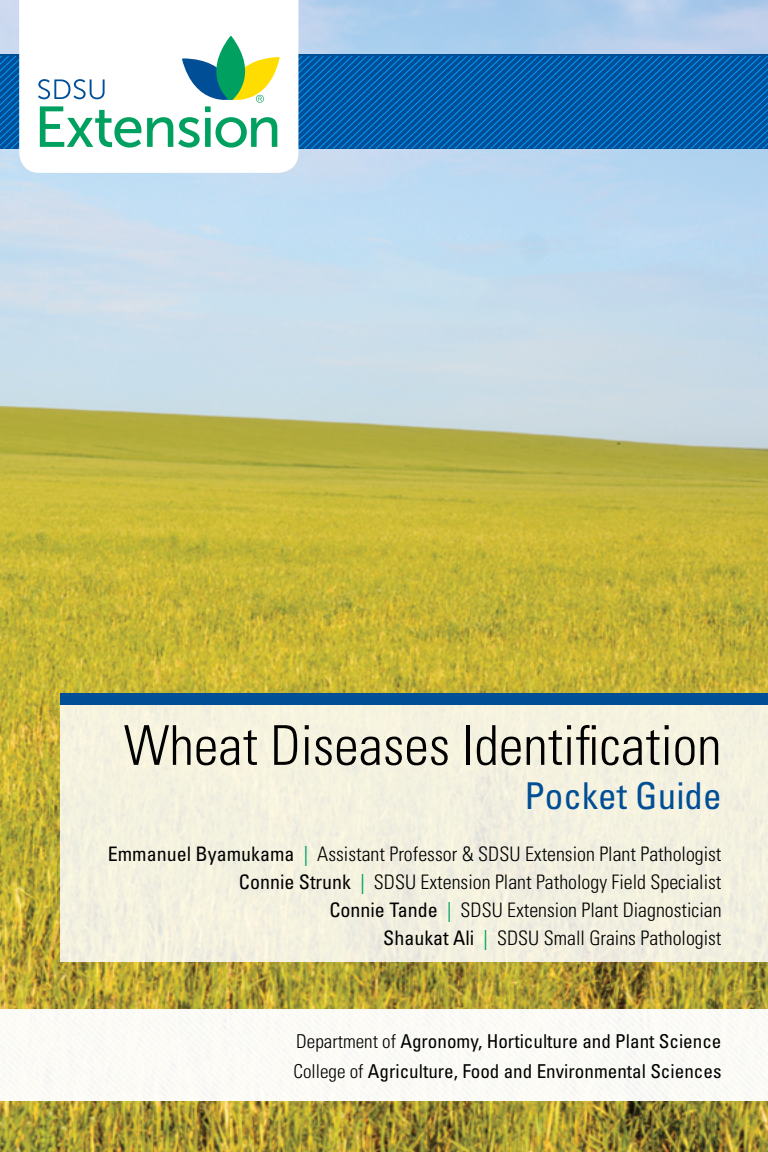

Wheat Diseases Identification

Pocket Guide

Emmanuel Byamukama | Assistant Professor & SDSU Extension Plant Pathologist

Connie Strunk | SDSU Extension Plant Pathology Field Specialist

Connie Tande | SDSU Extension Plant Diagnostician

Shaukat Ali | SDSU Small Grains Pathologist

Department of **Agronomy, Horticulture and Plant Science**

College of **Agriculture, Food and Environmental Sciences**

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Introduction

Accurate plant disease identification is the first step in designing effective and sustainable disease management programs. The purpose of this guide is to provide information on how to recognize wheat diseases and also to provide possible management options.

Scouting for wheat diseases

Scouting provides information from which economically feasible and environmental friendly management practices can be applied. Field scouting is conducted to: 1) diagnose diseases developing; 2) determine severity of the disease; 3) determine the need for treatment; and 4) assess the effectiveness of previous/applied control strategies. When planning to scout, note the current and forecasted weather conditions, wheat growth stage, agronomic practices (variety planted, time of planting) and field history. A wheat disease-scouting calendar (pg 19) provides an estimated period when certain wheat diseases are likely to develop.

