

Diseases of Small Grains in North and Central Florida

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Diseases of small grains (wheat, oats, rye, triticale, barley) are some of the most important plant diseases on a worldwide basis. Because of small profit margins for these crops, the primary control techniques have been resistant varieties, basic tillage techniques, and relatively inexpensive seed treatments. In recent years, emphasis on high yields coupled with new chemical control strategies offer potential for less traditional approaches. Effective use of the new wave of plant disease control techniques requires accurate diagnosis of the causal agent (fungus, virus, bacterium, non-parasite) of disease. Fungal and viral diseases have been the primary limiting factors for yield and quality of small grains grown in Florida.

DISEASES CAUSED BY VIRUSES

Soilborne wheat mosaic virus (SBWMV) was first found in Florida in 1970 in Escambia County. Since then, it has been found in Santa Rosa, Okaloosa and Madison Counties. Although the virus can be spread mechanically (by hand), natural spread occurs by moving soil that contains the soilborne fungus vector, *Polymyxa graminis*. Wheat that is infected by this fungus but not the virus sustains no known damage. Because the virus is associated with a soilborne organism, the initial distribution of the virus in a field is usually patchy or in streaks due to soil tillage operations (Fig. 1). SBWMV is sometimes found where the tillage equip-

ment is first used in the field. In 2000, SBWMV or a closely related virus was found in rye in an experimental rye planting in Gadsen County.

Wheat roots are infected by the zoospore (swimming) stage of the fungus. After entering the root, the fungus proceeds with a complex life cycle, simultaneously releasing the virus into the root. Virus multiplication and spread in the plant follows. Later, the fungus forms thick-walled spores for survival in soil. These spores are capable of carrying the virus during the survival period. The fungus will become active again during cool, wet weather. Transmission of the virus through seed has not been demonstrated.

Patches of infected plants show various degrees of symptom severity depending on time of infection, temperature, and the amount of virus within a plant (Fig. 1). Symptoms include stunting of plants, reduced tillering, delayed heading, shriveled seed, seed abortion, and vein-restricted, yellow to brown to white streaks or mosaic patterns on leaf blades and sheaths (Figs. 1 & 2). Some varieties may display oval-like leaf scalding symptoms. Also, root systems are reduced. In Florida, leaf symptoms are most vivid during late February to early April. Rosetting (severe stunting with abnormally high amount of leaf area to stem lengths) prior to stem jointing may occur in some susceptible varieties.

The most effective control is the use of resistant varieties. Equipment (tractors, implements, soil tube samplers, etc.) should be washed to remove clinging soil after its use in an infested field. Crop rotation with oats will offset damage because wheat, rye, barley and triticale are hosts of this virus. The fungus vector with the virus can live in the soil for years.

Oat Soilborne Mosaic Virus (OSBMV) is thought to occur in Florida but such has not been ascertained. Symptoms, affects on yield, and control measures would be expected to be similar to that of WSBMV.

Barley Yellow Dwarf Virus (BYDV) occurs in Florida and has been severe in some years. This virus is spread by many species of aphids and is capable of causing disease in wheat, barley, oats, and many grasses. Aphids acquire BYDV after feeding on infected plants for 30 minutes to 30 hours. One to four days later, they can transmit BYDV and some aphids may be able to transmit the virus for the rest of their lives. As the acquisition feeding time is increased the latent period of one to four days may be reduced. BYDV is not passed to the egg or nymph stages of the aphid. BYDV is not seedborne.

Symptoms of BYDV vary from none to brilliant leaf yellowing in wheat and barley or red to purple coloring of oat leaves (Fig. 3). Such off-colors tend to be associated with leaf margins at first, but later envelops the entire leaves. Leaves tend to curl or twist. Infected plants have reduced root systems, stiffer leaves, and possibly, darkened phloem within infected tissue.

Control BYDV with resistant varieties. In addition, control of aphids with insecticides has reduced this viral disease.

