PP-1249

Tan Spot and Septoria/Stagonospora Diseases of Wheat

Causal Organisms • Symptoms • Survival and Spread • Management

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Severe epidemics of these leaf spot diseases result in a disappointing harvest, when the grower finds that yields and bushel weights are much less than expected.

Causal Organisms

Fungal leaf spot diseases of wheat are common in North Dakota and, in some years, cause severe economic losses in yield and quality. NDSU-sponsored wheat disease surveys have shown tan spot, caused by the fungus *Pyrenophora tritici-repentis*, to be the most common leaf disease. It is found in all wheat classes throughout the growing season across North Dakota. The Septoria/Stagonospora leaf disease complex also is common in wheat in North Dakota each year. The infections by the Septoria fungi are most evident in North Dakota wheat following flag leaf emergence, although infection may occur earlier. Several pathogens make up the Septoria leaf disease complex: *Septoria nodorum* (this pathogen is now called *Stagonospora nodorum* or *Leptosphaeria nodorum*), *Septoria tritici* also called *Mycosphaerella graminicola*) and *Stagonospora avenae* f. sp. *triticea*. These fungi are collectively called Septoria blotch, Septoria leaf spot, Septoria glume blotch, or the Septoria complex.

Generally speaking, years with good moisture favoring crop production also favor the development of tan spot and the Septoria leaf disease complex. Severe epidemics of these leaf spot diseases result in a disappointing harvest, when the grower finds that yields and bushel weights are much less than expected.

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota 58105
NOVEMBER 2003

Symptoms

Leaves

The tan spot fungus produces oval or diamond-shaped to elongated, irregular lesions (spots) that are initially 1/8 to 1/2 inch long and 1/16 to 1/8 inch wide. On susceptible wheat varieties, they enlarge and develop a tan color with a yellow border and a small dark brown spot near the center **(Figure 1)**. The dark spot is best observed by holding the leaf up to the light. This pattern of a tiny dark spot in a tan lesion and a narrow-to-broad yellow border produces an "eyespot" type of symptom. In early-season infections of tan spot, the yellow border is usually distinctive **(Figure 2)**. As more lesions develop on the leaf, the spots tend to join together, producing large, irregular areas of dead tissue **(Figure 3)**. Destruction of large areas of leaf tissue reduces yields and lowers test weight.

Stagonospora nodorum and *Septoria tritici* also cause distinct symptoms on leaves. The first symptom of disease is small chlorotic (yellowed) lesions on the lower leaves of the plant. The lesions initially appear water-soaked but as they dry they become yellow and eventually red-brown. **Septoria leaf disease complex lesions are generally lens-shaped**, without the distinct yellow border typical of tan spot lesions **(Figure 4)**. As the disease progresses, the center of the lesions

Figure 1. Illustration of a typical tan spot infection on wheat leaves; note dark brown spot in center and yellow halo.

Figure 2. Tan spot lesions on leaves of wheat seedlings.

Figure 3. Tan spot lesions on upper leaves of headed plants.

Figure 4. Lens-shaped lesions with ashen-gray centers, typical of infections by fungi in the Septoria complex.

develop an ashen gray-brown center with brown to black specks in it. These small, globular specks are pycnidia, the asexual reproducing structure of the fungus, and one of the best diagnostic indicators of a septoria disease. The specks are distinctly black in *S. tritici*, but those of *S. nodorum* are less distinct in color, more tan to reddish-brown.

Grain head

Red smudge caused by the tan spot fungus

The tan spot fungus can infect the head and cause discoloration of the glumes and the kernels. Although tan spot leaf infections are common in North Dakota, kernel infection is relatively uncommon in most years. Symptoms on the head are difficult to distinguish at maturity but may be characterized by bleached or brownish glumes. Infected kernels can have a reddish color on the seed coat; this kernel infection is called **red smudge (Figure 5)**. Red smudge is more visible in durum kernels than in hard red spring wheat.

Red smudge may resemble two other diseases which also cause pink to red kernel discoloration, Fusarium scab and bacterial pink seed. Of the three kernel diseases, Fusarium scab infection generally is the most common and most damaging to grain quality. Kernels infected with the Fusarium scab fungus are very lightweight, shriveled, often chalky in appearance ("tombstones") and may contain mycotoxins, while red smudge kernels generally retain their vitreousness and plumpness, are not chalky and do not contain mycotoxins. Bacterial pink seeds also remain plump and vitreous and can be distinguished from red smudge kernels by the uniform discoloration throughout the seed versus the "smudged" discoloration over the seed coat with red smudge.

