a hot mail distribution site over the weekend and will literally become cooked by the heat or simply ferment due to lack of oxygen. Samples can be taken directly to your local K-State Research and Extension office, or mailed directly to:

Plant Disease Diagnostic Lab
1712 Claflin Rd
4032 Throckmorton
Kansas State University
Manhattan, KS 66506

6) Be patient. For many diseases, it is necessary to perform tests that have wait times or incubation periods associated with them. Unfortunately, a stressful situation cannot speed up chemical or biological reaction rates, so take a deep breath and relax! You should receive some feedback within a week to two weeks. To check status the status of your sample, you may call us at **(785) 532 – 5810** M-F, 8a-5p, CST.

This is an example of a good crop sample to submit. The entire plant was sent in, including the roots. Ideally, there would also be some soil from around the roots included.

Prepared by Jesse Ostrander, M. S. student, and Judy O'Mara, Director of the Diagnostic Clinic, 2010