



FUNGUS FOLIAGE DISEASES OF SOYBEANS

A number of fungi produce spots on soybean leaves. During a particular growing season, crop damage in any given area varies greatly, depending on weather conditions and the disease-causing fungi present. Foliage diseases are worse in wet years than dry ones, but they rarely cause serious economic losses. In most years, one or more of these diseases can be found in 90 percent or more of the soybean fields in Illinois.

BROWN SPOT

Symptoms

Brown spot, or Septoria brown spot, is caused by the fungus *Septoria glycines* (teleomorph *Mycosphaerella uspenskajae*). The disease has become more important in Illinois during recent years. It appears early in the growing season as small spots that are somewhat angular to irregular and light to dark brown (Figure 1). The spots develop on both surfaces of the lower leaves. Some heavily infected leaves quickly turn yellow and drop off. During warm wet periods the fungus moves progressively up the plant; and, if severe, may cause extensive defoliation and major yield reduction. Late in the growing season, infected leaves become a rusty-brown before dropping off prematurely. Brown lesions of an irregular size and shape with indefinite margins develop on the main stem, branches, petioles, and pods of the maturing plants. Symptoms on these organs are not sufficiently distinct from those of other diseases to be diagnostic.



Figure 1: *Septoria Brown Spot* symptoms on soybean leaves.

Brown spot is most severe when soybeans are grown continuously in the same field. Areas with poor drainage favor the spread of the *Septoria* fungus. Yield reductions of 8 to 15 percent or more are common.

Disease Cycle

The *Septoria* fungus overwinters in diseased crop debris as minute brown fruiting bodies (pycnidia) and mycelium in infected leaf and stem debris and in diseased seeds. During wet weather, the microscopic spores (conidia) produced within the pycnidia on living or dead plant parts are discharged. The needle-like spores are splashed by rain or blown by the wind onto healthy leaves where infection takes place. Lesions that develop on infected cotyledons and unifoliate leaves provide spores for later infections.

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Infection and disease development are favored by warm, moist weather. The spread of the disease is checked by hot, dry weather. The fungus enters the soybean plant through stomata and grows between the cells, killing those next to the fungal hyphae. Pods are penetrated through stomata or by growing through placental and funicular tissue, later invading the seed coat.

Resistant cultivars are not available. Some differences in susceptibility between cultivars has been observed. Determinant cultivars tend to suffer more from this disease than do indeterminate cultivars.

DOWNY MILDEW

Symptoms

This disease is caused by the fungus *Peronospora manshurica* (synonym: *P. sojae*). Downy mildew frequently is prevalent over most of Illinois. The first symptoms are the appearance of indefinite, yellowish green areas on the upper leaf surface. These areas later enlarge and turn a pale to bright yellow to a grayish brown or dark brown and are surrounded by yellowish green margins (Figure 2).



Figure 2. Downy mildew: Left, early stage; Center and right, advanced stages.

Downy mildew can be readily distinguished from other soybean diseases by tufts of a grayish to pale purplish mold on the lower leaf surface in humid weather (Figure 3A). Severely infected leaves turn yellow, then brown, curl at the edges, and drop early. The causal fungus also grows within the pods and may produce a whitish, crusty growth of mycelium and oospores on the seed. Oospore-encrusted seeds often appear dull white and have cracks in the seed coat (Figure 3B). The disease causes some defoliation, lowers seed quality, reduces seed size, and may cause yield reductions of up to 8 percent.

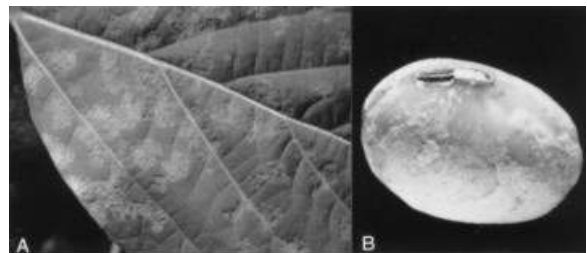


Figure 3. Downy mildew. A. Tufts of mold on lower leaf surface (courtesy C.T. Schiller); B. Oospore-encrusted seed.