Wheat Spindle Streak Virus (WSSV) has been identified in Georgia and Alabama but not yet in Florida. It is spread by the same fungus vector as that for SBWMV but the two vi-

ruses are distinct. WSSV infects both wheat and rye. WSSV has been reported to occur in patchy areas within a field, often in low wet areas, or throughout the entire field. Symptoms of WSSV are similar to that of SBWMV except that the linear chlorotic streaks between leaf virus tend to be tapered at their ends. Control for this virus would be similar to that for SBWMV.

DISEASES CAUSED BY FUNGI

Glume Blotch (GB) is caused by *Stagnospora nodorum* (*Septoria nodorum*). This fungus can live in old wheat debris for at least two years. Also, the fungus can be transmitted by infected seed. Survival of the fungus for seven years in seed has been reported. Weed hosts are not known to be sources of inocula (spores). Wheat, barley, rye, and blue grass are susceptible, but wheat is the principle host and the disease is most severe during spring months in Florida. Small amounts of GB occur during the fall and winter. GB reduces yield by reducing seed number, seed size (grade), and tillers.

Stagnospora nodorum is capable of producing ascospores that result from sexual mating, and pycnidospores that do not require mating for formation. Pycnidospores are the spores present in Florida. These spores are formed in flask-shaped structures (pycnidia) embedded within infected tissue (Fig. 4), and are formed in leaves 10-16 days after infection. Slightly longer intervals occur in stem tissues. Spores are splashed by rain or irrigation water from nearby pycnidia located on old crop refuse or growing plants. Penetration occurs through the cuticle of leaves by germ tubes growing from the spores. At least six hours of moisture on the leaf is essential for the penetration process but is not required for growth of the fungus within the leaf after penetration. Survival of spores outside of the pycnidia can occur but reports are varied as to how long.

Three to seven days after penetration, light-colored, chlorotic (yellow) to necrotic

(brown) blotches appear on leaves. From 10-16 days after penetration, the tiny, black, dot-like pycnidia mature and form spores internally. Adding a drop of water to dried lesions or blotches will swell pycnidia and allow the spores to ooze out in a tendril. This life cycle is shortest when temperatures are between 68° to 81°F. This fungus is capable of growth between 40 and 90° F. Mature lesions on leaves are football shaped, tan-colored in the center (Fig. 5), and vary in size. The leaf spot may be surrounded by a yellow halo. On glumes, awns, and stem parts, blotches rather than distinct spots are formed. On glumes, these blotches tend to be limited to the upper half of the glume (Fig. 4). Leaf spots of GB may appear similar to those caused by *Helminthosporium sativum* (*Bipolaris sorokiniana*) and sometimes one spot may have both organisms.

Control of GB is best achieved by two years of crop rotation plus a seed treatment or, better yet, use of seed not infected with this fungus. In many growers' situations, however, this ideal combination can not be achieved. Therefore, the use of a fungicide spray program as outlined in Plant Protection Pointer 27 offers a method to control GB as well as *Helminthosporium* leaf spot and leaf rust. Numerous cultural techniques (fertility, planting depth, row and plant spacing, and irrigation frequency) have been tested for their affects on severity of GB, but no clear results were found. Later planting dates in the fall would be expected to reduce the amount of spores available for spring months when GB epidemics are normally seen in Florida.

***Helminthosporium* Leaf Spot or Spot Blotch (HLS)** is caused by *Helminthosporium sativum* (*Bipolaris sorokiniana*). This disease has been more of a problem on wheat in the rye-growing areas of Florida, as HLS is common on rye and triticale. This fungus has a wide host range on many grass species, but does not infect corn, sorghum, or oats. This fungus survives on crop debris and is carried in or on seed.

All plant parts are susceptible; that is, this fungus causes spots or blotches on aboveground parts as well as stem and root rots and seedling blight.

Two kinds of spores are formed by *H. sativum*: ascospores from a mating process and conidia without a mating process. Conidia are the primary inocula of HLS in Florida. Conidia form on the surfaces of lesions and thus are suitable for spread by wind. With the aid of a hand lens the mass of spores appears as a miniature forest. If they land upon susceptible tissue that is wet with dew or rain water, they germinate, form germ tubes, and with special structures, the host tissue is penetrated. The life cycle varies from three to 20 days, depending upon temperature. Growth of the fungus occurs between 33 and 99° F, but temperatures from 71 to 85° F are optimal for infection and symptom development.

