Identification of Late-season Soybean Diseases

Depending on the environmental and agronomic conditions during the growing season, bacterial, fungal, and viral diseases may develop in soybean. Additionally, damage from nematode infestations may be apparent.

Soybean products can respond differently to a disease or diseases based on the plant's genetic resistance, tolerance, or susceptibility. Knowing the resistance level for soybean products can help determine if a disease can become economically damaging. Disease development is greatly influenced by the amount of rainfall or lack of, seasonal temperatures, time of infection, and the interaction of these elements. For some diseases, infection can occur early in the growing season; however, their affect is not notable until just prior to or during soybean reproductive growth stages.

Development of a bacterial disease is generally conditional on plant injury from hail, wind, insects, or mechanical injuries, and movement through the crop by animals, equipment, or humans when plants are wet. The bacteria can enter the plant through the wounds or natural leaf openings (stomates). The bacteria can overwinter on residue and within seeds.

Development of a fungal disease is conditional on infected residue from a previous crop, infected seed, or from spore-carrying winds. With the right temperature and sufficient moisture, spores can be produced on residue and be transmitted to the growing crop through splashing rain or wind. Some fungi-caused diseases are unable to overwinter on previous residue; however, spores can arrive by wind from areas where the disease can overwinter. Foliar fungicides can help protect yield potential depending on the fungal disease and application timing.

Viral diseases are generally vectored by insects such as aphids or bean leaf beetles; however, they can also be seedborne. If the insect vectors are present, their associated viral diseases may be present. Scouting for insects that have the potential to vector viral diseases and applying a timely insecticide may help protect plants from becoming infected; however, many viral diseases cannot be adequately managed by insecticides.

The potential for microscopic nematodes to infest fields depends on geography, soil type, previous crop, tillage, wildlife and livestock movement, and other factors. Soil and plant sampling can help identify the species and level of infection.

Bacterial Blight

Identification, Characteristics, and Diagnosis

- Caused by the bacterium *Pseudomonas syringae pv. glycinea.*
- More prevalent during the early part of the growing season but can appear late.
- Late-season symptoms include the development of angular lesions that form from small, yellow to brown leaf spots (Figure 1).
- Spots appear first in the mid to upper canopy.
- Spot centers turn dark-reddish-brown to black and dry out.
- Tissue around the spots appears water-soaked and develops a yellowish-green halo.
- Dried out lesions can drop from the leaf giving the leaf a shot-holed appearance.
- Seeds may be shriveled and discolored.
- The bacterium overwinters in crop residue and seed.
- Spread by wind-driven rain or splashing water, cultivation when foliage is wet, and moving wildlife.
- Bacterium enters the plant through natural openings and wounds when leaf surfaces are wet.
- Favored by temperatures in the range of 70 to 80°F.

Management

- Consider planting soybean products with higher ratings for resistance or tolerance.
- Rotate to non-susceptible crops.
- Incorporate residue.
- Avoid cultivation when foliage is

Figure 1. Bacterial blight.

Bacterial Pustule

Identification, Characteristics, and Diagnosis

- Caused by the *bacterium Xanthomonas axonopdis (syn. Campestris)* pv. *glycines*.
- Causes premature defoliation, reduced seed size, and reduced seed set.
- Initial symptoms include tiny, pale-green leaf spots with raised centers. Spots can be on either side of the leaf but primarily occur on the lower surface and are near the main leaf veins (Figure 2).
- Later symptoms include the development of light-colored pustules in the center of the spots.
- Pustules may have linear cracks across the top, which contrast to the round openings that appear in soybean rust pustules. Additionally, bacterial pustules do not produce spores.
- In contrast to bacterial blight *(Pseudomonas syringae pv. glycinea)*, water soaking is not present with bacterial pustule.
- Overwinters in crop residue and in seeds.
- Spread by wind-driven rain or splashing water, cultivation when foliage is wet, and moving wildlife.
- Bacterium enters the plant through natural openings and wounds.
- Favored by temperatures in the range of 86 to 92°F.

Management

- Consider planting soybean products with higher ratings for resistance or tolerance.
- Rotate to non-susceptible crops

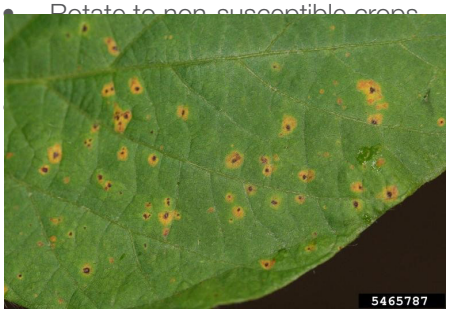

Figure 2. Bacterial pustule.
Photo courtesy of Daren Mueller, Iowa State University. Bugwood.org.