In-season plant disease management

Fungicides are the only in-season plant disease management practice for managing fungal diseases. However diagnosing diseases even when no in-season treatments can be done is important for future seasons. Fungicides can be effective against fungal diseases; however, timing and application of specific active ingredients are important in order to realize the benefits of a fungicide application. Wheat fungicide management practice is most economical when:

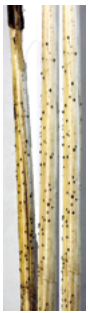
- Fungicides are used to manage actual disease risk rather than as a prescriptive ("insurance") application without a risk assessment; and
- Fungicides are used as part of an integrated disease management strategy and not when they are the only management method.

Integrated disease management

Well-adapted disease resistant or tolerant varieties should be combined with good cultural practices such as crop rotation, disease-free seed, control of weeds and volunteer wheat, and optimal planting dates. A fungicide should be used after scouting and when fungal disease pressure under current and forecasted weather indicates continued disease development. The best timing for fungicide application in wheat is at flag leaf, because the flag leaf contributes up to 75% to the grain yield. However, where there is an early onset of fungal diseases such as stripe rust or powdery mildew and where wheat is planted into wheat stubble, an early fungicide tank-mixed with a herbicide may be necessary. To avoid chances of fungicide resistance development, rotate fungicide modes of action within and between seasons, and apply fungicides only when warranted.

Tan Spot

Caused by: *Pyrenophora tritici-repentis*
Disease period: Throughout the growing season
Occurrence: Widespread
Impact on yield: Low to moderate



Left Photo: Tan spot symptoms on leaves. Right Photo: Tan spot resting spores on wheat straw. *(Photo credits: E. Byamukama)*

Symptoms and source of inoculum: Tan spot produces tan to brown lesions on the leaves. Lesions can vary from 1/8 of an inch to ½ of an inch in length and 1/16 of an inch to 1/18 of an inch wide. Lesions are often referred to as "lens-shaped" and are surrounded by a distinctive yellow halo with a small dark spot in the center. Tan spot lesions can coalesce, leading to larger areas of the leaf which are killed. In advanced cases, tan spot can develop on spikes and some bleaching of the spikes may be visible and the kernels will turn dark red. This change in color is known as red smudge. Red smudge usually develops under prolonged wet periods or high humidity during kernel development. Tan spot is usually more severe on lower leaves and then progresses upward. The tan spot pathogen survives on wheat stubble and inoculum can also come from wild grasses. The tan spot pathogen can infect wheat under a wide range of temperatures but requires at least 6 hours of leaf wetness.

Management:

- Select tolerant varieties.
- Remove or reduce residues infested with tan spot through tillage (where practical) or bailing wheat straw.
- Practice crop rotation to reduce the inoculum level within the field. Rotate wheat with broad leaf crops.
- Use clean-disease free seed.
- Apply a foliar fungicide when disease pressure is high.

Powdery Mildew

Caused by: *Blumeria graminis f. sp. tritici*
Disease period: Throughout the growing season
Occurrence: Widespread
Impact on yield: Low to moderate

Powdery mildew symptoms on wheat *(Photo credit: E. Byamukama)*

Symptoms and source of inoculum: Powdery mildew starts as raised, white, powdery spots on the lower leaves. The powdery mildew pathogen survives the winter in plant debris left on the field. Secondary infection from conidia, a type of asexual spore, can occur when these spores are blown by wind to other plants. Temperatures between 60-70°F with damp weather are favorable for powdery mildew buildup. Disease development is slowed when temperature is higher than 77°F. High planting rate and high fertility increase the humidity within the lower canopy and these conditions favor powdery mildew development.

Management:

- Plant wheat varieties with resistance/tolerance to powdery mildew.
- Practice crop rotations to reduce the risk of powdery mildew infection.
- Avoid over fertilization with nitrogen fertilizers. Use a balanced soil fertility program.
- Apply a timely fungicide if disease pressure warrants it.

Rusts
Leaf Rust

Caused by: *Puccinia triticina*
Disease period: Mid to late season
Occurrence: Widespread
Impact on yield: Low to moderate

