WINTER WHEAT DISEASES & THEIR MANAGEMENT

Wheat diseases can and do occur each year in Missouri. Problems with germination and stand establishment that are related to seed decay, damping-off and seedling blights may be encountered in the field. Diseases may cause leaf spots or leaf blights, wilts or premature death of plants. Wheat diseases can also cause harvest losses, affect the quality of the harvested crop and cause storage losses. The extent of the damage from wheat diseases in a given season depends on a number of factors, including the susceptibility of the wheat variety to the specific diseases, the level of the pathogen inoculum present and the environmental conditions during that season.

To minimize losses due to wheat diseases, it is important to correctly identify the disease or diseases present so that appropriate management steps can be taken. The principal diseases of wheat in Missouri can be divided into seedling diseases; virus diseases; foliage diseases; root, crown and wilt diseases; and head diseases. This section covers the common diseases and management strategies in each of these wheat disease categories.

SEEDLING DISEASES

Various seedborne and soilborne pathogens can cause seedling diseases in wheat. Seed may be rotted before germination, or developing seedlings may be infected before or after emergence. Stands may be thin or uneven (Figure 17). Seedlings may be yellow and stunted. Root systems may be poorly developed with root and crown tissue that is brown to black in color and soft or rotted (Figure 18). Severely infected seedlings may yellow, wilt and die. Seedling diseases tend to be more severe if poor quality or diseased seed is used and if conditions at planting are not favorable for quick germination and stand establishment. Planting good quality, disease-free seed is the most effective means of preventing problems from seedborne pathogens. If seed contaminated with a seedborne pathogen must be used for planting, it is important to clean the seed lot thoroughly to remove as much of the small, damaged seed as possible; to have a germination test done on the cleaned seed lot; and to consider the use of a fungicide seed treatment.

A management program for wheat seedling diseases should include the following steps:

- Plant good quality, disease-free seed under good seedbed conditions.
- Use a fungicide seed treatment.

Figure 17. Thin stand due to seedling blight.

Figure 18. Seedling on right shows stunting, yellowing and poor root development from seedling blight.

VIRUS DISEASES OF WHEAT

The virus diseases most likely to occur on winter wheat in Missouri are wheat spindle streak mosaic, wheat soilborne mosaic, barley yellow dwarf and wheat streak mosaic. Symptoms of barley yellow dwarf may be evident on young wheat plants in the fall, may show up on young plants early in the spring or may be evident later in the season primarily on the flag leaves of plants. Symptoms of wheat spindle streak mosaic and wheat soilborne mosaic typically show up during spring greenup and are most pronounced when air temperatures are around 50 F. Wheat streak mosaic symptoms tend to become obvious as air temperatures increase later in the spring.

Symptoms of wheat spindle streak mosaic (also referred to as wheat yellow mosaic) appear in early spring as yellow green streaks or mottling on the dark green background of the leaves (Figure 19). These lesions usually run parallel to the leaf veins and tend to be tapered at the ends giving the lesions a spindle-shaped appearance. Foliage symptoms are most obvious when air temperatures are about 50 F. Plants may be slightly stunted, off-color and have fewer tillers than normal (Figure 20).

Wheat spindle streak mosaic tends to be more prevalent in lower, wetter areas of a field. The virus that causes this disease is soilborne, and it is spread by the soil fungus *Polymyxa graminis*. Wet falls tend to favor outbreaks of wheat spindle streak mosaic the following spring. Symptoms are most pronounced when air temperatures are 46 to 54 F and tend to fade as air temperatures increase above that range. In years with extended periods of cool, spring temperatures, wheat spindle streak mosaic may be severe and contribute to yield losses.

Wheat soilborne mosaic causes light green to yellow green to bright yellow mosaic patterns in leaf tissues (Figure 21). Symptoms are most evident on early spring growth. Warmer temperatures later in the season slow disease development. Symptoms of wheat soilborne mosaic are not always distinctive and might occur as a more general yellowing, similar to that caused by nitrogen deficiency (Figure 22). Infected plants may be stunted and slow to green up in the spring (Figure 23).