Aerial Blight (Web Blight)

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Rhizoctonia solani* AG1-1A.
- Overwinters as sclerotia in soil or on plant residue.
- Foliar symptoms usually occur during late-vegetative growth stages on lower leaves.
- Initial leaf lesions appear water-soaked and grayish-green.
- Mature lesions are tan to brown (Figure 3A).
- Reddish-brown lesions can develop on petioles, stems, pods, and petiole scars.
- Long strands of web-like hyphae can spread along affected tissue and small, dark-brown sclerotia can form on diseased tissue (Figure 3B).
- Favored by warm (77 to 90°F) temperatures, high relative humidity, and wet weather.

Management

- Plant soybean products with higher tolerance ratings.
- Avoid planting soybean in previous rice fields with a history of sheath blight of rice (same pathogen, different disease name).
- Rotate with poor- or non-host

Figure 3A. Aerial blight
Picture courtesy of T. Allen, Mississippi State University Extension.

Figure 3B. Aerial blight webbing.
Picture courtesy of M. Emerson, University of Arkansas- Division of Agriculture, Cooperative Extension Service, Lonoke Extension Center

Alternaria Leaf Spot

Identification, Characteristics, and Diagnosis

- Caused by fungal species of *Alternaria*, a seedborne pathogen.
- Leaves may become reddish or yellowish.
- Dark-brown lesions, usually with concentric rings, ¼ to 1 inch in diameter usually appear on leaves and pods near soybean maturity throughout the canopy (Figure 4).
- Leaf lesions enlarge and merge together to produce large dead areas.
- Leaves eventually die and fall from the plant.
- Infected seeds are smaller, shriveled, and dark-brown to black.
- Favored by warm, moist conditions late in the growing season.
- Usually a secondary disease after mechanical or insect injury, or another disease.

Management

- Infection usually occurs very late; therefore, management is generally not necessary.
- Many soybean products have resistance.
- Seed treatments may offer protection.
- Apply Delaro® 325 SC Fungicide.

Figure 4. Alternaria leaf spot lesions
Photo courtesy of Robert Mulrooney, University of Delaware.

Anthracnose

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Colletotrichum truncatum.*
- Brown to black, irregularly-shaped lesions on stem, pods, and petioles (Figure 5).
- Premature defoliation can occur from petiole girdling.
- Infected pods may be filled with mycelium instead of seeds, or seeds may be fewer and/or smaller and can also be brown, moldy, shriveled, or normal in appearance.
- Dark spines or setae stick out from the acervuli (fruiting bodies) within the lesions.
- Leaves roll and exhibit necrosis of veins between the major veins.
- Favored by warm, wet, humid conditions.
- Infected seeds may fail to germinate.
- Infected seedlings develop dark, sunken cankers on the cotyledons, epicotyl, and radicle resulting in seedling damping-off.

Management

- Crop rotation to non-host crops.
- Incorporation of infested residue.
- Plant disease-free seed and/or treat seed with a recommended fungicide.
- Apply Delaro® 325 SC Fungicide. To learn more about Delaro® 325 SC Fungicide, please visit https://www.cropscience.bayer.us/products/fungicides/delaro and

Figure 5. Anthracnose lesions on a soybean stem.
Photo courtesy of Daren Mueller, Iowa State University, Bugwood.org.

Brown Stem Rot (BSR)

Identification, Characteristics, and Diagnosis

- Caused by the soilborne fungus *Cadophora gregata*.
- Foliar symptoms occur when pods begin to fill, about R3 to R4 growth stages; however, infection occurs early in the season through the roots.
- Depending on the environment and pathogen genotype, leaf necrosis may (genotype A) or may not (genotype B) occur along with vascular browning.
- A pathogen-produced toxin is believed to cause interveinal chlorosis and necrosis.
- Infected leaves remain attached to the plant.
- The pith of longitudinally-split stems is a light to dark, chocolate-brown color (Figure 6).
- Favored by cool weather during pod fill and soil pH less than 6.5.
- BSR foliar symptoms resemble those of sudden death syndrome (SDS) and northern (NSC) and southern stem canker (SSC). To distinguish, BSR develops a brown pith and no root rot, SDS plants retain a white pith and have root rot, and the stem cankers produce reddish-brown cankers' near the nodes and no root rot.