Leaf rust pustules on a wheat leaf *(Photo credit: E. Byamukama)*

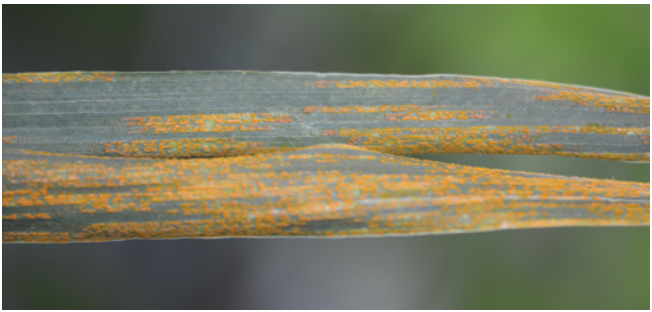
Symptoms and inoculum source: Leaf rust pustules are orange to dark reddish-brown, raised, and small (usually 1 mm or less in size), often found on the upper leaf surface. You can distinguish rust pustules from other leaf spot diseases by rubbing (smearing) your finger on the leaf surface which leaves a brownish color on the finger. The leaf rust pathogen does not overwinter in the northern states, and for the disease to start in any given year, new inoculum must be introduced from the southern states. Light rain, high humidity, or heavy dew and temperatures ranging between 59° and 77° are ideal for leaf rust development. Leaf rust continues to spread by means of wind-blown uredospores (from plant to plant and from field to field) until the wheat matures.

Management:

- Plant varieties with resistance to leaf rust.
- Apply a fungicide if the disease is established in the crop canopy and when weather favors rust development prior to wheat heading. Crop rotation or other cultural practices are not effective against rust diseases.

Stripe Rust

Caused by: *Puccinia striiformis f. sp. tritici*
Disease period: Throughout the season
Occurrence: Widespread
Impact on yield: Low to moderate, severe if infection takes place early



Stripe rust on wheat *(Photo credit: E. Byamukama)*

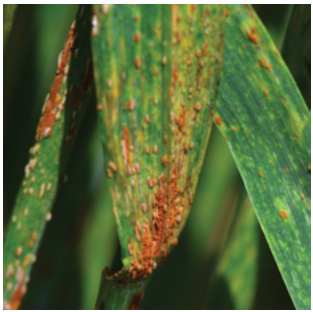
Symptoms and sources of inoculum: Small, yellow-orange pustules arranged in rows (stripes) on the leaves of wheat. Rows of pustules often resemble sewing machine stitches. Cool, wet weather favors stripe rust development. Rapid disease development occurs between 50° and 60°F when moisture is available, while temperatures over 68°F for several days in a row inhibits disease development. Stripe rust needs a green host (wheat, perennial grassy weeds) to survive and has been known to overwinter under snow cover as dormant mycelium in our region. However, stripe rust inoculum blowing into South Dakota from southern states in the spring plays an important role in the disease development.

Management:

- Plant resistant cultivars.
- Apply a fungicide if weather promotes stripe rust development and wheat has not reached flowering. Scout often.

Stem Rust

Caused by: *Puccinia graminis f. sp. tritici*
Disease period: Late season
Occurrence: Widespread
Impact on yield: Low to moderate, severe if the cultivar is susceptible



Stem rust on wheat stems (left) and leaves (right). *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Stem rust forms large orange to red oval shaped pustules on stems, leaves, and leaf sheaths of infected plants. At times, pustules can also be seen on awns, glumes, and spikelets. Stem rust causes conspicuous tears in the epidermal tissues of infected plants. Towards the end of the wheat growing season, stem rust pustules will form black spores called teliospores. With increasing severity, lesions can weaken the stem, causing lodging and prematurely ripened grain.
Like leaf and stripe rusts, stem rust spores are carried by the wind to the northern states (Puccinia pathway). Stem rust develops under warmer conditions (79-86°F) and 6-8 hours of free moisture (dew) on leaves.

Management:

- Plant stem rust resistant cultivars. New rust races develop most of the time. For example, a new race of stem rust called Ug99 currently found in Africa and the Middle East can overcome all known stem rust resistance genes. If a previously resistant cultivar is found with moderate level of a rust disease, this could mean that this resistance gene is no longer effective.
- Apply a well-timed fungicide to provide protection against yield loss caused by cereal rusts. Scout often.

Stagonospora Leaf and Glume Blotch

Caused by: *Parastagonospora nodorum* (formerly known as *Stagonospora nodorum*, *Septoria nodorum*)
Disease period: Mid to late season
Occurrence: Widespread
Impact on yield: Low to moderate

Stagonospora leaf and glume blotch symptoms *(Photo credit: (left) E. Byamukama, (right) Erik Stromberg, Virginia Polytechnic Institute and State University, Bugwood.org)*

Symptoms and sources of inoculum: Small lesions begin on the lower leaves as irregular water soaked patches that will eventually develop into lens-shaped lesions with dark brown borders. As the lesions expand, the centers will become lighter, necrotic, and take on the shape of a lens. Mature lesions have small black dots (pycnidia) fungal fruiting bodies which can be visible with a magnifying glass or hand lens. The fungus can also infect the wheat head causing purple-brown blotches on the glumes starting at the glume tip.