This disease may be more severe in low-lying, wet areas of a field. The wheat soilborne mosaic virus survives in the soil and is spread by the soil fungus *Polymyxa graminis*. Again, wet falls tend to favor outbreaks of wheat soilborne mosaic the following spring. Symptoms of wheat soilborne mosaic are most pronounced when air temperatures are 50 to 68 F and tend to fade when air temperatures increase above that range. In years with extended periods of cool spring temperatures, wheat soilborne mosaic may be severe and contribute to yield losses.

Both wheat spindle streak mosaic and wheat soilborne mosaic are vectored or spread by the soil fungus *Polymyxa graminis*. This fungus prefers wet conditions and is most likely to infect wheat roots during wet falls. Plants infected in the fall usually show the symptoms described above the

Figure 19. Foliage symptoms of wheat spindle streak mosaic.

Figure 20. Poor spring growth due to wheat spindle streak mosaic.

Figure 21. Foliage symptoms of wheat soilborne mosaic.

Figure 22. Extensive yellowing of lower leaves due to wheat soilborne mosaic.

Figure 23. Poor spring growth due to wheat soilborne mosaic.

Figure 24. Barley yellow dwarf symptoms on young plants.

Figure 25. Discoloration of flag leaves due to barley yellow dwarf.

following spring. Spring infections may occur during wet springs, but they usually occur too late to cause significant injury. In most years, the symptoms of these two wheat virus diseases are evident as the wheat crop is greening up and tend to fade as air temperatures increase. In years with late, cool springs, symptoms may be evident much later in the season, even on plants that have headed.

Barley yellow dwarf (also called yellow dwarf and red leaf) is an extremely widespread virus disease of cereals. Symptoms include leaf discoloration ranging from a light green or yellowing to a red or purple discoloration of leaf tissue (Figures 24 and 25). Discoloration tends to be from the leaf tip down and the leaf margin in toward the center of the leaf. Plants may be stunted or may have a rigid, upright growth form. Symptoms are most pronounced when temperatures are in the range of 50 to 65 F.

The barley yellow dwarf virus persists in small grains, corn and perennial and annual weed grasses. More than 20 species of aphids can transmit the barley yellow dwarf virus. Symptoms may be more severe and yield losses higher if plants are infected in the fall or early in the spring. Infections developing in late spring or summer may cause discoloration of upper leaves but little stunting of plants or yield loss.

The other virus disease likely to occur on winter wheat in Missouri is wheat streak mosaic. Wheat streak mosaic causes a light green to yellow-green mottling and streaking of leaves (Figure 26). The leaf streaks are yellow-green with parallel margins so they appear more as streaks than spindle- or oval-shaped lesions. Symptoms may vary with variety, virus strain, stage of wheat growth when plants are infected and environmental conditions. Plants may be stunted. As temperatures increase later in the spring, yellowing of leaf tissue and stunting of plants may become more obvious (Figure 27). The heads on severely infected plants may be partially or completely sterile.

The wheat streak mosaic virus is spread by the wheat curl mite. Symptoms are frequently found along the edges of fields where the mite vector first entered the field. Both the wheat streak mosaic virus and the wheat curl mite survive in susceptible crop and weed hosts, including winter and spring wheat, barley, corn, rye, oat and a number of perennial grasses. Thus, the destruction of volunteer wheat and grass weed

Figure 26. Wheat streak mosaic

Figure 27. Yellowing and drying of leaves from wheat streak mosaic.

control are important management options for wheat streak mosaic.

Mixed infections of wheat viruses in the same field or even the same plant are common in Missouri. When plants are infected with more than one virus disease, it may not be possible to identify the specific viruses present by symptoms. It may be necessary to submit a plant sample to a plant diagnostic laboratory for virus testing.

Most of the management options for virus diseases in wheat are preventative measures such as planting resistant or tolerant wheat varieties; avoiding continuous wheat production; destroying volunteer wheat and weed grasses near wheat production fields; delaying wheat planting until all corn is harvested; and avoiding early fall planting of wheat. Proper fertility may help reduce the impact of virus diseases on wheat.