Management

- Residue management through tillage can help reduce pathogen survivability.
- Crop rotation to non-host crops such as corn or small grains for a minimum of three years can help

Figure 6. Brown discoloration of soybean stem pith due to brown stem rot.

Cercospora Leaf Blight

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Cercospora kikuchii*.
- Usually noticed during reproductive growth stages.
- Light- to dark-purple areas develop on sun-exposed leaves and eventually cover the entire leaf.
- Leaves become leathery, dark, reddish-purple, bronzed, and/or blighted (Figure 7).
- Infected pods may have a purplish discoloration.
- The fungus also causes purple seed stain (Figure 8).
- Overwinters in infested debris and infected seed.
- Favored by extended periods of dew and high relative humidity.

Management

- Apply Delaro® 325 SC Fungicide. To learn more about applying Delaro® 325 SC Fungicide, please visit https://www.cropscience.bayer.us/products/fungicides/delaro and contact your retailer.
- Earlier-maturing soybean products may not be infected.
- Some soybean products have higher tolerance levels.
- Rotate to non-host crops.

Figure 7. Cercospora leaf blight.

Figure 8. Purple seed stain.
Picture courtesy of Adam Sisson, Iowa State University. Bugwood.org.

Charcoal Rot

Identification, Characteristics, and Diagnosis

- Caused by the soilborne fungus *Macrophomina phaseolina*.
- Infection generally occurs within two to three weeks after planting when soils are wet; however, the disease becomes dormant unless hot, dry conditions occur during the growing season.
- During reproductive growth stages, developing leaves may be small, rolled, lose vigor, turn yellow, wilt, die, and remain attached to petioles.
- Infected plants may mature early and develop tiny, black sclerotia that resemble charcoal powder beneath the epidermis on the lower stem, taproot, and pith (Figure 9).
- Black streaks may develop in the woody portion of the crown.
- Lower stems may appear silvery or light gray.
- Favored by high temperatures and light-colored soils under drought conditions. Infected plants may be noted first on field edges and ridges where soil is more prone to drought.

Management

- Plant soybean products that have higher levels of tolerance or resistance.
- Plant early-maturing soybean products early to reduce the potential of plants achieving reproductive growth stages during typical high-heat months.
- Plant a non-host crop for one to two years to help reduce pathogen populations.
- Use conservation tillage and planting methods to conserve soil moisture.
- Maintain fertility.
- Avoid high seeding rates and if possible, irrigate to help reduce

Figure 9. Charcoal Rot.

Downy Mildew

Identification, Characteristics, and Diagnosis

- Caused by a fungus-like organism, *Peronospora manshurica*.
- Overwinters in the soil and in infested crop debris.
- Infection occurs in the spring when oospores germinate and infect seedlings.
- Upper surfaces of young leaves develop pale-green to light-yellow spots which enlarge into pale- to bright-yellow lesions (Figure 10).
- White to gray fungal tufts develop on the underside of the lesion.
- Oldest lesions become grayish-brown to dark-brown with yellowish-green margins.
- Favored by high humidity levels.

Management

- Plant resistant soybean products.
- Rotate with a non-host crop for one year or more.
- Rarely affects yield; therefore, foliar fungicides are not recommended.
- Residue management.

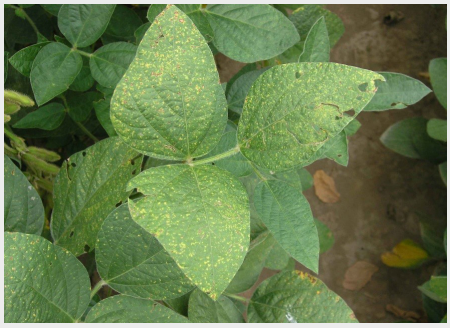

Figure 10. Downy mildew on soybean leaves.

Frogeye Leaf Spot

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Cercospora sojina*.
- Symptoms initially appear during reproductive growth stages as dark, water-soaked lesions on younger leaves with centers that become ash-gray to light-brown.
- Later, the lesions become circular to angular with a purple to dark-brown margin around the tan to gray center (Figure 11).
- On leaf undersides, the center of the lesions may have a dark-black area where spores are being produced.
- Favored by warm (77 to 86°F) temperatures and prolonged periods of dew or light rain.