This pathogen overwinters on volunteer plants and on wheat stubble from the previous season. Seed can also be the source of inoculum. Wet (12-18 hours of continuous free moisture) and warm weather are optimal for infection. Optimal temperatures range from 68°F to 81°F. For this reason, this disease develops at a higher rate around the time of heading.

Management:

- Plant varieties with resistance/tolerance to leaf and glume blotch.
- Practice crop rotation. A three-year crop rotation with two years of non-cereal crops is recommended.
- A foliar fungicide timed at flag leaf emergence is effective against Septoria/ Stagonospora nodorum blotch.

Root Rot Diseases

Common Root Rot

Caused by: *Bipolaris sorokiniana* (also called *Cochliobolus sativus*)
Disease period: Early, but symptoms obvious after heading
Occurrence: Localized
Impact on yield: Low

Common root rot on wheat plants *(Photo credit: E. Byamukama)*

Symptoms and source of inoculum: Common root rot pathogen causes dark brown lesions on the subcrown. These lesions will eventually spread to encompass the entire subcrown internode. Severe infection can lead to pre-mature ripening of the wheat head. But most of the time this disease goes unnoticed when tillers are not prematurely killed. Mildly infected plants have few tillers and may be stunted. The disease is favored by dry, droughty conditions. The common root rot pathogen survives in wheat residue and in soil.

Management:

- Crop rotation with a broadleaf crop such as sunflower, canola, soybean, etc.
- Plant resistant varieties.
- Use fungicide seed treatment where fields have a history of poor seedling emergence and root and crown rots.

Fusarium Foot and Crown Rot

Caused by: *Fusarium spp.* (mainly *F. graminearum*)
Disease period: Early, but symptoms obvious after heading
Occurrence: Localized
Impact on yield: Low

Fusarium foot and crown rot symptoms on the lower node of stem (left), A leaf sheath removed from an infected stem showing the pinkish color, a sign of the pathogen (right). *(Photo credit: Heather Kelly)*

Symptoms and sources of inoculum: Fusarium crown and foot rot can develop from the roots and progress up to the lower nodes. Roots are often brown, the subcrown internode is discolored, and a chocolate brown or reddish-brown lesion often extends up the plant stem. A pink, cottony fungal growth may sometimes be found in the interior of the lower stem when it is split open. Fusarium foot rot also produces sterile white heads and premature plant death. The severity of this disease is also worsened by prolonged drought and dry conditions. Source of inoculum for this disease is infested residue.

Management

- Crop rotation with a broadleaf crop such as sunflower, canola, etc.
- Plant tolerant varieties.
- Use fungicide seed treatment where fields have a history of poor seedling emergence and root and crown rots.

Take-all Root and Crown Rot

Caused by: *Gaeumannomyces graminis* f. sp. *tritici*
Disease period: Early, but symptoms obvious after heading
Occurrence: Localized
Impact on yield: Low

Take-all symptoms on wheat lower nodes and roots *(Photo credit: E. Byamukama)*

Symptoms and source of inoculum: Roots, crowns, and lower nodes have a shiny black discoloration. White heads are often observed on infected plants at or after heading. Under severe infection, plants are stunted and ripen prematurely and these are usually found in low laying areas of the field. The Take-all pathogen survives on infested residue and in soil.

Management:

- Crop rotation with a broadleaf crop such as sunflower, canola, soybean, etc.
- Plant tolerant varieties.
- Improve drainage.

Head Diseases

Fusarium Head Blight or Scab

Caused by: Mainly *Fusarium graminearum*
Disease period: After heading
Occurrence: Widespread
Impact on yield: Moderate to high

Fusarium head blight (FHB or scab) symptoms on wheat plants *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Bleaching of spikelets on the whole or parts of the head. Pink or orange-red spore masses are sometimes visible at the base of the glumes, especially during long periods of high humidity. The kernels from infected spikelets will be shriveled, and are often discolored, ranging from pink to gray to light brown. These kernels accumulate high levels of the mycotoxin, deoxynivalenol (DON). Scab infection is favored by warm (75° - 85°F), wet weather two weeks before flowering and continuing through the flowering period. Fusarium spp. overwinter as fruiting fungal structures known as perithicia on crop residue from the previous growing season.

