Southern Rust

Southern rust of corn is caused by the fungus *Puccinia polysora*. Although generally considered a "tropical disease," southern rust can occur in important corn production areas of the United States and Canada. This publication describes the symptoms and signs of southern rust, how to differentiate southern rust from other common diseases, environmental conditions that favor southern rust, and practices you can use to manage this disease.

Symptoms and Signs

The southern rust fungus produces raised structures called pustules, which rupture the outer leaf tissue (epidermal tissue). The pustules contain masses of colored spores called urediniospores.

Southern rust pustules are orange to tan, circular or oval, and about 1/16 inch (1.5 millimeters) in diameter (Figure 1). The majority of these pustules develop on upper leaf surfaces. You can rub rust spores off leaves, which will leave orange to tan streaks of spores on fingers or clothing. Late in the season, the fungus may form brown to black pustules known as telia (which contain teliospores) (Figure 2).

Figure 1. Southern rust pustules are small, orange, and clustered mostly on upper leaf surfaces.

Figure 2. Later in the season, the fungus forms darker pustules called telia.

Pustules are usually first observed in the middle or upper plant canopy in isolated "hot spots" of rust activity. These hot spots are often at the ends of rows along field borders. Secondary infections near initial infections are numerous and densely clustered on leaves. Pustules are often surrounded by light-green to yellow (chlorotic) halos, which are evident on the underside of a leaf (Figure 3). In severe cases, pustules may also develop on husks, leaf sheaths, and ear shanks (Figure 4).

Members of the Corn Disease Working Group are university scientists from many institutions, including: University of Arkansas, Colorado State University, Cornell University, University of Delaware, University of Guelph, University of Illinois, Iowa State University, Kansas State University, University of Kentucky, Louisiana State University, Michigan State University, University of Minnesota, Mississippi State University, University of Missouri, University of Nebraska, North Carolina State University, North Dakota State University, Ohio State University, Penn State University, Purdue University, South Dakota State University, University of Tennessee, Texas A&M University, and University of Wisconsin-Madison

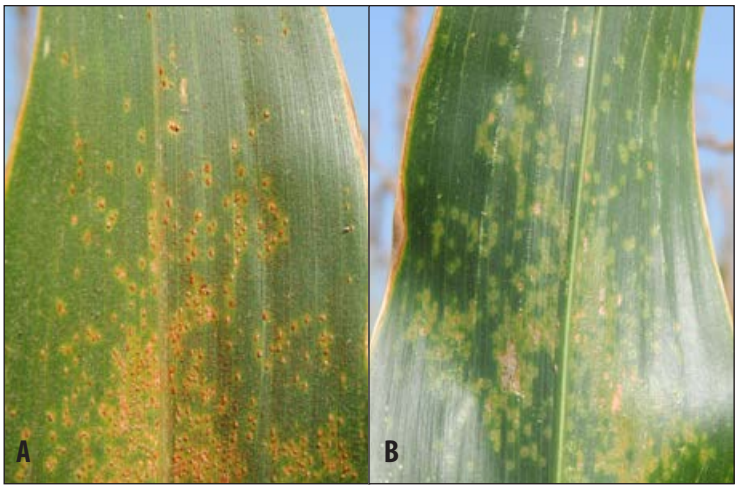

Figure 3. (A) Pustules occur primarily on the upper leaf surface. (B) On the lower leaf surface, only chlorosis is generally visible.

Figure 4. In severe cases, southern rust pustules can be present on ear husks (A) and leaf sheaths (B).

Disease Cycle

Puccinia polysora requires living host plant tissue to survive, so when corn matures or is no longer green, the southern rust fungus can no longer survive. Corn is the major host for the southern rust fungus, so the fungus does not overwinter in northern areas. Each year, wind currents from tropical areas carry rust spores (urediniospores) north and begin new infections (Figure 5).

When conditions favor rust development, the infection cycle continually repeats and causes secondary infections. The period between when a plant is infected and when the fungus develops pustules and spores can be as short as nine days when conditions are favorable. Each pustule can produce spores for up to eight days, which distributes thousands of spores that can cause secondary infections.

