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Managing Foliar Diseases in Soybean

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Fungicide resistance is a growing problem in soybean production. This NebGuide discusses four common foliar diseases that can reduce soybean yields and how to control them with fungicides and other management practices.

Integrated Pest Management

The use of foliar fungicides in soybean production has increased dramatically in the last 10 years. From 2004 to 2015, the percentage of planted soybean acres treated with a foliar fungicide rose from 1 percent to 11 percent. The cause of this increase is likely due to several factors, including increased disease prevalence, increased adoption of no-till, and recognized benefits of certain classes of fungicides to positively alter plant physiology. However, field trials still support using an integrated pest management (IPM) program to manage and control soybean diseases.

As part of an IPM program, it is best to consider foliar disease management prior to planting by selecting varieties that were disease resistant in previous years. Also, crop rotation should be a disease management strategy since inoculum can build up in crop residue under continuous soybean production. Despite these preventative strategies, foliar diseases can still reduce soybean yields, and foliar fungicides may be required to control a pathogen. Pathogens require specific modes of action and application timings for effective control, so it is important to understand how to recognize and differentiate soybean diseases that may be present in the field. The following is a description of four common foliar diseases that can reduce soybean yield in Nebraska and how to control them with fungicides and other management practices.

Disease Identification

Brown spot (*Septoria glycines*), Cercospora leaf blight (*Cercospora kikuchii*), frogeye leaf spot (*Cercospora sojina*), and white mold (*Sclerotinia sclerotiorum*) are foliar fungal diseases that should be monitored in Nebraska. Varieties vary in their response to these diseases, but each can significantly impact yield when conditions are favorable for disease development. Since fungicides can vary in their ability to control these diseases, it is important to properly identify which disease is present in the field. For example, bacterial pustule can easily be confused with soybean rust, and fungicides will not control bacterial pustule in soybeans. Making an incorrect identification could result in the wrong treatment for the disease.

Brown spot: Brown spot typically begins in the lower canopy during periods of high moisture or humidity. It is characterized by angular lesions with chlorotic mar-

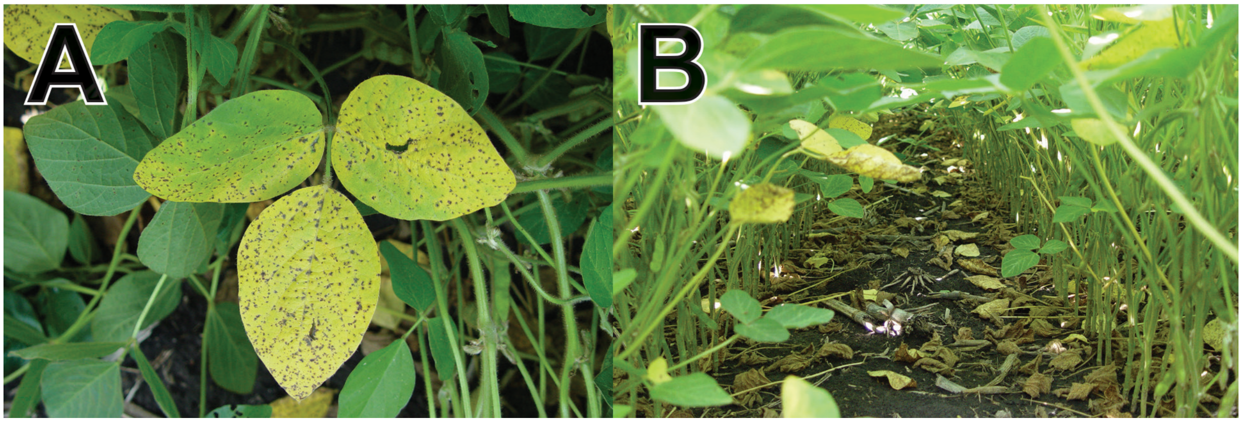

Figure 1: Brown spot on soybeans showing lesions and yellowing leaves (A) and lower canopy defoliation (B).