HLS may appear as dark, pin-point spots or may be up to one inch in length (Fig. 6). Spots are somewhat linear, paralleling the leaf veins, and are dark green, black, or brown. A yellow halo may or may not surround the dark lesion. Glume blotch lesions are lighter in color than HLS. Where flower parts are infected, the heads appear dirty green to black (Fig. 7) in contrast to dirty brown heads affected by glume blotch.

Control of HLS is similar to that of glume blotch. In addition, wheat plantings should be separated from rye plantings to the extent possible. Differences in susceptibility between crop varieties exist, but resistant varieties to HLS are not available.

Leaf Blotch (LB) of oats is caused by *Helminthosporium avenae* (*Drechslera avenacea*) and other plant species are not known to be susceptible. The life cycle of this fungus and control of this disease are similar to those for *Helminthosporium* leaf spot of wheat.

LB of oats is primarily a disease of the

leaves and panicles in Florida, although a black stem phase has occurred. Leaf symptoms include linear, reddish brown to black spots, usually 1/2 to one inch long, which are water-soaked (greasy) when small (Fig. 8). Spots are narrow, being somewhat limited by leaf veins, but they can be blotchy. With a hand lens, dark fuzzy spore masses may be seen near the center of the spots. Black stem symptoms of this disease display pinkish-brown blotches on the leaf sheaths or large black areas on the stem, the latter usually being associated with nodal tissue. A white mold growth occurs in the stem cavity near the blackened tissues. Stem breakage may occur. Control of LB is done with resistant varieties (if available), seed treatment, and crop rotation.

Powdery Mildew (PM) is caused by *Erysiphe graminis* (*Blumeria graminis*). In Florida, the only strain of PM of consequence on small grains is the one in wheat, usually during the spring months. On some varieties, PM can be severe, covering the entire leaves with a white, powdery mold growth (Fig. 9). PM can cause yield loss on susceptible varieties that maintain high disease severities from prior to jointing until flag leaves (uppermost leaf on a mature plant) form. Excess nitrogen predisposes plants to PM.

The fungus causing PM produces two spore types: one is produced after a mating process (ascospore) and the other is produced in large amounts without a mating process (conidia). Conidia are formed among the white powdery growths on leaves and appear to be the main source of inocula for PM in Florida. Upon germination, a conidium produces a germ tube from which an infection peg forms and penetrates directly through the leaf cuticle. Conidia of PM are unique as they do not require free moisture for germination, but germination is most rapid when free moisture is present. Conidia germinate from 34 to 86° F, but disease development is most rapid from 59 to 72° F. Above 77° F, disease progression is

slowed; this is why PM is not as severe on upper leaves of fully jointed wheat in Florida. PM consists of numerous races which differ in ability to cause disease in different varieties. The PM fungus survives from one season to another on volunteer wheat plants, in susceptible wild grasses, as a mycelial mat (dried up white fungus growth) and possibly by the ascospore within a cleistothecium (a fungus encapsulation).

Control is best achieved with varieties resistant to the current prevalent races. Some new fungicides may be available for control of PM, but discuss their use with your county agent first. Use a balanced soil fertility; do not use excess amounts of nitrogen.

Leaf Rust (LR) of wheat is caused by *Puccinia recondita* f. sp. *tritici*, and is a problem on susceptible varieties or previously resistant varieties infected by new or different races of this fungus. In Florida, LR occurs from late winter through spring. Occasionally, rye or barley may be infected by this fungus. This fungus produces three kinds of spores in wheat, urediospores, teliospores, and sporidia. The urediospore, contained in orange to brown uredia (Fig. 10), is thought to be the only spore of consequence for spread of LR in Florida. Uredial pustules can form on all parts of the plant above ground level. They first appear on lower leaves and with time the disease spreads to upper plant parts. When a urediospore germinates, it produces a germ tube from which structures are produced that penetrate the breathing pores (stomata) on plant tissue. A minimum of four hours of leaf wetness is needed for penetration to occur but longer wetting periods will result in more penetrations. Within 7 to 14 days, or more if temperatures or varieties are not ideal for the fungus, new pustules are formed in areas that began as yellow to tan flecks on susceptible tissue. If the tissue is less susceptible, no pustule is formed (highly resistant reaction) or the original fleck will be partially covered by a uredium (intermediate

responses). The life cycle is the shortest when temperatures are from 59 to 81° F.