When conditions that favor disease development last for a prolonged period, southern rust severity can quickly reach epidemic levels. Because favorable conditions for southern rust are more common in the southern United States, the disease is typically more problematic in these areas. Each year, spores produced on corn in southern states move north during the cropping season. Southern rust's severity and impact in the major U.S. Corn Belt states and Ontario depend on when it develops in the region and on how favorable conditions are for the disease.

Conditions that Favor Disease

The fungus that causes southern rust can infect a plant after approximately six hours of leaf wetness. Dew usually provides enough moisture to cause infection, but frequent rainfall can promote severe disease development. Southern rust is favored by high relative humidity and temperatures around 80°F (27°C).

The rate at which southern rust reaches damaging levels depends on:

- The crop's development stage at the onset of infection
- The hybrid's susceptibility
- How long favorable conditions last

Young leaves are more susceptible to infection than mature leaves, and late-planted or double-crop corn may be at greater risk for yield loss if environmental conditions favor disease development.

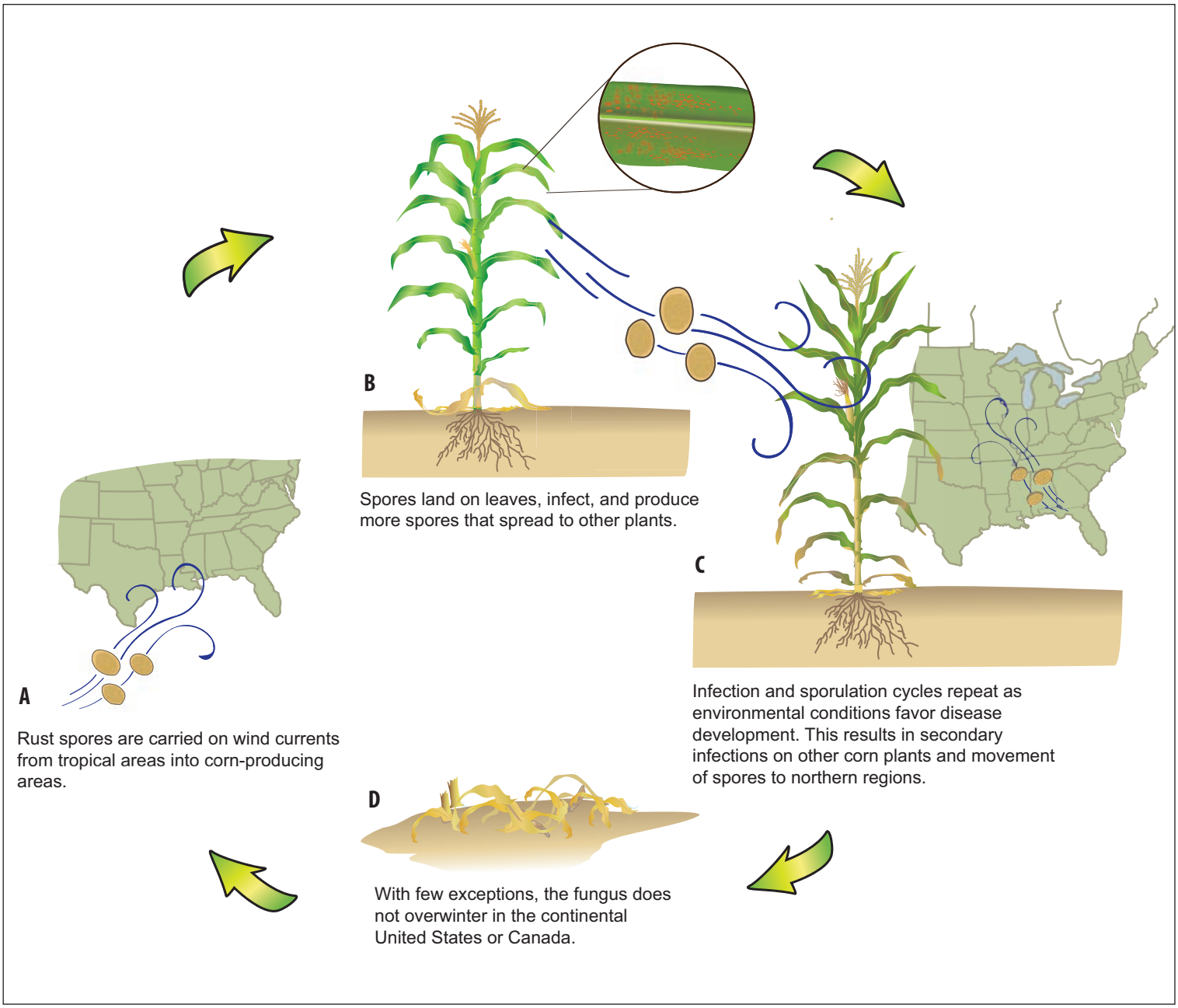

Figure 5. Life cycle of the southern rust fungus.

Yield Losses and Impact

The southern rust fungus uses the plant's nutrients for growth and reproduction, which affects grain fill and ultimately reduces yields. Rust pustules also rupture leaf epidermal tissue, which can interfere with the regulation of water loss by stomata (microscopic openings on the surface of leaves). Consequently, severe rust outbreaks make it harder for plants to use water efficiently, so infected plants may exhibit symptoms of mild drought stress. In severe cases, these infections may predispose plants to secondary infections by stalk rot pathogens, which leads to lodging. Yield losses up to 45 percent have been reported with severe disease.