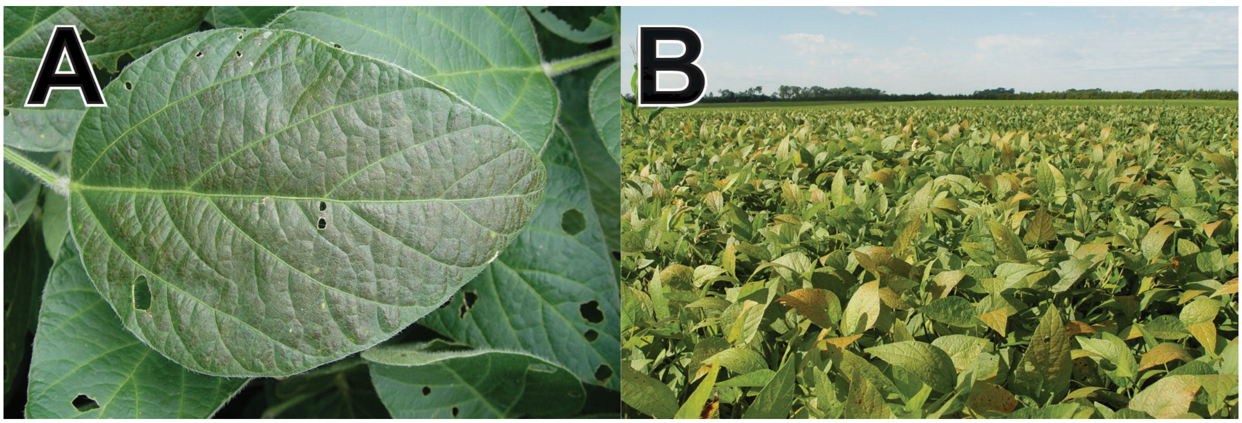

Figure 2. Cercospora blight on soybeans showing upper leaf surface (A) and upper canopy symptoms (B).

gins (*Figure 1*). Lesions can merge together to form large necrotic spots. Lesions will not have a pustule or visible spores. Yield losses typically range from 8 percent to 15 percent in severely affected fields. There are no known sources of genetic resistance, though some varieties may tolerate brown spot better than others. The best management strategy for brown spot is crop rotation.

Cercospora leaf blight: Cercospora leaf blight (CLB) affects leaves in the upper canopy (*Figure 2*). It favors hot temperatures and is characterized by a general bronzing or purpling of the upper leaf surface. Lesions are reddish purple and necrotic blotches form when the lesions coalesce. Yield loss can range from 15 percent to 30 percent nationally, but is typically less than 10 percent in Nebraska. The fungus causing CLB also causes purple seed stain, which can reduce seed quality and contribute to economic losses. Information on variety susceptibility to CLB is usually available from the seed company.

Frogeye leaf spot: Frogeye leaf spot typically develops on younger leaves in the upper canopy (*Figure 3*). Lesions are circular with purple or reddish margins. Older lesions may develop dark centers where the fruiting bodies of the fungus are visible. Yield losses can be as much as 30 percent in the United States. However, losses are much lower in Nebraska—typically less than 10 percent. Crop rotation is an effective management practice, and resistant varieties are also available.

Sclerotinia Stem Rot (White Mold): Infection can occur when conditions are wet and humid, and temperatures are moderate during flowering. The fungus infects soybean flowers, and initial symptoms are visible during pod development. Early stem or pod water-soaked symptoms often initiate near colonized flowers, and leaves may wilt and turn gray-green before turning brown, curling, and dying. In a few days, diseased stem areas are killed and become tan and eventually bleached.

Infected plant parts generally have signs of the fungal pathogen as white, fluffy mycelium (fungal growth) during humid conditions and sclerotia on the surface of or embedded in the stem tissue (*Figure 4*). Yield can be reduced by 2 to 5 bu/ac for every 10 percent increase in incidence at the R7 growth stage. Tillage and short-term crop rotations will not reduce inoculum (pathogen) levels. Fungicide applications can help control the disease, but application timing during bloom is critical for good control. Other management practices that may help reduce disease incidence and severity are delayed planting, wide row spacing, reduced plant populations, and the use of lactofen-containing herbicides.

Resistance Management

Pesticide resistance to herbicides is widely discussed, but resistance to fungicides is also a growing problem. When a single mode of action is selected for disease control, or to enhance plant health in the case of quinone outside inhibitors (QoI), selection pressure is increased for development of resistant fungal strains. *Cercospora sojina*, the causal agent of frogeye leaf spot, is an example of a fungal pathogen that has been identified as having evolved resistance to QoI fungicides. The large amount of genetic diversity found in *C. sojina* allows the fungus to evolve fungicide resistance more rapidly when single modes of action products are used. As more active ingredients are becoming available as generic products, growers must realize the importance of using multiple modes of action even though some products are available at a lower cost. If we are not diligent in managing resistance, we could soon be faced with the same situation challenging us in weed control. Many herbicides are available, but we currently only have three fungicide modes of action that are commonly used commercially. Because the tools in our disease management toolbox for fungal diseases are more limited than those for weed management, it is imperative that we all be good stewards of fungicide use in our row crops.

Disease Control

Some foliar fungal diseases of soybean have similar life cycles, which means controlling one disease may help control other diseases. For example, the pathogens that cause brown spot, Cercospora leaf blight and frogeye leaf spot produce spores that overwinter in soybean residue. If crop rotation is used to manage frogeye leaf spot, incidence of brown spot will also be reduced the next time soybeans are grown in the field. Please refer to *Table 1* for disease response to specific management practices.