Management

- Plant resistant soybean products.
- Crop rotation and tillage to encourage residue decomposition can help reduce pathogen levels.
- Apply Delaro® 325 SC Fungicide.

Figure 11. Frogeye leaf spot.

Phyllosticta Leaf Spot

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Pleosphaerulina sojicola*.
- Overwinters in infected soybean residue.
- Infection appears as circular, oval, irregular, and V-shaped lesions on leaves (Figure 12).
- Lesions are gray or tan with a narrow, dark margin. Black specks (pycnidia) may be visible in older lesions.
- Favored by cool, moist conditions.

Management

- Rotate to non-host crops.
- Utilize tillage to help destroy residue.

Figure 12. Phyllosticta lesions on a soybean leaf.

.Picture courtesy of Daren Mueller, Iowa State University Extension and Outreach.

Northern Stem Canker (NSC)

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Diaporthe phaseolorum var. caulivora*.
- Initial infection can occur around the V3 growth stage, at which point seedlings can die quickly or survive and develop stem symptoms during pod set.
- Symptoms during reproductive growth stages appear as small, reddish-brown spots on stems near a node within the canopy (Figure 13).
- Spots develop into long (1 to 3 inches) cankers running up the stem from the point of infection.
- Cankers can girdle the plant causing plant death from interrupted nutrient and water flow.
- On dead plants, the cankers are hard to distinguish from non-infected stem tissue. Plant death can occur from a fungus-generated toxin.
- •Foliar symptoms appear during reproductive growth stages as yellowing between the veins, usually on one side of the leaf. Leaves turn brown, die, and remain attached to the stem.
- The pith of dead plants is light brown and stems can easily snap because of brittleness.
- Favored by cooler temperatures and extended periods of rain occurring early in the growing season.
- Foliar symptoms of NSC resemble those of brown stem rot (BSR), sudden death syndrome (SDS), and southern stem canker (SSC). To distinguish, stem cankers cause reddish-brown cankers near the nodes and no root rot, BSR develops in a brown pith and no root rot, and SDS is associated with white pith and root rot.

Management

- Plant resistant soybean products.
- Rotate to a non-host crop for two years to reduce pathogen populations.
- Use tillage to help destroy infested

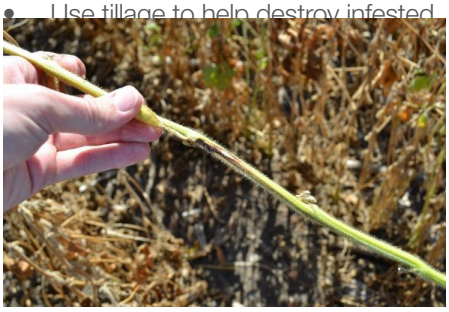

Figure 13. Northern stem canker lesion on a soybean stem.

Phytophthora Root Rot

Identification, Characteristics, and Diagnosis

- Caused by the soilborne fungal-like pathogen *Phytophthora sojae*.
- Can infect seedlings and plants at reproductive growth stages.
- Seedlings and plants infected at early-vegetative stages have stems that appear bruised and soft, secondary roots are rotted, leaves are yellow and brown, and plants can wilt and die (Figure 14).
- Plants infected later in the season have brown lesions on the roots, rotted roots, and dark, chocolate-brown colored stem lesions extending upward several inches from below the soil line (Figure 15).
- Leaves turn yellow, wilt, and remain attached to the plant after dying.
- Favored by wet, poorly-drained soils, clay soils, and compacted soils.
- There are 25 different races of this pathogen.

Management

- Plant resistant soybean products relative to the identified race within the field.
- Utilize seed treatments.
- Improve field drainage.
- Rotate to non-host crops.
- Consider tillage to help destroy residue.
- Cultivation may promote new root growth when soil is thrown against the stem base.

Figure 14. Soybean seedlings killed by Phytophthora

Figure 15. Phytophthora lesion on a soybean stem.

Phomopsis Seed Decay

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Diaporthe longicolla.*
- Infected seed can be shriveled, undersized, and have a white or chalky appearance (Figure 16).
- The interior of pods can contain a white, cottony mold.
- Favored by warm, wet weather during pod fill.
- Early-maturing soybean products may be more prone to infection.