Diagnosis

Southern rust can be confused with several diseases and disorders (see Diseases and Disorders with Similar Symptoms below). A plant diagnostic laboratory can distinguish southern rust from common rust and other issues by examining leaves under a microscope and looking for the fungal spores of *Puccinia polysora*. A trained diagnostician can differentiate southern rust spores from the spores of other plant pathogenic fungi (Figure 6).

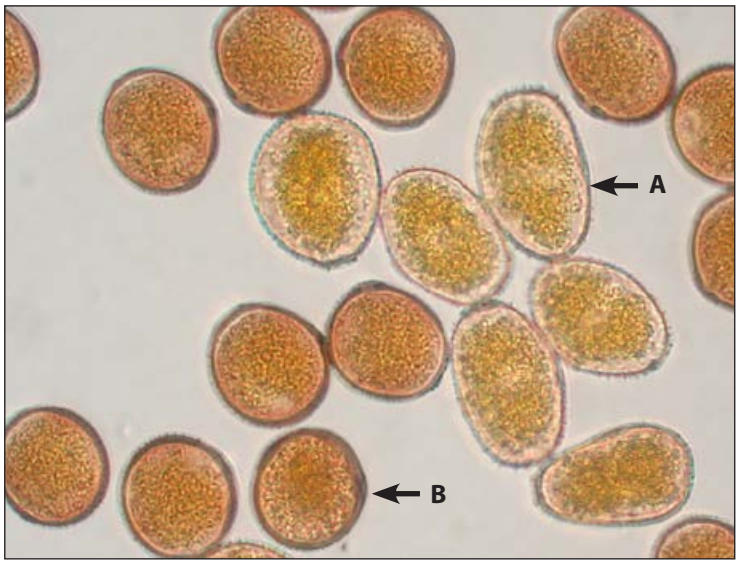

Figure 6. Southern rust spores (A) are lighter and slightly more elongated than common rust spores (B), which are darker and circular.

Diseases, Disorders, and Injury with Similar Symptoms

Diseases

Common Rust (*Puccinia sorghi*)

Common rust produces brick-red to brown elongated pustules that break through the leaf surface and produce dusty spores (Figure 7). Pustules appear on the upper or lower leaf surfaces in the low- to mid-canopy. Pustules are often scattered across leaf surfaces.

Most yellow dent corn hybrids have moderate to high resistance to common rust, so fungicides for managing common rust are generally unnecessary (sweet corn, seed corn inbreds, and other specialty corn types may be exceptions). Therefore, it is important to correctly diagnose the disease, because foliar fungicides are more likely to be warranted when southern rust is present. Both rust fungi can infect the same plant, which can complicate diagnosis.

How to distinguish common rust from southern rust:
Common rust pustules appear on both upper and lower leaf surfaces, tend to be spread out, and are not densely clustered. Conversely, southern rust pustules typically form on upper leaf surfaces, and are densely clustered.