Disease Cycle

The *Peronospora* fungus overwinters as thick-walled oospores in infected leaves and on seed. Seedling hypocotyls are also infected by soilborne oospores. Planting infected seeds can produce a few systemically infected seedlings under cool conditions. Such plants remain small—with mottled, gray-green leaves that curl downward. Microscopic conidia (or sporangiospores) produced in the downy growth on newly infected leaves during moist weather are disseminated by air currents. Spores that land on leaves may germinate within 12 hours and penetrate the leaf through stomata or directly by forming appressoria and penetration pegs.

Older leaves are resistant to infection. The number of lesions increases and the size decreases as the leaves age. Downy mildew is favored by high humidity and a temperature of 68° to 72° F (20° to 22° C). The production of spores occurs between 50° and 77°F (10° to 25°C) with no sporulation above 86°F (30°C) or below 50°F (10°C).

Over 30 physiological races of the causal fungus have been identified in the United States on the basis of disease reactions, using a set of differential cultivars. This greatly complicates the development of resistant varieties.

FROGEYE LEAF SPOT

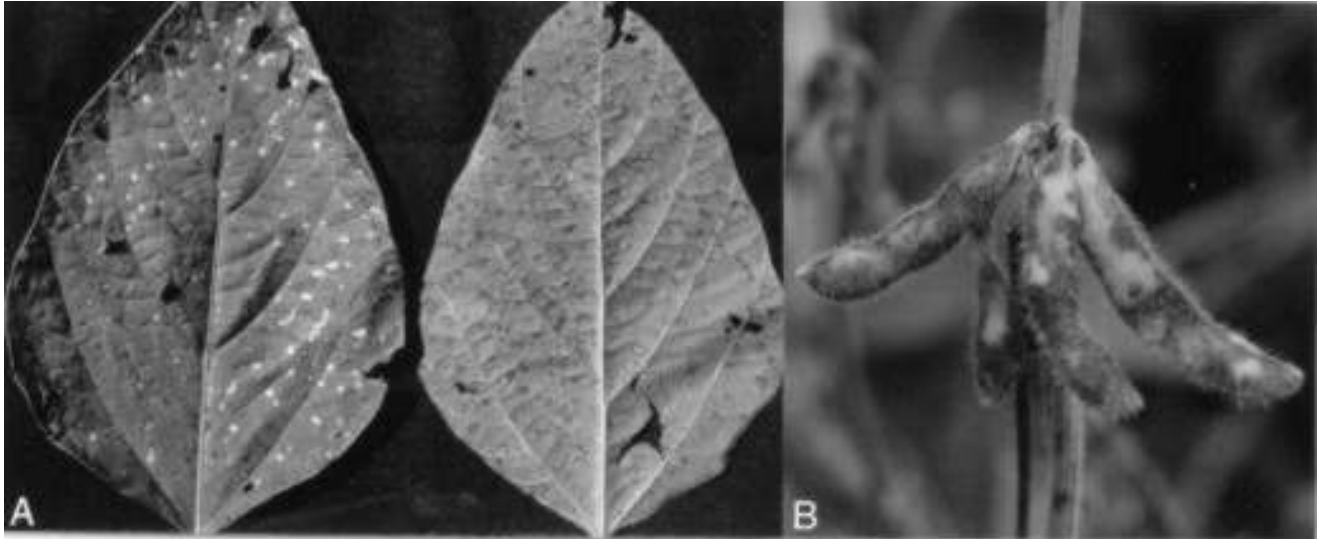


Figure 4. Frogeye leaf spot caused by *Cercospora sojina*. A. Lesions on upper and lower leaf surfaces; B. Lesions on pods (courtesy J.T. Yorinori).