The tan spot organism also is one of several fungi that cause a dark discoloration of the embryo tip of the kernel ("black point"). Black point causes dark specks in pasta products.

Red Smudge *Healthy* *Red Smudge*

Figure 5. Healthy durum and durum kernels with red smudge symptoms.

The red smudge and black point kernel symptoms are favored by prolonged wet periods and high humidities during kernel development. Infected seeds have lower germination and vigor than seed not infected with the tan spot fungus. Seedlings from infected seed can suffer from reinfection by the tan spot fungus under cool temperatures, but seeds are not considered an important factor in disease spread in North Dakota.

Glume blotch

Caused by fungi in the Septoria leaf disease complex

S. nodorum and S. avenae f sp *tritici* may cause a disease on the wheat head, commonly called **glume blotch**. Symptoms on the head resemble symptoms on the leaves but appear grayer and have a dull, dry appearance **(Figure 6)**. Glumes are often infected from the glume tip downward, and brown specks on the awns are sites of infection, too. Severe levels of glume blotch can completely decimate the head and cause severely **shriveled kernels (Figure 7)**.

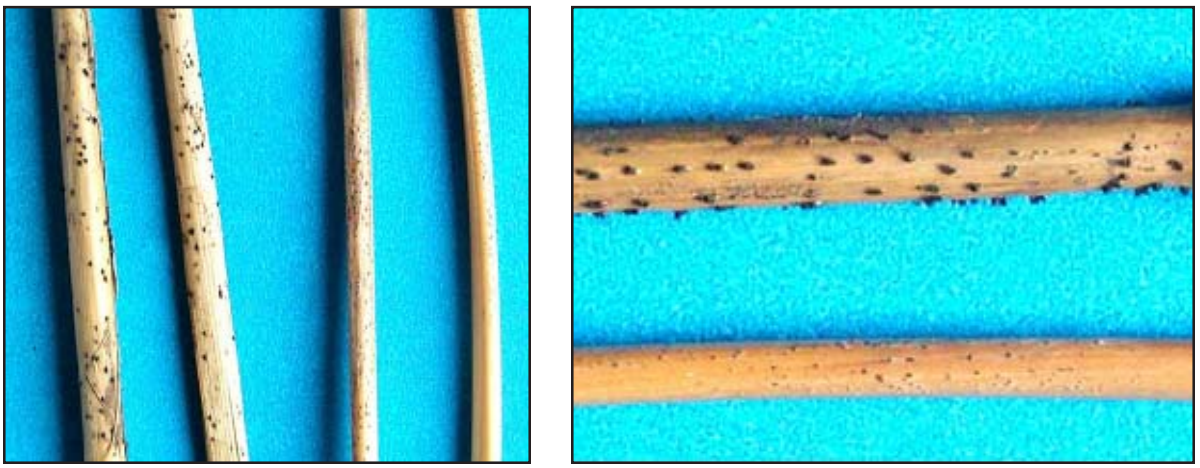
Bacterial infections of glumes also produce a brown discoloration of glumes, but the bacterial infections, called black chaff, generally begin as water-soaked spots on the glume which turn a shiny brown to purple in color.

Figure 6. Glume blotch caused by *Stagonosopora nodorum* infections. Note browning of glumes and brown infected spots on awns.

Figure 7. Shriveled durum kernels due to glume blotch (top), normal durum kernels (bottom).

Survival and Spread

Tan spot: The tan spot fungus survives and reproduces in standing wheat stubble and in wheat residue that is laying on the soil surface. The fungus produces black pinhead-sized **fruiting structures on the wheat residue (Figure 8)**. These are the sexual structures (pseudothecia), and they release sexual spores (ascospores) in spring and early summer. Asexual spores (conidia) also are produced as the season progresses, on the stubble and on older leaf spots. Both kinds of spores are carried by air currents to developing wheat plants in the same or nearby fields. Wheat planted into fields with wheat stubble or wheat residue is more likely to develop tan spot on seedlings and jointing plants than wheat planted into stubble of a different crop or in a clean, cultivated field. During wet growing seasons, which favor rapid buildup of tan spot, large numbers of asexual spores



Tan Spot *Septoria* *Top: Tan Spot* *Bottom: Septoria*

Photo credit: Carl Bradley, NDSU Extension Service

Figure 8. Fruiting bodies of the tan spot fungus and the Septoria fungal complex on wheat straw.

are in the air by heading time, as indicated in the **disease cycle diagram (Figure 9)**. These spores are wind dispersed. This high spore concentration in the air can result in development of severe tan spot epidemics under prolonged periods of rain or dew.