Telia are black and contain teliospores. Typically, telia form on older infected leaves. When teliospores germinate, they produce sporidia that infect the alternate hosts (meadow rue and others). On the alternate host, pycnia and aecia are formed, and each containing their respective spore types. However, in Florida, direct pertinence of spore stages other than the urediospores is probably negligible. The significance of the alternative host relates to the potential for new races to form and aeciospores are infectious to wheat.

Control of LR is by use of resistant varieties or with foliar sprays during spring months; see Plant Protection Pointer No. 27.

Stem Rust (SR) is caused by *Puccinia graminis*. Nearly all small grains are susceptible to different “form-species” of this fungus. The form-species *tritici* infects wheat; the form-species *avenae* infects oats; etc. Although SR can be devastating, the SR epidemic in 1974 in wheat is the only known case in Florida and this was related to the widespread planting of a highly susceptible variety. Normally, SR is seen in trace amounts each year in Florida.

The SR fungus has a life cycle and temperature responses similar to leaf rust of wheat, but the alternate hosts (barberry, and others) are different. The length of the life cycle on wheat has been as short as five days and as long as 85 days, depending on temperature and variety-race combination. A seven to 15 day life cycle would be typical.

SR can appear similar to leaf rust on leaves of wheat, but often the uredial pustules are red to brown, rather than orange as with leaf rust. Should SR be seen on stems, including leaf sheaths, long red to brown uredia will be evident (Fig. 11). With a microscope, the two rusts can be distinguished by urediospore shape;

spores of SR are oblong whereas those of leaf rust appear round or block-shaped.

Control SR with resistant varieties. Foliar sprays may be useful, but this depends upon the type of fungicide used.

Leaf Rust and Stem Rust of Rye can occur but only the former has been seen on occasion in Florida. These rusts have similar symptoms to their respective rusts on wheat. The alternate hosts for SR on rye is the same as for wheat, but the alternate host for LR on rye is different (*Anchusa* spp.).

Crown Rust (CR) of oats is caused by *Puccinia coronata*. It has a life cycle similar to that of leaf rust of wheat, except its alternate host is *Rhamnus* spp. When free moisture is present, urediospores will germinate from near freezing to 86° F. Temperatures near 77° F shorten the life cycle to five days, depending upon the variety. A nine to 15 day life cycle is typical during the spring months in Florida. Penetration of leaf tissue by infection structures may occur in three hours near 70° F or take 12 hours at 86° F or 24 hours at 41° F.

Symptoms and control for CR are similar to those for leaf rust of wheat, except a foliar spray program is usually not advised.

Loose Smuts (LS) of wheat, oats, and barley have occurred in Florida but none of these fungal diseases has been severe except on occasions in some fields. LS is caused by *Ustilago tritici*, *U. avenae*, *U. nuda* on wheat, oats, and barley, respectively. LS on wheat and barley are seedborne within normal-appearing seed. Upon seed germination, the fungus grows systemically within the plant and after flowering, black spore masses are present within florets instead of seed (Fig. 12). These black spores, called teliospores, are spread by wind to other flowers within the crop where they germinate and infect the female portion of the flower. The seed then forms normally.

With LS on oats, the life cycle is the same on occasion, but most infections occur in the field during the early seedling stage. The black teliospores, which are carried on seed, germinate to form sporidia that in turn germinate. If a fusion occurs between the germ tubes of certain sporidia, the fused-germ tube is capable of penetrating the seedling. Infection is favored by somewhat dry conditions and is best at 64 to 72° F.

Control of LS is done with resistant varieties and seed treatments that are highly selective for control of smuts. Also, seed sources should never be from fields that had smut.