Management

- Do not plant infected seed.
- Seed treatments may help improve emergence.
- Plant resistant soybean products.
- Select fuller-season (for the area to be grown) soybean products.
- Utilize tillage to help promote residue deterioration.
- Control weedy hosts such as velvetleaf.

Figure 16. Phomopsis seed decay.

Pod and Stem Blight

Identification, Characteristics, and Diagnosis

- Caused by various species of the fungi *Diaporthe* and *Phomopsis. Diaporthe sojae* is the preferred scientific name.
- Pathogens overwinter on infected seed and soybean residue.
- Linear rows of dark specks (fungal fruiting bodies) develop on stem nodes, pods, and petioles (Figure 17).
- The upper plant canopy turns yellow and dies.
- Seed quality can be reduced.
- Pod infection can occur at flowering; however, most are infected around the R7 growth stage (beginning pod maturity).
- Injury to pods by insects favors pod infection.
- Favored by wet weather during maturation growth stages and delayed harvest.

Management

- Rotate crops to help reduce the amount of infected residue.
- Utilize tillage to promote decay of infected residue.
- Harvest in a timely manner to reduce the risk of extended exposure of the mature crop to wet weather.
- Utilize seed treatments to protect seed.
- Apply Delaro® 325 SC Fungicide. To learn more about Delaro® 325 SC Fungicide, please visit https://www.cropscience.bayer.us/products/fungicides/delaro and contact your retailer.

Figure 17. Linear lesions produced by pod and stem blight.
Picture courtesy of Daren Mueller, Iowa State University, Bugwood.org

Red Crown Rot

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Calonectria ilicicola.*
- The pathogen overwinters on infected residue in and on the soil.
- Root infection can occur soon after planting; however, initial symptoms may not appear until mid- to late-reproductive growth stages.
- Brick-red reproductive structures appear (usually during high soil moisture) on the base of the stem at the soil line (Figure 18), roots become black with areas of rot, and leaves have interveinal yellow or brown blotches (Figure 19).
- Favored by moderate soil temperatures (77 to 86°F) and wet soil.

Management

- Rotate to non-host crops for two or more years; avoid planting peanuts.
- Delay planting until soil conditions are favorable for rapid emergence.
- Manage nematode populations.
- Utilize tillage to help destroy residue.

Figure 18. Red lesions on soybean stems resulting from red crown rot

Figure 19. Foliar symptoms of red crown rot.
Picture courtesy of Dr. Guy B. Padgett, LSU AgCenter

Septoria Brown Spot

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Septoria glycines.*
- Irregular, dark-brown lesions or spots that often have a surrounding yellow halo develop on lower plant leaves (Figure 20).
- Lesions can be small specks to 1/5 inch in diameter and coalesce to form larger spots.
- Defoliation can occur.
- Favored by wet weather and temperatures ranging from 79 to 83°F.

Management

- Foliar fungicides are rarely justified; however, it may be economically justified if conditions are extremely favorable and the disease develops in the upper canopy. Delaro® 325 SC Fungicide is an option. To learn more about applying Delaro® 325 SC Fungicide, please visit https://www.cropscience.bayer.us/products/fungicides/delaro and contact your retailer.
- Rotate to a non-host crop for at least one year (avoid continuous soybean).
- If possible, improve field drainage.
- Planting later may reduce

Figure 20. Septoria brown spot.

Sclerotium Blight, Southern Blight

Identification, Characteristics, and Diagnosis

- Caused by the soilborne fungus *Sclerotium rolfsii*.
- Sclerotia overwinter in soil and can remain viable for 3 to 4 years.
- The fungus infects plants when conditions are wet and hot (77 to 95°F).
- Seedlings are subject to damping-off.
- Brown spots develop and expand on leaves. Leaves finally turn brown and remain attached.
- Lesions can develop at the soil line and extend up the stem several inches with a white fungal mass on or above the lesion.
- Residue near infected plants may have fungal growth.
- Small, yellow/red/brown fruiting structures (sclerotia) can be observed on the stem (Figure 21).
- Soybean plants are susceptible from emergence through pod fill. The greatest concern is when infection occurs during vegetative growth stages.

Management

- Rotate to corn or other non-host crops for at least one year.
- Do not plant tomatoes because of susceptibility.
- Reduce the potential for transfer of soil or residue to non-infected fields.
- Deep tillage to bury sclerotia may

Figure 21. Sclerotium fruiting bodies on a soybean stem caused by Sclerotium blight.
Picture courtesy of Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org.