The tan spot fungus spores germinate and infect wheat over a wide range of temperatures if the leaves are wet for a long enough period. Severe spotting will occur if spores are on susceptible varieties and the leaves are wet for 12 hours, but severe spotting will not occur with wheats which are moderately resistant unless the leaves are wet for at least 18 hours. Almost all of our current wheats (hard red spring, hard red winter or durum) are severely spotted when many spores are present and extended periods (24 hours or greater) of rainy, misty or foggy weather allow the spores to germinate and infect the plants.

The fungus also causes spots and reproduces on about 50 species of native prairie and introduced forage grasses. The majority of forage grasses in the region are moderately resistant to resistant. The fungus causes only small dark spots on barley and oats, which are highly resistant.

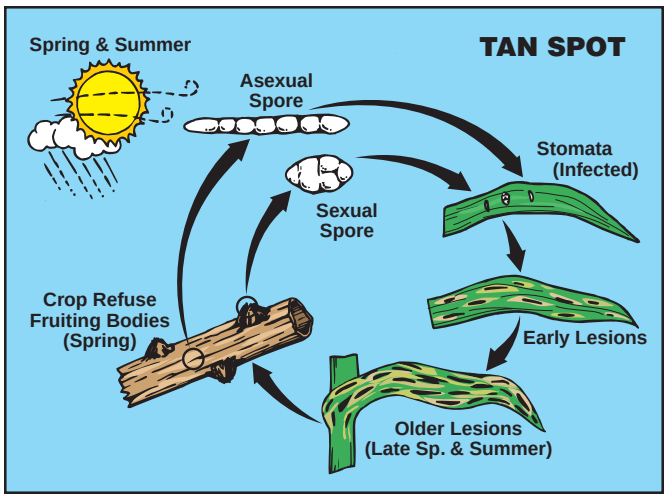


Figure 9. Disease cycle of the tan spot fungus.

The Septoria leaf disease complex

Fungi in this complex may overwinter as dormant vegetative strands, sexual reproductive structures (pseudothecia) or asexual structures (pycnidia) in wheat straw, seed or overwintering crops. The overwintering reproductive structures are similar in appearance to those of the tan spot fungus, only smaller **(Figure 8)**. The fungi may also overwinter on wild grasses, but they generally are not considered important sources of the fungi. From the overwintering reproductive structures, fungal ascospores are disseminated by wind and the asexual conidia are disseminated by rain in the spring and summer **(Figure 10)**. Infection sites are formed when the spores land on the leaves under appropriate environmental conditions. Once disease is established on the leaves, spores from the pycnidia are rain splashed to the higher leaves or the head of the plant, resulting in further,