Management:

- Plant moderately resistant varieties.
- Practice crop rotation. Corn and other small grains are also hosts for the FHB pathogen.
- Apply a timely triazole fungicide. Consult the FHB risk assessment tool to decide on the need for a fungicide. http://www.wheatscab.psu.edu/riskTool_2011.html, https://climate.sdstate.edu/tools/smallgrains/

Loose Smut

Caused by: *Ustilago tritici*
Disease period: After heading
Occurrence: Widespread
Impact on yield: Very low

Loose smut symptoms on wheat *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Loose smut of wheat is observed as masses of black spores in place of the glumes and kernels on the head. Often, only the rachis remains after the spores are released. The fungus survives on the embryo of wheat seeds and grows inside the plant after seed germination. Spores from affected heads can be blown onto non-affected heads and cause infection during wheat flowering, allowing the fungus to grow into the developing seed.

Management:

- Plant resistant cultivars.
- Use clean disease-free seed.
- Use a systemic fungicide seed treatment for seed harvested from infected fields.

Common Bunt or Stinking Smut

Caused by: *Tilletia tritici* and *T. laevis*
Disease period: After heading
Occurrence: Localized
Impact on yield: Moderate

Wheat kernels filled with spores of common bunt pathogen spores. *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Infected plants often produce fewer and smaller heads than normal ones, and the heads of diseased plants are generally dark green and retain their green color longer than healthy heads. Diseased heads tend to have a more open appearance due to the expanding of the smutted kernels which causes a spreading of the glumes. In heads infected with common bunt, the outer hull of the kernels will remain intact, but the inside of the kernel will be replaced with brown or black spores that have a fishy odor. During harvest and handling, the bunt balls will break open and contaminate healthy seeds with the spores, as well as spread the spores and odor throughout the seed lot.

Common bunt is normally a seed-borne disease, but the pathogen can also survive in the soil and infect otherwise healthy, emerging seedlings. Smut spores that are adhered to infected kernels germinate at the same time as the wheat seed germinates, and the fungus invades the coleoptile before emergence. The fungus invades the young tissues and becomes established in the tissues that eventually develop into the head.

Management:

- Plant disease-free seed, preferably certified seed.
- Use fungicide seed treatments.
- Planting winter wheat early (when soil temperatures are above 60 degrees F) and spring wheat when soils have begun to warm may allow the seedlings to outgrow the fungus and escape infection. Planting winter wheat too early may also pose an increased risk of virus diseases and excess growth which may cause moisture stress.

Ergot

Caused by: *Claviceps purpurea, Claviceps paspalli* and *Claviceps fusiformis*
Disease period: After heading
Occurrence: Localized
Impact on yield: Low

Ergot bodies in wheat heads *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Purple-black, hornlike sclerotia (ergot bodies) replace one or more seeds in the head. Infected florets exude a sugary slime in sticky yellow droplets. The pathogen survives as a hardened fungal mass called ergot bodies, and in spring, wet, cool weather stimulates the ergot bodies lying on the soil surface or slightly buried in the soil to produce spores that can infect the florets of wheat, rye, triticale, barley, oats and wild oats, as well as some grasses. An ergot body can survive for approximately one year in or on the soil, but for several years in dry storage. Ergot bodies from previous seasons or from grass are the source of inoculum.

Management:

- Plant seed free of sclerotia. Certified seed can have no more than 2% maximum ergot sclerotia for the registered class and no more than 3% for the certified seed class.
- A triazole fungicide seed treatment may inhibit germination of ergot.

Bacterial Disease

Bacterial Leaf Streak/ Black Chaff

Caused by: *Xanthomonas tranclucens pv. undulosa*
Disease period: Flag leaf
Occurrence: Widespread
Impact on yield: Low to moderate



Bacterial leaf streak symptoms *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: Infection starts as water soaked streaks or spots on the surface of upper leaves which is then followed by a shiny glaze. Olive green translucent streaks will develop into yellow-brown streaks. Brown, dry spots begin to emerge on the surface of the leaf, usually beginning at the tip of the leaf or in the middle of the leaf. In infected plants, black chaff can be present in the head and glume. Black chaff occurs when the bacteria invade the glumes during grain fill and cause dark purple or black streaks and spots on the exterior of the glume, hence the name black chaff.