A management program for virus diseases of wheat should include the following steps:

- Plant good quality seed of resistant varieties.
- Avoid planting too early in the fall to minimize opportunity for vectors to transmit viruses to young wheat plants.
- Destroy volunteer wheat and control weed grasses that may be hosts of the virus pathogens or insect vectors.
- Rotate crops.
- Maintain good plant vigor with adequate fertility.

Figure 28. Young lesions of Septoria leaf blotch.

Figure 29 (left). Mature lesions of Septoria leaf blotch with pycnidia evident in the centers of lesions.
Figure 30 (right). Severe Septoria leaf blotch on flag leaves.

FOLIAGE DISEASES

Many different fungi and bacteria can cause foliage diseases on wheat. These pathogens cause a wide range of leaf spots, leaf blights and similar symptoms on wheat. Foliage diseases that can cause significant injury to wheat in Missouri include Septoria leaf blotch, Stagonospora glume blotch, tan spot, leaf rust, stem rust, stripe rust, powdery mildew and bacterial stripe or black chaff.

Lesions of Septoria leaf blotch begin as light yellow flecks or streaks. These flecks expand into yellow to reddish brown, irregularly shaped blotches (Figure 28). As the lesions mature, the centers may turn lighter gray in color. Dark brown specks (fruiting bodies or pycnidia of the causal fungus, *Septoria tritici*) may be scattered within the centers of mature lesions (Figure 29).

Lesions may coalesce, killing larger areas of leaf tissue (Figure 30).

Stagonospora glume blotch (formerly called Septoria glume blotch) may also begin as light yellow flecks or streaks on leaves. The lesions also turn yellow to reddish brown but usually have a more oval- to lens-shaped appearance than those of Septoria leaf blotch.

Again, the dark brown specks or fungal fruiting bodies of the causal fungus, *Stagonospora nodorum* may be evident within the lesions, but they are not as conspicuous in leaf tissue as are those of *Septoria tritici*. Symptoms of Stagonospora glume blotch are more common on heads than on

Figure 31. Stagonospora glume blotch on head.

Figure 32. Tan spot.

Figure 33. Leaf rust.

Figure 34. Yellowing of lower leaves from leaf rust.

Figure 35. Stem rust (with leaf rust on some leaves).

Figure 36. Stripe rust.

foliage of wheat. Infected heads will have dark blotches on the glumes (Figure 31).

The initial symptoms of tan spot are small, tan to brown flecks on the leaves. These expand into tan to light brown, elliptical lesions that often have yellow borders (Figure 32). The centers of mature tan spot lesions may have a dark brown region caused by an outgrowth of the fungus *Pyrenophora tritici-repentis*. Since the tan spot fungus does not produce pycnidia or fruiting bodies, mature tan spot lesions do not have the distinct dark brown specks scattered in the centers of the lesions as do Septoria leaf blotch lesions.

Leaf rust lesions appear primarily on the upper leaf surfaces and leaf sheaths. Initially, lesions are small, yellow to light green flecks. Eventually, leaf rust appears as small, circular to oval-shaped, orange red pustules. These pustules break open to release masses of orange red spores of *Puccinia recondita* (Figure 33). The edges of the open pustules tend to be smooth without the tattered appearance of stem rust pustules. Heavily rusted leaves may yellow and die prematurely (Figure 34).

Stem rust, caused by the fungus *Puccinia graminis* f. sp. *tritici*, is most common on stems and leaf sheaths of wheat plants but may develop on any of the aboveground portions of the plant, including both upper and lower leaf surfaces, glumes and awns. Stem rust pustules are small, oval and reddish brown (Figure 35). The ruptured pustules tend to have more ragged edges than leaf rust pustules. Frequently, both leaf rust and stem rust occur on the same plant, and both types of pustules may develop on an individual leaf.