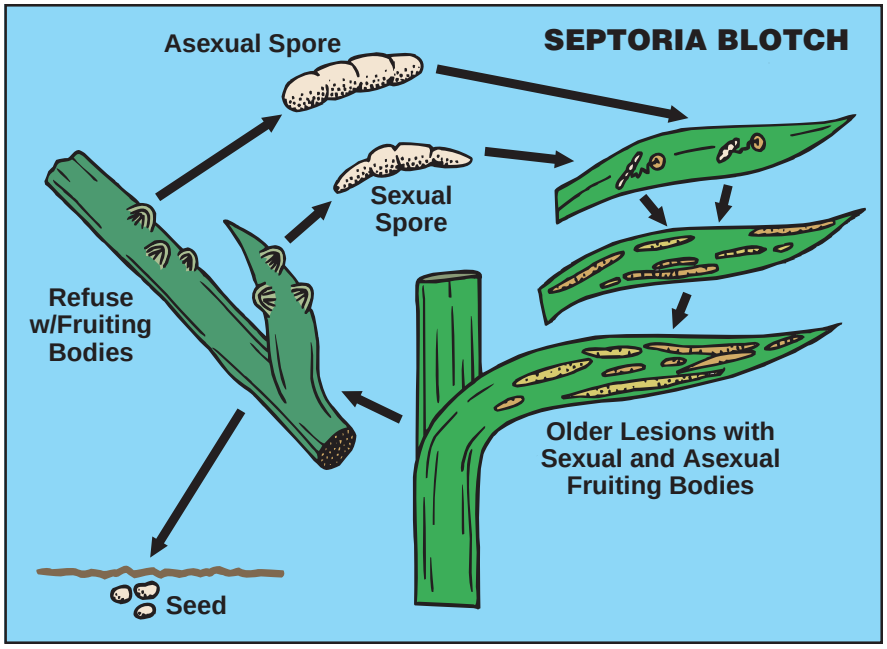


Figure 10. Disease cycle of Septoria/Stagonospora blotch.

more severe infection. After harvest, reproductive structures are left in the wheat residue and the disease cycle is continued the next year.

- Initial infection requires at least 12 hours of wetness. *S. nodorum* generally requires 12-18 hours ad *S. tritici* requires more than 24 hours of wetness.
- Septoria/Stagonospora diseases can occur between 41 and 95 degrees.
- *S. nodorum* is most destructive between 68 and 81 degrees; *S. tritici* is most destructive between 50 and 68 degrees.
- Inoculum can survive in infested residue for several years.

Management

Seed quality and seed treatment

Good quality seed that is free of red smudge or black point infections should be used for planting. Planting seed with fungal infections can result in reduced germination and poor seedling vigor. If grain with kernel infections is used for seed, various effective fungicide seed treatment products are available to reduce the risk of seedling diseases that might arise from planting a red smudge or Septoria infected seed.

Crop rotations and tillage

For tan spot and the Septoria complex diseases, crop rotations and burying wheat stubble by tillage can reduce the level of disease early in the season. Wheat disease surveys in North Dakota have recorded previous crop history, and where small grains were the previous crop, tan spot and the Septoria leaf spot complex always were more prevalent than if a broadleaf crop had previously been grown.

Where rotation is possible, particularly in reduced tillage farming, mustard, crambe, flax, soybeans, millet or buckwheat furnish stubble free of these wheat leaf spot fungi. Sunflower stubble is satisfactory from the standpoint of leaf disease control, but planting through the old stalks may be difficult. Oat and barley stubble also are satisfactory for leaf spot management, but barley can be a problem as it will carry over root rot fungi to a subsequent wheat crop.

Corn is not a host of these leaf spot fungi, but planting wheat into corn residue dramatically increases the risk of Fusarium head scab infection.

Potatoes, dry beans and sugarbeets leave little crop refuse to hold the soil but are satisfactory rotation crops for reducing wheat disease. If wheat is planted onto wheat ground,

burying the stubble by tillage may reduce tan spot early in the season. However, burying may have no effect on tan spot late in the season because of the spread of spores from other areas.

Burning the wheat stubble will reduce the amount of the leaf spot fungi in the field, but burning is not a recommended practice because it reduces organic matter. Burning and fall tillage leave the soil bare in the winter, and snow does not accumulate for soil moisture recharge. Serious wind erosion can occur on bare fields during dry, open winters. Spring tillage leaves the soil bare for a shorter time and will result in reduced fungal leaf spot inoculum. However, there is still a chance for erosion from wind or rain until the crop becomes established.

Varieties

Differences in fungal leaf spot susceptibility exist among durum and bread wheat varieties. Wheat growers are advised to consult reports of their nearest North Dakota State University research extension centers or the NDSU variety trial publications for current information about variety response to fungal leaf spot diseases. Disease resistance is one of many factors influencing variety choice.

Foliar fungicides

Wheat producers have a number of fungicide products available now that may be used to control tan spot and the Septoria leaf disease complex. Fungicides are available for both early season control of tan spot and for later season leaf spot control. NDSU research has shown two to six bushel yield responses with application of reduced rates of fungicide to wheat for control of early season tan spot when: 1) wheat was grown on wheat residue; 2) a susceptible to moderately susceptible variety was grown; and 3) when spring rains favored disease development.

Fungicide trials with late season application to control leaf spots on flag leaves have resulted in up to 20 percent yield improvements over the untreated check in years and locations where rainfall favored leaf disease development and a susceptible to moderately susceptible variety was grown. Late season application of fungicide protects the flag leaf and grain spike, which combined account for 70-80 percent of photosynthetic tissue to produce food for grain fill. Heading time application of these fungicides also will help control red smudge and glume blotch infections.