Symptoms

This disease, caused by the fungus *Cercospora sojina* (synonym: *C. daizu*), was formerly common in the southern half of Illinois. Now, it is rare because of the widespread use of resistant cultivars. Frogeye can be recognized by the small, round to angular “eye spots” on the leaves. The ash-gray to light brown central area is surrounded by a narrow, darker, somewhat purplish to reddish brown border. The distinct border and dark gray clusters of spore-bearing fungus structures (conidiophores) in the center of the spot—mostly on the underleaf surfaces—make frogeye easy to identify (Figure 4A). There is no yellow zone around the spots. Several lesions may merge to form large, irregular spots. Severely spotted leaves wither and drop early. Stems and pods may become infected late in the growing season. Lesions on young stems are elongated and deep red, with a narrow, dark brown to black border. Later, the lesions turn brown, then a pale smoky-gray, and finally almost black, due to clusters of conidiophores and numerous conidia. Lesions on ripe pods are circular to elongate, reddish brown to light gray and usually bordered by a dark brown ring (Figure 4B). The fungus may grow through the pod wall into maturing seeds. Infected seeds develop areas that are light to dark gray or brown which vary from specks to large blotches covering the entire seed coat. Such areas may show alternating bands of light and dark brown. Usually, there is some cracking or flaking of the seed coat. When susceptible cultivars are grown, yields may be reduced as much as 15 percent. Seed quality is lowered by discoloration and by the lower germination of infected seed.

Disease Cycle

The *Cercospora* fungus overwinters as mycelium in crop residue and seed. When an infected seed germinates, it may produce a weak and stunted seedling with lesions on the cotyledons. Large numbers

of microscopic spores (conidia) are produced on the cotyledonary lesions in warm, humid weather. The spores begin to germinate within an hour if free water is present. The conidia are carried short distances by air currents and splashing rain and can result in secondary leaf, stem, and pod infections throughout the season under favorable conditions. Young leaves are infected more rapidly than older ones. At least five different races of the fungus are known in the United States.

CERCOSPORA BLIGHT AND LEAF SPOT AND PURPLE SEED STAIN

Symptoms

Cercospora blight and leaf spot, as well as purple seed stain, which occur worldwide, are caused by the fungus *Cercospora kikuchii*. The disease is first observed on the young upper leaves at the beginning of and throughout seed set. The sun-exposed leaves have a light purple discoloration which may darken and extend over the entire upper surface of affected leaves, giving them a dark, reddish purple to bronzed, leathery appearance. Angular, to irregular, reddish purple lesions later appear on both leaf surfaces. The lesions, which vary in size from pinpoint spots to irregular patches, may merge to form large dead areas. Numerous infections result in rapid yellowing and browning of leaf tissues followed by defoliation, starting with the upper leaves. Green leaves usually remain below the defoliated area.



Figure 5. Purple seed stain (courtesy T.M. Sjulín)

Lesions on petioles and stems are reddish purple and slightly sunken. The lesions may merge and girdle affected stems and petioles. The petioles remain attached to the branches but the leaflets commonly drop prematurely. Reddish purple lesions, which later turn purplish black, form on the pods. A general, dark reddish purple discoloration also occurs on the upper stems, petioles, and pods exposed to the sun. Some foliar infections are latent and express no symptoms.

The disease is most conspicuous on the seed. A pink or lavender to a dark purple discoloration in the seed coat easily identifies the disease (Figure 5). The discolored areas range from specks to large, irregular blotches, which may completely cover the surface of the seed. Cotyledons are not usually discolored. Seeds that are invaded by the fungus may not show symptoms.

Severely affected seed is often cracked, rough, and dull. Such seed commonly has a reduced germination percentage. The discoloration of the seed may lower the grade and is objectionable to the producer of pure seed. The purple color disappears after heating and is thus not detrimental to soybean processors. U.S. grading standards, however, do not allow more than 5 percent purple-stained seeds in No. 1 yellow soybeans.

Infected cotyledons are often shrunken, turn dark purple, and drop early. Cotyledon infection may spread to the stem, forming dead areas that may girdle the young stem, killing the plant. Other seedlings are stunted but survive. During seedling emergence, if the weather is warm and humid, a velvety, grayish white mass of conidiophores and conidia may appear on the cotyledons and stems.

Disease Cycle

The *Cercospora* fungus overseasons in diseased leaves, stems, and seeds and infects soybean plants at flowering. If heavily infected seeds are planted, the seed coat may adhere to the cotyledons and emerge with the seedlings. The fungus may grow into the cotyledons and then into the stem of a small percentage of the seedlings. In warm, 73° to 81°F (or 23° to 27°C) humid weather, the fungus sporulates abundantly on the cotyledons, stems, and leaves producing a velvety, grayish white growth of conidiophores and conidia. The microscopic spores are wind-borne and rain-splashed to other leaves and stems where secondary infections occur. Such infections, in turn, produce more conidia that infect other leaves, stems and pods during warm, moist conditions. The fungus grows through the pod wall and spreads through the hilum and into the seed coat, producing the distinctive purple stain.