Figure 7. Common rust pustules (right) are generally more scattered and darker red-brown in color than southern rust pustules (left), which are grouped closer together and orange in color.

Physoderma Brown Spot (*Physoderma maydis*)

Physoderma brown spot produces small, round, yellow-brown lesions that often occur in bands across the leaf (Figure 8). Dark purple to black circular lesions occur on the midrib of the leaf.

How to distinguish Physoderma brown spot from southern rust:
Physoderma brown spot leaf lesions do not have spores that can be brushed off the leaf like southern rust has. Purple to black lesions on the midrib also distinguish Physoderma brown spot from southern rust.

Figure 8. Physoderma brown spot lesions do not erupt with pustules like southern rust lesions do. Physoderma brown spot also produces dark purple to black spots on the leaf midrib.

Eyespot (*Aureobasidium zeae*)

Eyespot lesions are tiny (1/8-1/4 inch, 3-6mm), clustered, circular spots with tan/brown centers (Figure 9). Each lesion forms a translucent yellow halo around the margin, which you can easily observe if you hold the leaf to the sun. Leaf blighting may occur when these lesions join, which kills large portions of leaf tissue.

How to distinguish eyespot from southern rust:
The fungus that causes eyespot does not produce the raised, orange pustules that develop on the leaf surfaces of plants infected with southern rust.

Figure 9. Eyespot lesions have yellow halos when held up to a light, but they do not produce raised, orange pustules.

Curvularia Leaf Spot (*Curvularia* spp.)

Curvularia leaf spot produces faint, tan to yellow halos on leaves (Figure 10). These spots are most frequently observed in the upper canopy.

How to distinguish Curvularia leaf spot from southern rust:
In general, you can observe Curvularia leaf spot lesions by looking up through the crop canopy from the ground level. Check a lesion with magnification. Curvularia lesions will not sporulate.

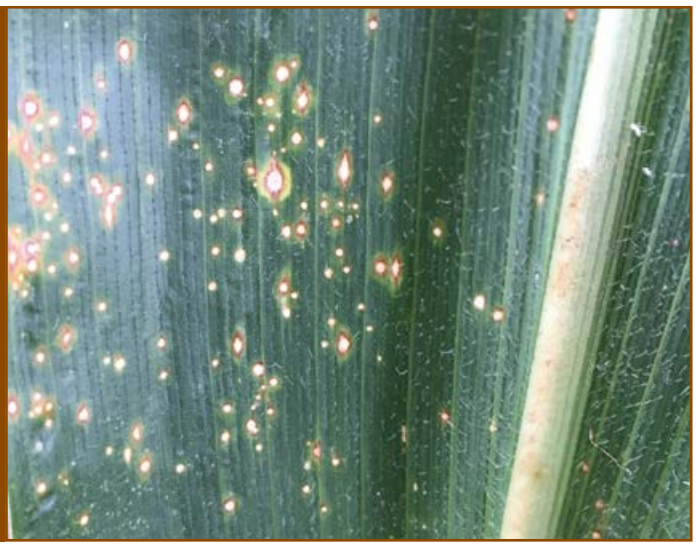

Figure 10. Curvularia lesions appear with yellow halos and can be observed by looking up through the canopy.

Tar Spot (*Phyllachora maydis*)

Leaves with tar spot have small, raised, round, and shiny black fungal structures that can be surrounded by narrow tan halos (Figure 11). These structures (ascomata) are raised and feel bumpy to the touch. Leaves may have a few ascomata, or ascomata can densely cover the leaf.

How to distinguish tar spot from southern rust:
Tar spot ascomata appear smooth and raised, but they cannot be rubbed off the plant tissue like southern rust fungus spores can. Since tar spot ascomata are easily confused with southern rust telia (dark pustules) late in the season, a laboratory may need to confirm the diagnosis.

Figure 11. Tar spot ascomata look similar to southern rust telia; however, ascomata cannot be scraped from the leaf surface.

Other Conditions

Genetic Disorders

Genetic disorders (such as genetic leaf flecking or spotting) affect all leaves on a single plant or on a few randomly scattered plants in the field and do not spread to other plants (Figure 12).