Stripe rust, caused by the fungus *Puccinia striiformis*, has become more prevalent in Missouri over the last few years. Stripe rust may develop earlier in the season than either leaf rust or stem rust. The pustules of stripe rust are yellow or yellowish red in color and occur in obvious stripes or streaks that run lengthwise on wheat leaves (Figure 36). This disease is more commonly associated with lower temperatures (especially lower night temperatures) and intermittent rain or dew.

Powdery mildew infections begin as light green to yellow flecks on the leaf surface. As powdery mildew develops, the leaf surfaces become covered with patches of cottony white mold growth of *Erysiphe graminis* f. sp. *tritici*, the causal fungus (Figures 37 and 38). These patches eventually turn a grayish white to grayish brown

Figure 37. Young lesions of powdery mildew.

Figure 38. Powdery mildew covering leaf.

Figure 39. Bacterial stripe.

color. Small, black fungal fruiting bodies may be visible within the patches of mildew growth.

The fungi that cause most of these wheat foliage diseases survive in infested wheat residues left on the soil surface. The next growing season, spores are produced during moist periods and are carried by wind currents to susceptible wheat leaves where infection may begin. Disease problems tend to be more severe when wheat is planted in fields with infested wheat residue left on the soil surface. Eventually, spores that are produced in the initial lesions on plants are wind blown to other leaves or other plants causing secondary infection.

Leaf rust, stem rust and stripe rust are exceptions to this simplified explanation of disease development. The rust fungi do not survive in infested residue left in a field and, in fact, do not survive the winter months in this area at all. Rather, the rust fungi are reintroduced into this area each season when spores are carried up on air currents from the southern United States. Most of the foliage diseases of wheat are favored by warm, wet or humid weather. Frequently, infection begins on the lower portion of the plant.

If weather conditions are favorable for disease development, the disease may move up through the plant. Severely infected leaves may yellow and die prematurely. Yield losses tend to be highest when the flag leaves are heavily infected.

There are several fungicides labeled for use on wheat to control fungal foliage diseases. It is important to scout wheat fields and determine which leaf diseases are occurring, as well as the level of their severity, before making a decision to apply a foliar fungicide. In particular, be on the lookout for Septoria leaf blotch, Stagonospora glume blotch, tan spot and leaf rust. When scouting fields, try to identify the disease(s) that are present; determine the average percent of infection on a leaf and the number of leaves showing infection; and determine the stage of crop growth.

Generally, the profitable use of foliar fungicides on wheat depends on a number of factors, including varietal resistance, disease severity, effectiveness of the specific fungicides and timing of fungicide application. The greatest increases in yield are usually obtained when fungicides are applied to disease susceptible varieties with high yield potential at the early boot to head emergence growth stage when the flag leaf is in danger of severe infection.

Fungicide applications are seldom beneficial if applied after flowering or after the flag leaf is already severely infected.

It is also important to read the fungicide label for specific information on rates, recommended timing of application, frequency of applications, preharvest intervals and grazing restrictions.

A management program for foliage diseases of wheat should include the following steps:

- Plant disease-free seed of varieties with resistance to diseases likely to occur in your area.
- Rotate with nonhost crops.
- Manage residues (if tillage system is a conservation tillage system, particular care should be given to rotation and variety selection).
- Maintain good plant vigor with adequate fertility.
- Use foliar fungicides if warranted.

Figure 40. Black chaff.

Figure 41. Initial symptoms of Cephalosporium stripe.

Black chaff (also called bacterial stripe) is a bacterial disease that produces symptoms on both leaves and heads. Water-soaked lesions may develop on young leaves. These develop into reddish brown to brown to brownish black streaks on the leaves (Figure 39). Glumes and awns show brown-black blotches or streaks (Figure 40). The bacterium that causes this disease, *Xanthomonas campestris* pv. *translucens*, is seedborne, so the use of disease-free seed is a primary control measure. Use of resistant or tolerant varieties and crop rotation should also reduce the incidence of bacterial stripe and black chaff.