Some fungicide products are protectants, while others are locally systemic. The mancozeb fungicides (Dithane products, Manzate 200, Manex II, Penncozeb products, Manzate 75, etc.), and copper (Kocide, Champ) or combination products of mancozeb + copper (ManKocide) are protectant fungicides. To prevent infection, they must cover the leaf surface prior to spore arrival. A three- to five-day incubation period occurs before fungal leaf spot lesions appear, and application of a protectant fungicide during the incubation period (after spore infection) will not "cure" the developing disease and will not prevent the lesions from appearing. It is important that the application be made to healthy, green tissue.

Protectant fungicides, at the two lb./acre rate, generally should be applied as soon as the flag leaf has fully emerged. This is when you can feel the boot swelling near the top leaf; few beards may be starting to show on bearded varieties. A second application of fungicide should be made about seven to 10 days after the first application to provide continued protection of the flag leaf. Some growers choose to delay or eliminate the second spraying if the weather is not favorable for continued leaf disease development. Spreader-stickers are recommended for use with mancozebs to increase coverage and longevity. An early season application of one pound of mancozeb product at the five-leaf stage occasionally is applied in conjunction with herbicides, without an additional spreader-sticker. This treatment has resulted in yield responses during wet springs when wheat was planted in wheat stubble.

Propiconazole (Tilt, Bumper, Propimax, Contend) is a systemic fungicide registered for wheat, barley and rye leaf disease control. The federal label for propiconazole allows application only up through early flag leaf emergence (Feekes growth stage 8), but North Dakota 24C labels allow application of most propiconazole products on wheat up through heading (Feekes 10.5). The systemic activity of propiconazole provides both good protection

against fungal leaf spots and some curative activity against some established infections. Half (2 fl. oz.) the full label rate (4 fl. oz.) of propiconazole products has commonly been used to provide control of early season tan spot infections.

Two strobilurin fungicides and a combination strobilurin plus propiconazole fungicide also have registration on wheat for control of fungal leaf spot diseases. Strobilurins act as preventive and curative systemic fungicides. Quadris (azoxystrobin), Headline (pyraclostrobin) and Stratego (trifloxystrobin plus propiconazole) are registered for wheat (as of 2003). All have either federal or state registration allowing application through Feekes 10.5 heading. All have excellent activity against tan spot and the Septoria leaf spot complex. Half the full label rates have been used for early season tan spot control, while full label rates are applied to the flag leaf near Feekes 10.5 for maximum control of late season leaf disease development.

Foliar fungicides may be applied with aerial or ground equipment. Five gallons of water per acre are recommended for air; ground application generally requires 10-20 gallons water per acre.

Spray guidelines

Spraying with a foliar fungicide seldom results in an economic return if yield potentials are less than 40 bushels per acre. A fungicide may be planned into the crop budget when adequate moisture is available at the beginning of the cropping season and the wheat crop is to be fertilized for at least a 40-bushel yield. The fungicide can always be cancelled later if drought or other problems lower yield expectations. An NDSU small grain disease forecasting system provides information on risk of tan spot and Septoria blotch infection at the following Web site: *www.ag.ndsu.nodak.edu/cropdisease/* .

At this Web site, information for the previous 12 days is given on whether the environment was favorable for infection of tan spot and Septoria blotch at approximately 40 locations in North Dakota.

When yield potentials are good and leaf disease pressure is severe, the return from the use of a properly timed fungicide application may be expected to be high, more than twice to three times the investment; years with less severe leaf spot disease may be break-even years.

Economic return from using fungicide is dependent on the price received for the wheat, the price of the fungicide and the bushel response to use of the fungicide. When yield potential is adequate, the following factors may help indicate the need for a fungicide:

1) when leaf spots are already severe on the lower leaves at the four- to five- leaf to late-jointing stage;
2) when extended wet weather has occurred or is forecast;
3) when wheat is planted on wheat ground under a reduced tillage situation;
4) when a susceptible variety is grown.

Summary

Reduce the risk of tan spot and the Septoria leaf disease complex by:

1. Using appropriate crop rotation;
2. Choosing moderately resistant wheat varieties;
3. Incorporating wheat residue prior to planting, when feasible;
4. Applying fungicides in a timely manner.

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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5M-11-03