The fungus can establish symptomless colonization in the seed, cotyledons, leaves and stems. Planting purple-stained seeds may introduce the fungus into a field, but usually has little influence on the amount of purple stain in the resulting crop. Several crops and weeds may serve as alternate hosts of the *Cercospora* fungus.

No public soybean varieties currently recommended for growth in Illinois are highly resistant.

ALTERNARIA LEAF SPOT; POD AND SEED DECAY

Symptoms

Alternaria leaf spot, caused by species of *Alternaria*, appears as dark brown lesions, often with concentric rings, 1/4 to 1 inch in diameter (Figure 6). The spots usually occur on leaves and pods nearing maturity, but occasionally appear on seedlings and on young plants. The lesions enlarge and may merge to produce larger dead areas on the leaves. Infected leaves later dry up and fall early. Dark brown to black pod and seed infections are usually associated with senescence, frost injury, insect feeding, or wounding. Infected seeds are commonly smaller than normal, shriveled and discolored dark brown to black.

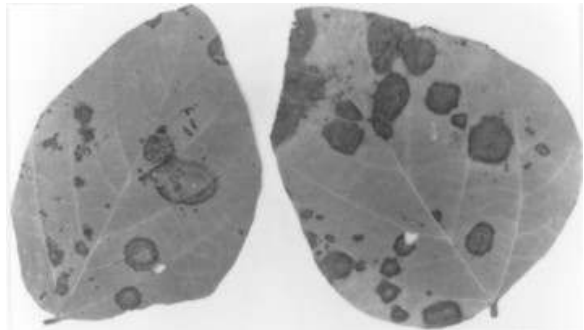


Figure 6. Leaf spots caused by *Alternaria* spp. (courtesy D.W. Chamberlain).

Disease Cycle

The *Alternaria* fungi are seed-borne. Seed invasions occur most commonly through breaks in the pod walls. Infection increases as harvesting is delayed. The disease is favored by warm, moist weather late in the growing season.

ANTHRACNOSE, LEAF AND STEM SPOT

Anthracnose is usually caused by two fungi—*Colletotrichum truncatum* (synonyms: *C. dematium* var. *truncatum*, *C. dematium* var. *truncata*, and *C. glycines*) and *C. destructivum* (teleomorph *Glomerella glycines*)—that produce similar symptoms and may affect soybeans at any stage of growth. Both fungi

have wide host ranges. Symptoms typically appear in the early reproductive stages on stems, pods, and petioles as irregularly shaped brown areas that may resemble pod and stem blight.

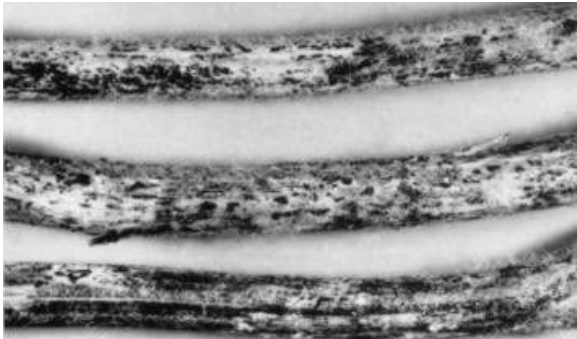


Figure 7. Soybean anthracnose on stems (courtesy T.M. Sjulín).

Stems, pods, and leaves may also be infected but show no symptoms. Anthracnose fungi primarily attack older, mature plants, usually in the late reproductive stages. Indefinite, enlarging areas that are dark brown or reddish brown may cover the surface of infected stems and pods. Later, these areas may become black-speckled with fungus fruiting bodies (acervuli), which form black spines (setae) that can be seen with the unaided eye (Figure 7). The lower, shaded leaves and branches may die and fall prematurely. Young pods may be attacked and killed. Infected seed within diseased pods may be shriveled, dark brown, and moldy or fail to form. Less severely infected

seed may show no external sign of infection. Germinating seeds may be killed before or after emergence. Dark brown, sunken cankers develop on the cotyledons of emerging seedlings. The anthracnose fungi may grow from infected cotyledons into young stems where small deep-seated cankers may form that kill young plants.