ROOT, CROWN & WILT DISEASES OF WHEAT

Several soilborne fungi can cause root and crown diseases of wheat. Affected plants may be stunted or less vigorous than healthy plants. Plants may yellow, wilt and die prematurely. Dead plants may have a bleached or white appearance. When affected plants are dug up, root systems may be poor with roots and crown tissues discolored and deteriorated.

Cephalosporium stripe has not been a significant problem on wheat in most of Missouri. With recent wet seasons, shorter rotations between wheat crops and reduced tillage, this disease has become more common in the northern part of the state. Foliage symptoms are most evident during jointing and heading. Light green to yellow-green, longitudinal stripes develop on the leaves of infected plants (Figure 41). The stripes run parallel to the leaf midrib and may extend the entire length of the plant. Older lesions are predominantly yellow or even brown (Figure 42). Severely infected plants may be stunted, produce few tillers and die prematurely (Figure 43). The fungus that causes this disease, *Cephalosporium gramineum*, persists in association with wheat residues and may also be soilborne. Fungicides are not effective in controlling Cephalosporium stripe and resistant varieties are not available for Missouri.

A management program for Cephalosporium stripe should include the following steps:

- Crop rotation to corn or legumes for at least two years.
- Residue management.
- Proper fertility.
- Proper weed control.

Figure 42. Cephalosporium stripe.

Figure 43. Stunting of plants due to Cephalosporium stripe.

Take-all is one of the more common root and crown rot diseases of wheat in Missouri. The fungus that causes this disease may infect seedlings in the fall.

Symptoms are usually most evident after heading as white heads on wheat plants (Figure 44). Entire heads on infected plants may be bleached (white heads) and sterile. Infected plants are also stunted and slightly yellow, have few tillers and ripen prematurely (Figure 45).

Plants with take-all usually have poorly developed root systems and roots are sparse, blackened and brittle. With sufficient soil moisture, a black-brown dry rot may extend into the crown and up the lower stem. This shiny, black discoloration of the lower stem and crown may be evident if the lowest leaf sheath is scraped off with a knife or fingernail (Figure 46).

Diseased plants may lodge and fields may appear uneven in height and irregular in maturity. At harvest, the heads on diseased plants may be darkened by "sooty" molds and may contain either no grain or shriveled grain.

Take-all of wheat is caused by the fungus *Gaeumannomyces graminis*. This fungus survives in infected host plants (wheat, barley, rye and weed grasses such as smooth bromegrass, quackgrass and bentgrass) and in infested host debris.

Infection occurs when the fungus penetrates the young roots of a living host plant. Infection can occur throughout the growing season but is more severe when the temperature is 54 to 64 F. The take-all fungus is more active in wet soils, so the disease is typically most severe in wet areas or years, or in irrigated fields. Root infections in the fall and early spring are most likely to progress to the crown and foot of the plant.

Hot, dry weather after heading increases the water stress on plants infected with take-all and may lead to the sudden development of white heads on plants that were actually infected earlier in the season or the previous fall.

Take-all is favored by continuous cropping of wheat. It is also more severe in lighter, alkaline, infertile and poorly drained soils. Plant nutrients offer increased resistance to take-all and a greater capacity to tolerate infections by producing more roots.

It is important to maintain good levels of available nitrogen, phosphorus and potassium. Soil pH also affects the development of this disease. Disease damage is usually worse as soil pH approaches 7.0.

Figure 44. White heads due to take-all.

Figure 45. Severe take-all symptoms in wheat field (field had been in wheat four out of last five years).

Figure 46. Take-all symptoms on lower stem, crown and roots.

Figure 47. Loose smut.

A management program for take-all should include the following steps:

- Plant good quality seed of adapted, disease resistant varieties.
- Plant in well-drained sites under good seedbed conditions.
- Rotate with nonhost crops for one to three years.
- Control weed-grass hosts and volunteer wheat.
- Use seed treatment fungicides.
- Maintain good plant vigor with adequate fertility.