Southern Stem Canker (SSC)

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Diaporthe phaseolorum var. meridionalis*.
- Initial infection can occur around the V3 growth stage, at which point seedlings can die quickly or survive and develop stem symptoms during pod set.
- Symptoms during reproductive growth stages appear as small, reddish-brown spots on stems near a lower node.
- Spots develop into long (1 to 3 inches) cankers running up the stem from the point of infection (Figure 22).
- Cankers can girdle the plant causing plant death from interrupted nutrient and water flow.
- On dead plants, the cankers are hard to distinguish from stem tissue. Plant death can occur from a fungus-generated toxin.
- Foliar symptoms appear during reproductive growth stages as yellowing between the veins, usually on one side of the leaf. Leaves turn brown, die, and remain attached to the stem.
- The pith of dead plants is light-brown, and plants can easily snap because of brittleness.
- Favored by extended periods (24 to 96 hours) of moderate temperatures (72 to 86°F) and wet weather.
- Foliar symptoms of SSC resemble those of brown stem rot (BSR), sudden death syndrome (SDS), and northern stem canker (NSC). To distinguish, stem cankers cause reddish-brown cankers near nodes and no root rot, BSR causes a brown pith and no root rot, and SDS is associated with a white pith and root rot.

Management

- Plant resistant soybean products.
- Plant a non-host crop for two years to reduce pathogen populations.
- Delayed planting can help reduce the incidence of the disease.
- Use tillage to help destroy infected

Figure 22. Southern stem canker.

Soybean Rust

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Phakopsora pachyrhizi*.
- Does not overwinter in most Midwestern areas. Spores are carried by wind currents from southern locations into the Midwest.
- Initial infection may appear as small, brown or brick-red dots on the upper leaf surface (Figure 23).
- Later, raised pustules (viewable with a 30X lens) resembling small volcanoes develop in angular lesions on the underside of leaves in the center and lower canopy. The pustules release spores through a central opening.
- Optimum conditions for infection include a minimum of six hours of leaf wetness (10 to 12 hours considered very favorable) and temperatures ranging from 70 to 80°F (infection can occur as low as 59°F).

Management

- If local sentinel plots indicate the presence of soybean rust, scouting should be diligent and thorough, particularly in early-planted fields, early-maturing soybean products, low-lying or fields with prolonged wetness, and fields with early canopy closure.
- Apply Delaro® 325 SC Fungicide. To learn more about applying Delaro® 325 SC Fungicide, please visit https://www.cropscience

Figure 23. Soybean rust.

Sudden Death Syndrome (SDS)

Identification, Characteristics, and Diagnosis

- Caused by the soilborne fungus *Fusarium virguliforme*.
- Initial visual symptoms appear as small, yellow spots on leaves during reproductive growth stages (infection usually occurs at the seedling stage).
- The spots progress to interveinal chlorosis (yellowing) and eventually the leaf tissue dies (Figure 24).
- Leaves may fall prematurely, leaving petioles attached.
- The foliar symptoms are almost identical to those associated with brown stem rot.
- Roots are rotted, pith tissue remains white (Figure 24), and xylem (cortical tissue) is gray to brown. Under some conditions, a light-blue spore mass may form on the tap root.
- More severe in the presence of soybean cyst nematode (SCN), and in low, wet field areas.
- Favored by cool, wet conditions and may be worse following corn as the pathogen also causes stalk rot.
- SDS foliar symptoms resemble those of brown stem rot (BSR) and northern (NSC) and southern stem canker (SSC). To distinguish, SDS is associated with a white pith and root rot, BSR causes a brown pith and no root rot, and stem cankers cause in reddish-brown cankers near the nodes and no root rot.

Management

- Plant soybean products with higher tolerance ratings. Earlier-maturing products may have a lower potential for infection.
- Utilize soybean seed treatments.
- Reduce [illegible] soil conditions

Figure 24. Sudden death syndrome of soybean.

Target Leaf Spot

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Corynespora cassiicola*.
- Lower leaves develop small, brown specks (spots) that are round to irregular with a possible yellow halo.
- Mature spots may be 3/8 to 5/8 inches or more in diameter. Some may have a zonate appearance (Figure 25).
- Areas of infection on stems and petioles are dark brown and range from specks to elongated lesions.
- Lesions developing on pods are circular, usually small (1/32 inch), and purple or black with brown margins.
- Favored by high humidity (greater than 80%) or free moisture and cool to moderate soil temperatures. Dry conditions help suppress the disease.