Disease Cycle

Both of the principal anthracnose fungi overseason as mycelium in diseased crop residue or in infected seeds. Planting infected seed may cause the seedlings to die (damping-off) before or after they emerge. Seedlings may also be infected, but may show no symptoms until the plants begin to mature. Secondary stem and pod infections mostly occur in the reproductive stages from bloom to pod fill during warm, moist weather (below 95°F, 35°C) when free moisture is present for 12 hours or longer.

PHYLLOSTICTA LEAF SPOT

Symptoms

Phyllosticta leaf spot or leaf blight, caused by *Phyllosticta sojicola* (synonym: *P. glycines*), teleomorph *Pleosphaerulina sojicola*, is a minor disease in Illinois, rarely spreading beyond the first few trifoliate leaves. Where the disease is severe, young plants may be partially defoliated, but they recover rapidly. Areas that are pale green, round-to-oval, or V-shaped appear at the tips or margins of the leaves of young plants. These areas become tan to dull gray in 1 to 3 days with a narrow, dark brown or purplish border. Numerous small, black specks (fungus fruiting bodies, or pycnidia) form in older lesions (Figure 8). The fungus may grow from the leaf blades into the petioles and then to the stipules and stem tissues at the leaf scar. Superficial, light gray, tan or brownish lesions with a narrow, brown or purplish border may form on the petioles, stems, and pods. The pod lesions are roundish with a reddish margin. Seeds located beneath the pod lesions may become infected.



Figure 8. *Phyllosticta* leaf spots (U.S. Department of Ag photo).

POWDERY MILDEW

Symptoms

Powdery mildew, caused by the fungus *Microsphaera diffusa* (synonyms: *Erysiphe polygoni* and *E. glycines*) is a minor disease of soybeans. White, powdery patches form on both leaf surfaces and on the stems and pods about midseason (Figure 9). These areas may enlarge to cover much of the aboveground plant parts. On very susceptible cultivars, severely affected leaves may turn yellow, wither, and drop prematurely. Heavily infected pods usually contain shriveled, deformed, undeveloped, and flattened seeds.

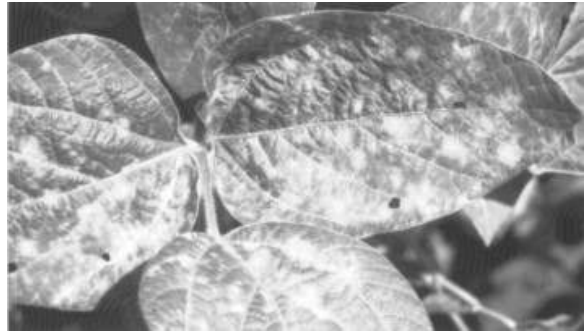


Figure 9. Powdery mildew.

Disease Cycle

The fungus overwinters in speck-sized, black fruiting bodies (cleistothecia) within the mildew colonies late in the fall. Ascospores produced within the cleistothecia are wind-borne in the spring and early summer, producing primary infections. Secondary infections result from other spores (conidia) produced on infected leaves and other plant parts.

Powdery mildew is favored by warm, dry days and cool, damp nights. Cool weather of 65° to 76°F (18° to 25°C) favors disease development, while temperatures above 86°F (30°C) check the growth and reproduction of the fungus. The *Microsphaera* fungus infects a wide range of crop and weed plants.

TARGET SPOT, ROOT AND STEM ROT

Symptoms

Target spot is caused by the cosmopolitan fungus *Corynespora cassiicola* (synonyms: *Cercospora melonis*, *C. vignicola*, *Helminthosporium vignae*, and *H. vignicola*) which infects a wide range of economic plants (Table 1). The disease affects the leaves, stems, pods, seeds, hypocotyls and roots. The reddish brown leaf lesions are round to irregular varying from specks to mature spots a centimeter or more in diameter. A dull green or yellowish green halo commonly surrounds the lesions, which often become concentrically ringed at maturity—hence the name target spot (Figure 10). Severely affected leaves fall prematurely. Dark brown specks to elongated, spindle-shaped lesions form on the petioles and stems. Pod lesions are round and small but may enlarge and merge to cover the entire pod during wet or very humid periods. The fungus may sometimes grow through the pod wall and form small, blackish brown lesions on the seeds.