The bacteria can survive on seed, debris and in soil. Inoculum is splashed during rainfall onto healthy tissues. The bacteria enter the host plant through stomatal openings or wounds. Droplets of bacterial ooze during high humidity periods may act as inoculum for secondary infection. The disease can develop under a relatively wide range of temperature (59-86°F) and humidity levels. Infection is enhanced by frequent rainfall and warm temperatures.

Management:

- Use certified, pathogen-free seeds.
- Plant resistant varieties.
- Control volunteer cereal and grassy weeds around the wheat field to reduce the inoculum pressure on the field.

Viral Diseases

Wheat Streak Mosaic Virus

Caused by: *Wheat Streak Mosaic Virus* (WSMV)
Disease period: Throughout the season
Occurrence: Widespread
Impact on yield: Low to severe

Wheat Streak Mosaic symptoms *(Photo credit: E. Byamukama)*

Symptoms and sources of inoculum: The most common symptoms of WSMV are stunted growth and yellowing. Infected plants will show yellow and green streaks parallel to the leaf veins. Leaves will curl inwards and young leaves get "trapped" due to the presence of a high population of wheat curl mites, the vector of WSMV. Symptom severity can vary based on the cultivar of wheat, time of infection (fall vs spring infection), and environmental conditions. Warm fall and dry and warm spring increase symptom severity.

WSMV is spread between winter wheat crops by wheat curl mites (WCMs) moving off volunteer wheat and grassy weeds to the emerging winter wheat in the fall and from winter wheat, volunteer winter wheat or grassy weeds to the spring wheat in spring. The WCMs are not visible to the human eye. When observed under a microscope, the mites resemble small, white grains of rice with two pairs of legs near the head. The mites rely on the wind for transportation from plant to plant. Warm temperatures are optimal for mite reproduction. Temperatures near freezing will stop reproduction, but will not kill the mites. WCMs overwinter near the growing point of winter wheat or in perennial grasses as eggs, nymphs or adults. Spring wheat infection is heavily dependent on the survival of mites during the winter.

Management:

- Destroy volunteer wheat and grasses at least two weeks before planting a new crop.
- Avoid early planting in areas with history of WSMV. Winter wheat planting should be delayed until after mid to late September for optimum WSMV control.
- Plant wheat cultivars tolerant to WSMV.

Barley Yellow Dwarf Virus

Caused by: *Barley Yellow Dwarf Virus (various strains)*
Disease period: Throughout the season
Occurrence: Localized
Impact on yield: Low

Barley Yellow Dwarf symptoms on wheat *(Photo credit: E. Byamukama)*

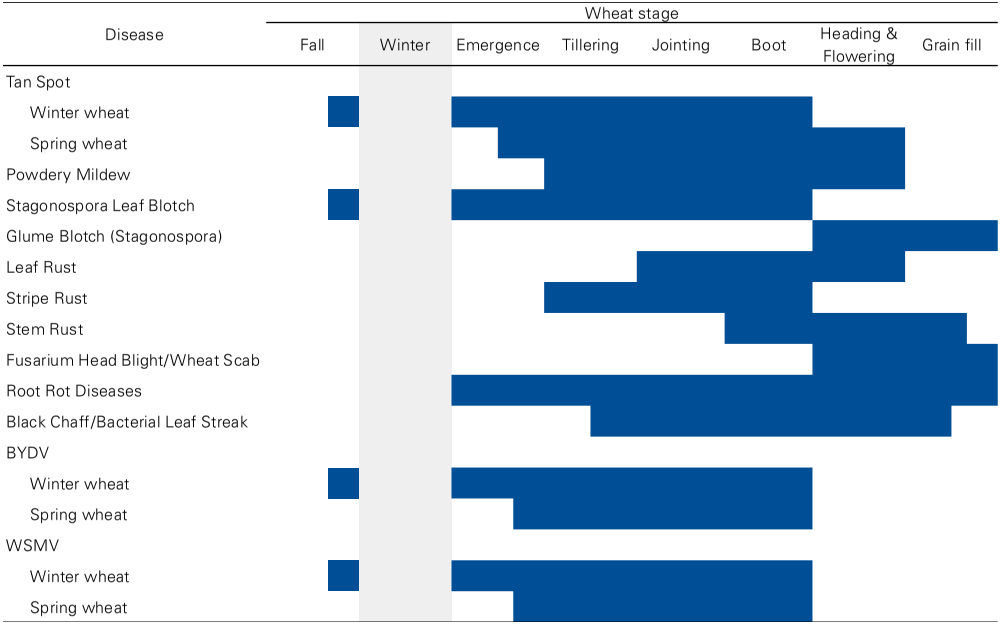
Symptoms and source of inoculum: Symptoms of Barley Yellow Dwarf Virus (BYDV) can vary based on the strain of virus present, the cultivar, environmental conditions, and the growth stage at which plants become infected. Typical BYDV symptoms include yellow, purplish-red discoloration of leaves, usually the flag leaf. Depending on the time of infection, the symptomatic flag leaf may start to die from the leaf tip. Other common symptoms include upright and stiff leaves, serrated leaf borders, reduced tillering and flowering, small grain heads, and an inability to fill the grain. If plants are infected very early in the season, severe stunting may occur and yield is most likely to be significantly impacted.