Management

- Plant tolerant soybean products.
- Reduce surface residue through tillage.
- If possible, avoid planting back-to-back soybean crops.

Figure 25. Target spot lesions on a soybean leaf.

White Mold

Identification, Characteristics, and Diagnosis

- Caused by the fungus *Sclerotinia sclerotiorum*.
- Germinating sclerotia (small, hard, black fruiting structures) near the soil surface produce small, tan to gray mushroom-shaped structures that produce spores which spread by wind and infect dead soybean flowers.
- Lesions develop at stem nodes during or after flowering.
- Lesions become larger (3 to 18 inches long), and the tops of plants turn grayish-green, wilt, and die (Figure 26).
- Stems become soft, watery, and covered with white mold (Figure 27).
- Dry, dead stems may have a bleached, white appearance.
- Hard, black fungal fruiting bodies (sclerotia) are produced on or inside stems and pods.
- Dead plants remain upright and may be scattered or in patches throughout an infected field.
- Favored by moist soils, rainy weather, high relative humidity, cool (less than 85°F) conditions during flowering, reduced air circulation in fields with high populations and narrow rows, high fertility, and possibly earlier planting.

Management

- Plant disease-free seed.
- Select soybean products that may have some level of resistance.
- Consider reducing seeding rates and utilize wider rows.
- If irrigating, reduce the frequency during flowering.
- Sclerotia can remain viable for several years in the soil; therefore,

Figure 26. Wilting in the top of the soybean canopy due to white mold.

Figure 27. White mold growth on soybean stems.

Bean Pod Mottle Virus (BPMV)

Identification, Characteristics, and Diagnosis

- Vectored by the bean leaf beetle, *Cerotoma trifurcate Förster.*
- Foliar symptoms range from mild chlorotic mottling on upper leaves to puckering and severe mosaic on lower leaves (Figure 28).
- Delayed maturity or green stems are often observed near harvest.
- Seed coat mottling may be present.
- The virus overwinters in bean leaf beetles and can infect seedlings as the beetles feed.
- The virus can also overwinter in perennial weeds and infected seed.
- Plant infection by BPMV and soybean mosaic virus (SMV), vectored by soybean aphid, may cause severe dwarfing, foliar distortion, leaf necrosis, leaf mottling, and severe yield loss.

Management

- Managing emerging and first-generation bean leaf beetles in the spring with timely and labeled insecticides can reduce populations of the virus-laden insects.
- Controlling alternative BPMV hosts (cowpea *(Vigna unguiculate)*, other bean species, and *Demodium* species) can help reduce the inoculum source.
- Delayed planting may increase

Figure 28. Bean pod mottle virus symptoms on soybean leaves.

Picture courtesy of Edward Sikora, Auburn University, Bugwood.org.

Soybean Mosaic Virus (SMV)

Identification, Characteristics, and Diagnosis

- Aphids are a primary vector.
- A green/yellow mosaic pattern is the most common initial symptom on leaves (Figure 29).
- More mature leaves may exhibit a yellow/brown mosaic pattern.
- Premature defoliation is common.
- Infected seeds exhibit a brown or black mottling.
- Spreads from plant to plant by soybean aphid feeding.
- Plant infection by SMV and bean pod mottle virus (BPMV), vectored by bean leaf beetles, may cause severe dwarfing, foliar distortion, leaf necrosis, leaf mottling, and yield loss.

Management

- Seeds should be virus-free.
- Plant resistant soybean products.
- Early planting may minimize aphid transmission at an early crop growth stage.
- Insecticide applications are not recommended because some insecticides may increase soybean aphid movement in the field, increasing the dissemination of the virus.

Figure 29. Soybean mosaic virus symptoms.

Picture courtesy of Daren Mueller, Iowa State University, Bugwood.org.

Soybean Vein Necrosis Virus (SVNV)

Identification, Characteristics, and Diagnosis

- Vectored by soybean thrips, *Neohydatothrips variablilis* Beach; can also be transmitted by seed.
- Virus infection can occur throughout the growing season; however, symptoms are most visible after flowering, around mid-June.
- Initial symptoms appear as thread-shaped vein clearing along the main leaf veins; severe infections may result in purple to dark-brown lesions across most of the leaf (Figure 30).
- Veins become yellow and necrotic as the growing season progresses.
- Several areas on a leaf may have lesions.
- Early lesions lack defined edges.
- Highest canopy leaves are most affected because emerging leaves are prime feeding sites for soybean thrips.
- Favored by cool temperatures and mild winters followed by a warm spring, which may help increase the thrips population.