How to distinguish genetic disorders from southern rust:
Most genetic disorders occur only on a few scattered plants in a field. Southern rust tends to occur on many plants that can be in localized or widespread areas of a field. Genetic disorders will not produce raised pustules or spores. Unlike southern rust, genetic disorders do not spread from plant to plant.

Figure 12. Genetic leaf spots will not spread from plant to plant and do not have spores that can be rubbed off.

Spider Mite Injury

Spider mites pierce leaf cells and feed on the contents. The upper surfaces of affected leaves can have white or yellow spots (sand-blasting) due to feeding injury (Figure 13).

How to distinguish spider mite injury from southern rust:
When spider mites are present, you can observe a fine webbing on the underside of the leaf and you may see very small black moving dots. You can shake spider mites off the leaf onto a white piece of paper where you can see them move around. Magnification is not necessary. Spider mites are more likely to cause injury when conditions are dry, whereas, southern rust will be more prevalent when conditions are moist.

Figure 13. This photo shows spider mite feeding (sandblasting) and fine webbing on leaf.

Table 1. Symptom distribution and expression for diseases and disorders with symptoms similar to southern rust.

Disease, Disorder, or Injury	Fungal Structure	Color	Lesion Distribution	Location on Plant
southern rust	Raised bumps (pustules) with spores that can be wiped off	Orange to light brown; older pustules may turn black	Pustules generally densely grouped and often occur at tassel stage (VT) or beyond	Nearly all pustules appear on upper leaf surface
common rust	Raised bumps (pustules) with spores that can be wiped off	Brick-red to brown; older pustules may turn black	Individual pustules may not be densely grouped together; often starts at late vegetative stages	Pustules are produced on upper and lower leaf surfaces
tar spot	Raised bumps (ascomata)	Black	Ascomata are densely grouped; often occurs at tassel stage (VT) or beyond	Moves up from bottom leaves to upper leaves, leaf sheath, and husks
Curvularia leaf spot	None	Tan to yellow	Small patches on individual leaves to large patches on multiple leaves in an entire field	Lesions generally produced on leaves in the upper canopy
eyespot	None	Tan/brown centers with yellow halos	Individual lesions and patchy clusters; occurs anytime	Small yellow lesions; no pustules produced
Physoderma brown spot	None	Yellow to brown on leaf, with purplish to black lesions on leaf midrib	Clusters and bands; often found at tassel stage (VT) and beyond	Purple to brown lesions on leaf and midrib; no pustules produced
genetic disorders	None	Small, round flecking to large lesions on most of the leaf	Individual lesions; can occur at any growth stage	All leaves of plant affected; no pustules produced
spider mites	None	White to yellow mottled leaves	Sandblasting appearance of leaves	Starts on lower leaves on plants near field edges or grassy areas
herbicide drift	None	Will vary with herbicide active ingredients	Will vary depending on circumstance; may also affect other plants (weeds, etc.)	Will often be a gradient of affected plants to less-affected plants from field edge into the field

Management

Tracking Southern Rust Movement

The Integrated Pest Information Platform for Extension and Education (iPiPE) helps track the movement of southern rust throughout the season (Figure 14). It is available online at ext.ipipe.org.