Figure 3. Frogeye leaf spot on soybeans.

Figure 4. Sclerotinia stem rot (white mold) on soybeans.

Table 1. Recommended control methods for foliar fungal diseases.

	Control Method				
	Crop Rotation	Tillage	Variety Selection	Fungicide[1]	Fungicide Timing
Brown spot	YES	YES	YES[2]	YES	R3–early R4
Cercospora leaf blight	YES	YES	YES	YES	R3–R5[3]
Frogeye leaf spot	YES	YES	YES	YES	R3–early R4[4]
White mold	NO	NO	YES	YES	R1–R2[5]

1. Follow fungicide label instructions for application rates and timings of product for effective control of each specific disease.

2. Varieties vary in susceptibility, but are not typically rated in variety information profiles.

3. Application timing for Cercospora leaf blight can be made through R5 with late disease onset, but the most probable returns can be expected from applications between R3 and early R4.

4. Application timing results vary and are not consistent for maximum returns with R3–R4 applications.

5. Best results expected with applications during bloom. Limited studies have shown benefits with applications at R3.

Crop Rotation: Rotating to a nonhost crop after soybeans will interrupt the life cycle of certain fungi and reduce the amount of inoculum in the field for the next soybean crop. However, sclerotia of the white mold fungus can survive for a long time without a host crop, so rotations out of soybeans require several cropping seasons and the addition of cereal grain crops to reduce inoculum.

Tillage: Tillage after harvest will bury fungal-infested residue, which will break down more rapidly with soil contact. However, tillage practices may not be possible in no-till operations, or inadvisable if there is a potential for soil erosion.

Variety Selection: Many seed companies screen their genetic lines against specific diseases. Planting a variety resistant to a disease may greatly reduce potential yield losses. Ask your seed company representative for information concerning disease resistance in that company's varieties.

Fungicide Selection and Application: These diseases do not typically cause an economic yield loss except for white mold. However, each can reduce yield when conditions for disease development are favorable. When market prices are higher, preventing small yield losses with a fungicide application may increase profitability. Field history, cropping sequence, variety susceptibility, and scouting should be used to determine the need for a fungicide. Two families of fungicides are primarily used for foliar disease control in soybeans in Nebraska. Quinone outside inhibitor (QoI) fungicides, formerly known as strobilurins, are most effective when they are applied before infection or at the very early stages of disease development.

Triazole fungicides can be applied after infection takes place but are most effective when applied at early stages of disease development. Succinate dehydrogenase inhibitors (SDHI) are a new mode of action that has come to market in limited products and will be important as we manage for fungicide resistance. Refer to *Table 2* for efficacy information regarding different products on specific foliar diseases.

Many product labels recommend beginning fungicide application no earlier than the R1 (beginning flower) growth stage. In Nebraska, foliar diseases typically do not become a problem until the R3 (beginning pod) growth stage. Yield loss caused by foliar diseases primarily occurs from premature leaf drop, reducing the photosynthetic area and the amount of material the plant can produce to form grain, so fungicides must be applied at the correct time to prevent economic losses (*Table 1*). Additionally, follow fungicide labels to ensure proper nozzle selection and application pressure for optimal disease control.

Disclaimer

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by Nebraska Extension is implied for those mentioned.

Disclosure

In accordance with the University of Nebraska-Lincoln's Conflict of Interest policy, the Conflict of Interest Review Committee has determined that it must be disclosed that Dr. Giesler has financial interest in Field Screen, LLC, which receives funding from agricultural companies for pesticide testing in southeast Missouri. For more information on this disclosure, please see his CropWatch biography at http://cropwatch.unl.edu/author/loren-giesler-extension-plant-pathologist#anchor.

Table 2. Relative efficacies of fungicides on foliar diseases that may occur in Nebraska.[1]

