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Frogeye Leaf Spot of Soybean

Linda Weber, Graduate Research Associate, Department of Plant Pathology, The Ohio State University. Dana Martin, Research Associate, Department of Plant Pathology, The Ohio State University.

Anne E. Dorrance, Professor, Department of Plant Pathology, The Ohio State University.

Frogeye leaf spot of soybeans has been consistently diagnosed in several fields in Ohio throughout the past decade, especially in those fields planted with highly susceptible varieties. This disease is more common in the southern United States in regions with warm, humid environments. However, yield and seed quality reduction from this disease can still occur in Ohio, especially on food grade and seed production fields.

Causal Agent

The causal agent of Frogeye leaf spot is the fungus *Cercospora sojina*. In the lab, the fungus sporulates best on V8 or lima bean agar, producing elongate conidia. In 2008, one study classified 93 isolates of *C. sojina* collected worldwide into 11 races. More diversity among races as well as more physiological races have since been detected.



Figure 1. Comparison of frogeye leaf spot in a highly susceptible variety (left) to one with moderate levels of resistance (right).



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Symptoms and Signs

Symptoms are most commonly observed shortly after flowering to early maturity on leaves in the upper part of the canopy. Young leaves are extremely susceptible while older leaves are more resistant. Lesions appear as small, gray spots with reddish-brown to purple borders (Figure 1). On the underside of the leaf, the lesion appears brown to gray with tiny dark "hairs" (Figure 2). These hairs are the long conidia, or infective spores, of the fungus. Smaller lesions may coalesce to form larger, irregular spots on leaves. In severe cases, frogeye leaf spot can cause premature leaf drop and, if rainfall and humidity persist, stems and pods may also become infected. Lesions on pods are reddish brown, shrunken, and circular to elongate in shape. Older lesions on pods become brown to dark gray, usually with a narrow, dark brown border.

Disease Cycle

Extended periods of wet weather during the growing season will favor disease development. The pathogen overwinters on crop residue left on the soil surface. Rain splashing on the residue will carry spores to young leaves. It takes 7 to 12 days after spores infect the plant for symptoms to develop, depending on the temperature. From these primary lesions, more conidia develop which can spread to new leaves on the plant throughout the same growing season. Spores can also be carried by winds to surrounding fields. Hurricane Dennis in 2005 is believed to have brought this fungus to Ohio, based on sentinel plot observations that year. If the first symptoms of this disease are detected late in the season (at or after growth stage R4-R5) there is very little impact on the plant. However, if this cycle begins prior to or at flowering, then substantial amounts of disease can develop on plants that will impact vield.

Previously, this disease was believed to be a problem limited to Southern states due to low survival rate of inoculum from freezing temperatures in northern states. However, a 2007 study in Ohio the residue from two soybean fields, which were heavily infected with *C. sojina*, was monitored throughout the winter. At both locations, conidia of this fungus were recovered throughout the winter



Figure 2. On left, frogeye lesions scattered over the upper surface of the leaf. On right, the same lesions as viewed from the underside of the leaf. Note "whisker" appearance inside lesions which are the conidia or spores of this fungus.

and more importantly, into the spring. Thus, this fungus could indeed overwinter here in Ohio.

Disease Management

Host Resistance: Plant varieties that are resistant to Frogeye leaf spot. This disease is effectively managed via single genes (*Rcs* genes). *Rcs*³ is still effective against all U.S. populations, including Ohio.

Identification: Scout susceptible varieties for the presence of frogeye leaf spot. The scale in figure 4 may be used to estimate the percent leaf area affected. Fungicides have been shown to be highly effective when 1 or 2 lesions were found every 25 feet at soybean growth stage R2 (full flowering).

Cultural Practices: In fields where very high levels of disease develop, burying residue and/or crop rotation become very important. Crop residue should be fully buried. If residue cannot be buried then crop rotation to non-host crop is the next best step. *C. sojina* can overwinter in Ohio and planting soybeans back into infested residue increases the chance of an epidemic occurring the following season. Soybeans should not be planted for at least one year followed by planting resistant variety.

Fungicide Applications: When frogeye lesions are found on plants prior to soybean growth stage R3 (pods formed at the top nodes of the plant), fungicide applications may be warranted on highly susceptible varieties. This is entirely dependent on the occurrence of extended weather conditions that favor infection and lesion development. Hot, dry conditions will arrest disease development and prevent further spread within the crop canopy. Pathogen resistance to Quinone outside inhibitors (QoI), strobilurin fungicides, has been detected in Ohio.



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Figure 3. Ohio county map showing the presence of quinone outside inhibitors (QoI) fungicide resistance (G143 mutation) in frogeye leaf spot pathogen samples detected from 2015-2017 by county.

Isolates of *Cercospora sojina* recovered from frogeye leaf spot samples were tested for strobilurin fungicide sensitivity by detecting the presence of the G143A mutation that confers QoI fungicide resistance. The presence of the G143 mutant in several counties across Ohio suggests the continued development of strobilurin fungicide resistance in *C. sojina* populations.

	OARDC- Wooster (Wayne Co.)				Wes	Western Agricultural Research Station (Clark Co.)			
Winter	<17°F	17-27°F	28-36°F	>36°F	<17°F	17-27°F	28-36°F	>36°F	
1983-84	20	22	24	25	17	21	28	25	
1984-85	20	25	18	26	19	23	21	26	
1985-86	18	23	34	15	19	22	33	16	
2005-06	7	22	28	33	6	22	30	32	
2006-07	14	19	23	34	14	18	27	31	
2007-08	12	22	38	19	12	20	37	22	
2012-13	6	12	27	22	5	16	29	33	
2013-14	24	18	30	18	27	20	28	15	
2015-16	10	12	29	37	11	10	29	40	
2016-17	7	19	29	33	8	16	32	34	

Table 1. Comparison of the number of days at critical temperatures during the months of December, January, and February. In recent years, there have been fewer days below 17°F resulting in higher pathogen survival rates over winter months.

Useful References

Crop Protection Network – Frogeye Leaf Spot

http://cropprotectionnetwork.org/soybean/frogeye-leaf-spotcpn-1017/

Plant Health Progress – Cruz & Dorrance

http://www.plantmanagementnetwork.org/pub/php/research/ 2009/frogeye/



Figure 4. A quantitative scale that can be used to measure disease severity of Frogeye leaf spot on soybean leaves.

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