HEAD DISEASES OF WHEAT

Diseases such as smuts, bunts and scab affect primarily the head of the wheat plant. Smut and bunt diseases, such as stinking smut or loose smut, tend to replace the normal kernels in the head with galls that contain masses of powdery black spores. The scab fungus can colonize heads producing kernels that are shrunken, shriveled and discolored.

Loose smut is obvious as heads emerge from the boot. All portions of the head except the rachis are converted to masses of dusty black spores (Figure 47). These spores are eventually dislodged by wind and rain, so later in the season the smutted stems are less evident (Figure 48).

The fungus that causes loose smut, *Ustilago tritici*, survives within the embryo of wheat seeds, so planting disease-free seed or using systemic fungicide seed treatments are important management tools.

Stinking smut (also called covered smut or common bunt) is not as obvious as loose smut. The kernels are replaced with smut galls, but the pericarp covering the smut gall remains intact and masks the smut gall.

At harvest, the pericarps are broken, releasing clouds of dark spores. Grain contaminated with stinking smut has a strong fishy odor and a darkened appearance. The fungus that causes stinking smut can survive on wheat seed and in the soil. Disease development is favored by cool, wet conditions.

A management program for smut and bunt diseases should include the following steps:

Figure 48. Bare rachis remains after smut spores are dislodged.

- Plant disease-free seed.
- Use a systemic fungicide seed treatment.

The characteristic symptom of scab on wheat is a premature bleaching of a portion of the head or the entire head (Figures 49 and 50). Superficial mold growth, usually pink or orange in color, may be evident at the base of the diseased spikelets. Bleached spikelets are usually sterile or contain shriveled or discolored seed (Figure 51).

Scab is caused by the fungus *Fusarium graminearum*. This fungus overwinters on host residues such as wheat stubble, corn stalks and grass residues. Spores are carried by wind currents from the residues on which they have survived to wheat heads.

If environmental conditions are favorably warm and moist, the spores germinate and invade flower parts, glumes and other portions of the spike. Scab infection occurs when the wheat crop is in the flowering to early grain fill stages. Infection depends on environmental conditions while wheat is in susceptible stages of growth. Moderate temperatures in the range of 77 to 86 F, frequent rain, overcast days, high humidity and prolonged dews favor infection and development of the scab fungus.

An additional concern with wheat scab is the possibility of mycotoxin production in the infected grain. Mycotoxins are naturally produced chemicals that in small amounts may be deleterious to animal or human health.

The fungus that causes wheat scab may produce several different mycotoxins, including vomitoxin (deoxynivalenol or DON) and zearalenone. This is a primary concern where grain is fed to nonruminant animals.

Figure 49. Scab or Fusarium head blight.

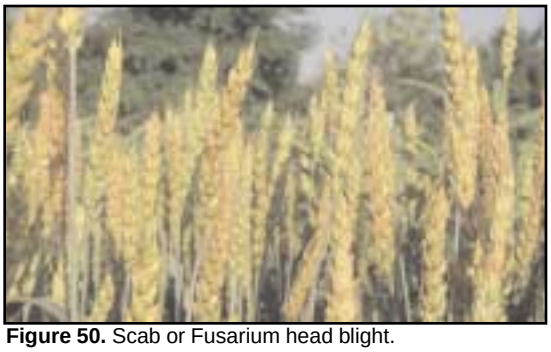

Figure 50. Scab or Fusarium head blight.

Figure 51. Scab symptoms on kernels.

Ruminants are fairly tolerant of these two mycotoxins. Swine and poultry may refuse to eat grain containing high levels of these mycotoxins. Where mycotoxin problems are suspected, a sample should be submitted to a qualified laboratory for mycotoxin analysis.

A management program for wheat scab should include the following steps:

- Plant adapted varieties with tolerance to scab.
- Rotate to nonhost crops (corn is also a host, so rotation should be to crops other than small grains or corn).
- Manage residues.
- Plant disease-free seed (If planting seed from a field that had scab, clean seed thoroughly before planting, have a germination test done on the lot and use a fungicide seed treatment to minimize seedling blight problems caused by seedborne Fusarium).