Fungicides[2] Class		Product / Trade Name	Active Ingredient(s) (%)	Rate/A (fl oz)	Brown Spot	Cercospora Leaf Blight[3]	Frogeye Leaf Spot[4]	White Mold[5]	Harvest Restrictions[6]
MBC Thiophanates (Group 1)		Topsin® M/ Multiple Generics	Thiophanate-methyl 70.0	10.0–20.0	U	F	VG	F	21 days
DMI Triazoles (Group 3)		Alto® 100 SL	Cyproconazole 8.9	2.75–5.5	VG	F	F	NL	30 days
		Domark® 230 ME / Multiple Generics	Tetraconazole 20.5	4.0–5.0	VG	P-G[7]	G-VG	F	R5 (beginning seed)
		Proline® 480 SC[8]	Prothioconazole 41.0	2.5–5.0	NL	NL	G-VG	F	21 days
		Tilt® 3.6 EC / Multiple Generics[9]	Propiconazole 41.8	4.0–6.0	G	NL	F	NL	R5 (beginning seed)
		Topguard® 1.04 SC	Flutriafol 11.8	7.0–14.0	VG	P-G	VG	F	21 days
SDHI Carboximides (Group 7)		Endura® 0.7 DF	Boscalid 70.0	3.5–11.0	VG	U	P	VG	21 days
QoI Strobilurins (Group 11)		Aftershock® 480 SC / Evito® 480 SC	Fluoxastrobin 40.3	2.0–5.7	G	P	P	NL	R5 (beginning seed) 30 days
		Aproach® 2.08 EC	Picoxystrobin 22.5	6.0–12.0	G	P	P	G-VG[10]	14 days
		Headline® 2.09 EC/SC	Pyraclostrobin 23.6	6.0–12.0	G	P	P	NL	21 days
		Quadris® 2.08 SC	Azoxystrobin 22.9	6.0–15.5	G	P	P	P	14 days
2,6-dinitro-anilines (Group 29)		Omega® 500 DF	Fluzinam 40.0	12.0–16.0	NL	NL	NL	G	R3 (beginning pod)
Mixed Modes of Action	3 +11	Aproach Prima® 2.34 SC	Cyproconazole 7.17 Picoxystrobin 17.94	5.0–6.8	VG	P-G	G	NL	14 days
	3 +11	Fortix® SC / Preemptor® SC	Flutriafol 19.3 Fluoxastrobin 14.84	4.0–6.0	G	U	G	U	R5 (beginning seed)
	3 +11	Quadris® Top 2.72 SC	Azoxystrobin 18.2 Difenconazole 11.4	8.0–14.0	G-VG	P-G	VG	NL	14 days
	3 +11	Quadris® Top SBX3.76 SC	Azoxystrobin 19.8 Difenoconozole 19.8	7.0–7.5	U	U	G-VG	U	14 days
	3 +11	Quilt® 1.66 SC / Multiple Generics	Azoxystrobin 7.0 Propiconazole 11.7	14.0–20.5	G	F	F	NL	21 days
	3 +11	Quilt® Xcel 2.2 SE	Azoxystrobin 13.5 Propiconazole 11.7	10.5–21.0	G	F	F	NL	R6
	3 +11	Stratego YLD 4.18 SC[11]	Trifloxystrobin 32.3 Prothioconazole 10.8	4.0–4.65	VG	F	F	NL	21 days
	7+11	Priaxor® 4.17 SC	Pyraclostrobin 28.58 Fluxapyroxad 14.33	4.0–8.0	E	P-G	P-F	P	21 days
	3+7+11	Priaxor® D							
	3+7+11	Component A	Pyraclostrobin 28.58 Fluxapyroxad 14.33	4.0	VG	U	G-VG	P	R5 (beginning seed) 21 days
	3+7+11	Component B	Tetraconazole 20.5	4.0					
	3+7+11	Trivapro® Co-Pack							
	3+7+11	Trivapro A	Benzovindiflupyr 10.27	4.0	VG	U	VG	NL	R6 14 days
	3+7+11	Trivapro B	Azoxystrobin 13.5 Propiconazole 11.7	10.5					

1. **Efficacy categories: NR=Not recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL=Not Labeled for use against this disease; U=Unknown efficacy or insufficient data to rank product efficacy.** Developed by the North Central Regional Committee on Soybean Diseases (NCERA-137).

2. Table includes available systemic fungicides that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products.

3. Cercospora leaf blight efficacy relies on accurate application timing, and standard R3 application timings may not provide adequate disease control. Fungicides with a solo or mixed QoI or MBC mode of action may not be effective in areas where QoI or MBD resistance has been detected in the fungal population that causes Cercospora leaf blight.

4. In areas where QoI-fungicide resistant isolates of the frogeye leaf spot pathogen are not present, QoI fungicides may be more effective than indicated in this table.

5. White mold efficacy is based on R1-R2 application timing, and lower efficacy is obtained at R3 or later application timings, or if disease symptoms are already present at the time of application.

6. Harvest restrictions are listed for soybean harvested for grain. Restrictions may vary for other types of soybean (edamame, etc.) and soybean for other uses such as forage or fodder.

7. Ranges of ratings occur based on difference among trials conducted by multiple specialist groups.

8. Proline has a supplemental label (2ee) for soybean, only for use on white mold in IL, IN, IO, MI, MN, NE, ND, OH, SD, WI. A separate 2ee for NY exists for white mold.

9. Multiple generic products containing this mode of action may also be labeled in some states.

10. Rating is based on two applications of a 9 oz/ac rate of Aproach at R1 and R3.

11. Stratego YLD has a supplemental label (2ee) for white mold on soybean only in IL, IN, IA, MI, MN, NE, ND, OH, SD, WI.

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