Anthracnose of rye, caused by *Colletotrichum graminicola*, appears during warm (77° F) and wet periods in the spring. Premature ripening and bleaching of the lower stem occur. Later, the lower stem turns purple to brown where dark fungal structures with spines may be seen with a hand lens. Root rot, culm rot, lodging, and flower sterility are further symptoms. This disease is most apt to occur in fields with acidic soil or low in phosphorus. Broom sedge fields are indicators of such conditions. Crop rotation with non grass crops is suggested.

Pythium Root Rot (PRR) of small grains is caused by several species of *Pythium* which are common in soils in Florida. These fungi produce swimming spores which germinate in water. From the germ tube, structures are produced that are capable of infecting root tissue. Also, several types of resting spore types may form that allow these fungi to survive harsh conditions in the soil or in old plant debris.

Symptoms of PRR include lower leaf yellowing (similar to nitrogen deficiency). Eventually, all leaves on a plant may be yellow followed by stunting, leaf browning, and death of the plant (Fig. 13). Although entire plantings may display these symptoms, this disease occurs commonly in patches or linear streaks in the field (Fig. 14). These fungi may also cause a pre- or post-emergent seedling blight. After jointing occurs, PRR occurs but is less damaging than early season infections.

Control of PRR on small grains is with seed treatment, avoidance of planting prior to the middle of November, and avoidance of deep planting. After stand establishment, soil moisture, nitrogen levels, and overall fertility levels should be adequate to promote a consistently growing plant. Plants are more apt to be infected when the root system is not expanding. Where the crop is to be used for grazing and planted early or in warm soils, the use of an effective seed treatment is highly important.



Figure 1. Stunting of wheat caused by soil-borne wheat mosaic virus.



Figure 2. Mosaic symptoms in wheat caused by soilborne wheat mosaic virus.



Figure 3. Leaf symptoms in oats caused by barley yellow dwarf virus.



Figure 4. Lesions of glume blotch in a wheat spike.



Figure 5. Leaf lesions of glume blotch in wheat.



Figure 6. Leaf lesions in wheat caused by *Helminthosporium sativum*.



Figure 7. Blotches on wheat spikes caused by *Helminthosporium sativum*.



Figure 8. Leaf lesions and effects of leaf blotch in oats.



Figure 9. Powdery mildew of wheat.



Figure 10. Pustules of wheat leaf rust.



Figure 11. Pustules of stem rust in stems and leaves of wheat.



Figure 12. Loose smut of wheat.



Figure 13. Pythium root rot in young rye plants.

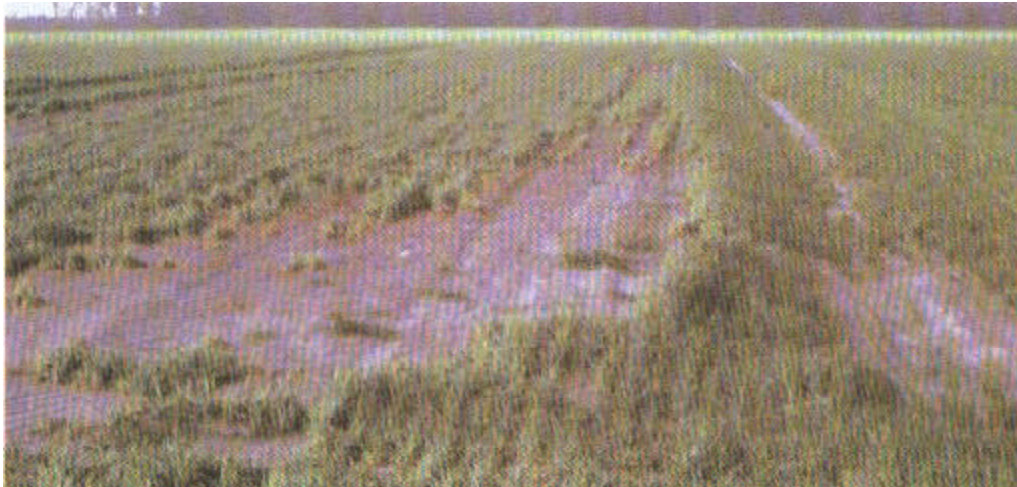


Figure 14. Pythium root rot in wheat.