Figure 10. Target spot (U.S. Department of Agriculture photo).

Round to oval, dark reddish brown lesions form on the hypocotyl and roots sometimes girdling the lateral roots. The lesions turn a dark violet brown when the fungus sporulates, producing masses of conidiophores and conidia. As the soybean plant ages the lesions elongate and merge, frequently girdling the taproot and stem. Entire roots may be discolored. The fungus that infects the hypocotyl, roots, and stems is probably a different species from the one that infects the leaves, pods, and seeds.

Disease Cycle

The *Corynespora* fungus overseasons in infected soybean debris and seeds and can survive in fallow soil for more than two years. The fungus can colonize a wide range of plant residues in soil as well as the cysts of the soybean cyst nematode.

Leaf infections occur when free moisture is present on the leaves and the relative humidity is 80 percent or above. Dry weather inhibits infection and colonization in both leaves and roots. Stems and roots first become infected in the seedling stage. Soil temperatures of 59° to 64°F (15° to 18° C) are optimal for infection and disease development. Large lesions form on the primary roots at 59°F and growth of the secondary roots is retarded. At 68°F (10°C), symptoms are less severe and seedling produce almost normal root systems. No symptoms develop at soil temperatures above 68°F.

Control of Fungus Foliage Diseases

1. Grow only well-adapted, disease-resistant cultivars when available. Cultivars differ in their resistance to powdery mildew, downy mildew, and *Cercospora* blight and leaf spot and purple seed stain. For further information read Illinois Agronomy Handbook, 2000-2001. This publication is revised annually and is available from the University of Illinois Ag Services, P345, 1917 South Wright St., Champaign, IL 61820 (1-800-345-6087) or your nearest Extension office.
2. Plant high-quality, certified, disease-free seed, that has been thoroughly cleaned, in warm, fertile soil. Treat the seed with a fungicide or fungicide mixture. The Agronomy Handbook lists the recommended seed-treatment fungicides.
3. Where water and wind erosion is not a problem, and disease has been severe, cleanly plow-down all crop residue after harvest.
4. Rotate soybeans at least one year or more with corn, sorghum, small grains, alfalfa, or forage grasses.
5. Apply an EPA-approved foliar fungicide from late bloom to pod fill where brown spot, anthracnose, target spot, *Cercospora* or frogeye leaf spot, and purple seed stain are a serious problem. Properly applied and timed sprays also control pod and stem blight and stem canker.
6. Harvest as soon as the soybeans are mature.

Table 1. Economically important plants infected by the target spot fungus *Corynespora cassicola*.

Common name	Scientific name
Cassava	<i>Manihot</i> sp.
Castor bean	<i>Ricinis communis</i>
Cotton	<i>Gossypium hirsutum</i>
Cowpea	<i>Vigna unguiculata</i>
Cucumber	<i>Cucumis sativus</i>
Florida velvetbean	<i>Mucuna deeringianum</i>
Garden bean	<i>Phaseolus vulgaris</i>
Lima bean	<i>Phaseolus lunatus</i>
Mung bean	<i>Vigna radiata</i>
Guar	<i>Cyamopsis tetragonoloba</i>
Blue lupine	<i>Lupinus hirsutus</i>
Yellow lupine	<i>Lupinus luteus</i>
Okra	<i>Hibiscus esculentus</i>
Papaw or papaya	<i>Carica papaya</i>
Pepper	<i>Capsicum frutescens</i>
Rubber	<i>Hevea braziliensis</i>
Sesame	<i>Sesamum indicum</i>
Siclepod	<i>Cassia tora</i>
Tomato	<i>Lycopersicon esculentum</i>
Velvetleaf	<i>Abutilon theophrastii</i>
Watermelon	<i>Citrullus vulgaris</i>