Barley yellow dwarf virus is vectored by different aphid species. The virus is not seed-borne, therefore the only means of virus spread is through these aphid vectors. The aphids acquire the BYDV as they feed on infected plants and transmit it to healthy plants as they feed within a field or when they are emigrating from other fields and hosts. BYDV can survive between crop cycles in volunteer wheat, barley, oats and several grass weed hosts, or in winter sown cereals.

Management:

- Plant winter wheat after the migration season of bird cherry-oat aphid to reduce the risk of early BYDV/CYDV infection. Generally, planting winter wheat after September 15 reduces infestation of aphids and subsequent BYDV/CYDV infections.
- Plant varieties with low susceptibility against BYDV.
- Insecticide seed treatments may be a good strategy when winter wheat needs to be planted early.

Wheat disease scouting calendar for South Dakota.



Management of Small Grain Diseases
2018 Fungicide Efficacy for Control of Wheat Diseases

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products and is not intended to be a list of all labeled products.

Fungicide(s)				Efficacy of fungicides for wheat disease control based on appropriate application timing								
Class	Active ingredient	Product	Rate/A (fl. oz)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab[4]	Harvest Restriction
Strobilurin	Picoxystrobin 22.5%	Aproach SC	6.0-12.0	G[1]	VG	VG[2]	VG	E[3]	VG	VG	NL	Feekes 10.5
	Fluoxastrobin 40.3%	Evito 480 SC	2.0-4.0	G	--	--	VG	--	VG	--	NL	Feekes 10.5 40 days
	Pyraclostrobin 23.6%	Headline SC	6.0-9.0	G	VG	VG[2]	E	E[3]	E	G	NL	Feekes 10.5
	Metconazole 8.6%	Caramba 0.75 SL	10.0-17.0	VG	VG	--	VG	E	E	E	G	30 days
Triazole	Tebuconazole 38.7%	Folicur 3.6 F5	4.0	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41% Prothioconazole 19%	Proline 480 SC	5.0-5.7	--	VG	VG	VG	VG	VG	VG	G	30 days
	Tebuconazole 19%	Prosaro 421 SC	6.5-8.2	G	VG	VG	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC45	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4
Mixed modes of action[5]	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima SC	3.4-6.8	VG	VG	VG	VG	E	VG	--	NR	45 days
	Fluoxastrobin 14.8% Flutriafol 19.3%	Fortix	4.0-6.0	--	--	VG	VG	E	VG	--	NL	Feekes 10.5 40 days
	Fluapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	Nexicor EC	7.0-13.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0-8.0	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE	10.5-14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4

Management of Small Grain Diseases
2018 Fungicide Efficacy for Control of Wheat Diseases

Fungicide(s)				Efficacy of fungicides for wheat disease control based on appropriate application timing								
Class	Active ingredient	Product	Rate/A (fl. oz)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab[4]	Harvest Restriction
Mixed modes of action[5]	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Benzovindiflupyr 2.9% Propiconazole 11.9%	Trivapro SE	9.4-13.7	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4 14 days
	Azoxystrobin 10.5% Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0-9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5

[1] Efficacy categories: NL=Not Labeled; NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; -- = Insufficient data to make statement about efficacy of this product.
[2] Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.
[3] Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.
[4] Application of products containing strobilurin active ingredients may result in elevated levels of the mycotoxin Deoxynivalenol (DON) in grain damaged by head scab.
[5] Multiple generic products containing the same active ingredients also may be labeled in some states.
[6] Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Nexicor, Priaxor and the Trivapro include carboxamide active ingredients.