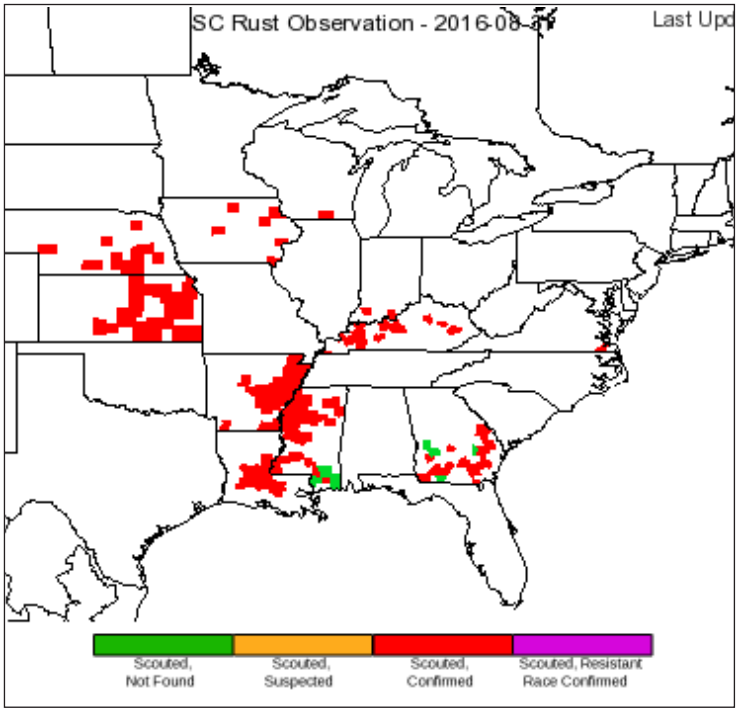

Figure 14. The Integrated Pest Platform for Extension and Education (iPiPE) tracks southern rust movement during the growing season. Note that the map may display "gaps" where active monitoring and scouting for southern rust may not be occurring.

Resistant Hybrids

Most hybrids are susceptible to southern rust, but a few resistant hybrids may be available. Resistant hybrids may contain a specific type of gene (known as an *Rpp* gene) that confers resistance to southern rust. Some moderately-susceptible hybrids may be available that do not contain specific *Rpp* genes. Such hybrids may use multiple genes that slow down southern rust development. Many inbred lines for hybrid production, sweet corn, popcorn, and specialty corn hybrids are highly susceptible to the disease.

In 2008, researchers discovered a new strain (race or pathotype) of the southern rust fungus in Georgia that was able to cause disease on hybrids that utilized the *Rpp9* resistance gene. This new race of the southern rust fungus has increased the importance of the disease in southern areas, and scouting programs have been implemented in the region to monitor fields for southern rust more carefully.

Foliar Fungicides

Fungicides are effective at protecting uninfected leaf tissue from southern rust; however, there currently is no economic threshold for fungicide applications. Factors to consider include corn stage of development, yield potential, threat or observation of southern rust in the field or region, type of irrigation, and environmental conditions that favor disease development.

Applying fungicides between the silking (R1) and milk (R3) stages when southern rust has been detected are most beneficial at protecting corn yield potential. However, additional applications may be needed for season-long crop protection, depending on the timing of disease onset (Table 2). Applying a fungicide to field corn within two weeks (50 percent starch line) of physiological maturity (black layer) is unlikely to provide an economic benefit.

The Corn Disease Working Group updates foliar fungicide efficacy guides each year that contain more specific information about fungicide modes of action and commercial availability. For a current fungicide list, see *Diseases of Corn: Fungicide Efficacy for Control of Foliar Corn Diseases* (Purdue Extension publication BP-160-W), available from the Education Store, edustore. purdue.edu.

Table 2. Possible benefits (by growth stage) from applying fungicides to protect against southern rust.

Crop Stage When Southern Rust Is First Detected	Possible Benefit from Spraying	Comment
Vegetative	Not likely to find southern rust at this stage unless corn is planted very late for the region	Scout fields for disease
VT (tasseling)	Yes	May need a second spray
R1 (silking)	Yes	May need a second spray
R2 (blister)	Yes	Less likely to need a second spray
R3 (milk)	Yes	No second spray needed
R4 (dough)	Maybe, with severe disease pressure	No second spray needed
R5 (dent)	Unlikely	No second spray needed
R6 (black layer)	No	

Cultural Practices

Cultural practices do not influence southern rust development, because the fungus does not survive in crop residue. However, planting date may influence southern rust development, because the risk of yield-limiting disease levels increases when corn is planted late (Table 2).

Find Out More

Other publications in the *Corn Disease Management* series are available on the Crop Protection Network website (cropprotectionnetwork.org).

More information is about the new strain of southern rust is available in the journal, *Plant Disease*:

Dolezal, W., K. Tiwari, R. Kemerait, J. Kichler, P. Sapp, J. Pataky. 2009. An unusual occurrence of southern rust caused by Rpp9-virulent *Puccinia polysora,* on corn in southwestern Georgia. *Plant Disease* 93:676.

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GRAIN FARMERS OF ONTARIO

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