Management

- Control soybean thrips with timely and labeled insecticides.
- Controlling alternate virus hosts, ivyleaf morning glory *(Ipomoea hederacea Jacq*), cowpea (*Vigna*

Figure 30. Soybean vein necrosis virus.

Soybean Nematodes

Columbia Lance Nematode

Identification, Characteristics, and Diagnosis

- *Hoplolaimus columbus.*
- Very common in coarse-textured soils, primarily in southeastern states.
- Feeds internally and externally on soybean roots.
- Oval patches of stunted and/or wilted plants parallel to soybean rows.
- Feeding lesions can coalesce and appear like a root rot.
- The taproot and secondary roots are pruned.
- Nitrogen uptake and nodulation are reduced resulting in yellowish plants.
- Wilting can occur regardless of ample moisture.

Management

- Some soybean products may have tolerance.
- Utilize an in-furrow or seed treatment nematicide.
- Rotate to peanuts (corn or cotton can increase populations).

Lesion Nematode

Identification, Characteristics, and Diagnosis

- *Pratylenchus species.*
- Common in coarse-textured soils, primarily in southeastern states.
- Penetrates roots to feed and lay eggs.
- Feeding lesions can coalesce and appear like a root rot.

Management

- Some soybean products have tolerance.
- Utilize an in-furrow or seed treatment nematicide.
- Delay planting.
- Rotate with corn.

Soybean Cyst Nematode (SCN)

Identification, Characteristics, and Diagnosis

- *Heterodera glycines.*
- More common in sandy soils; however, SCN is well distributed throughout most soil types.
- Penetrates roots to feed.
- Evidence of feeding may be unnoticed until plants are under stress.
- Common symptoms include yellowish leaves and stunting.
- Nitrogen-fixing nodule formation can be reduced.
- Feeding wounds can be entry points for other diseases.
- Female cysts (initially white) that contain up to 500 eggs develop on roots. As cysts mature, their color changes from white, to yellow, to brown. Brown cysts have died and become the overwintering stage.
- Hot weather can reduce reproduction while cool to moderate weather can increase reproduction.
- Genetic variance occurring within SCN populations creates distinct and different HG-types.

Management

- Plant soybean products that are resistant to field-identified HG-types.
- Utilize an in-furrow or seed treatment nematicide.
- Rotate to non-host crops.
- Manage weedy hosts.
- Maintain adequate fertility.
- Soil sample in the fall to determine the SCN population and race(s).

Sting Nematode

Identification, Characteristics, and Diagnosis

- *Belonolaimus longicaudatus.*
- Found in very sandy soils.
- Feeds externally on roots and lays eggs in the soil.
- Common symptoms include poor growth, stubby roots, and possibly a tap root with few lateral roots, but no fibrous roots.

Management

- Utilize an in-furrow or seed treatment nematicide.
- Rotate to non-host crops.

Reniform Nematode

Identification, Characteristics, and Diagnosis

- *Rotylenchulus reniformis.*
- Found in any soil type.
- Survives winter as either wormlike pre-adults or eggs.
- Common symptoms include stunted plants and roots.
- Soil particles adhere to egg masses.

Management

- Plant resistant soybean products.
- Utilize an in-furrow or seed treatment nematicide.
- Rotate to non-host crops.

Root-knot Nematode

Identification, Characteristics, and Diagnosis

- Several species: southern root-knot (*Meloidogyne incognita*), guava root-knot (*M. enterlobii*), Javanese root-knot (*M. javanica*), northern root-knot (*M. hapla*), and peanut root-knot (*M. arenaria*).
- Non-uniform stunting, wilting, chlorotic patches, and possible root galls.
- Most common in sandy soils.
- Eggs can survive in soil for several years until favorable conditions for hatching exist.
- Lab analysis may be required to distinguish which species is present.

Management

- Plant resistant soybean products.
- Utilize an in-furrow or seed treatment nematicide.
- Rotate to non-host crops.
- Sanitize equipment when moving from field to field.

Sources

Faske, T. and Kirkpatrick, T. Aerial blight of soybean. University of Arkansas. https://www.uaex.edu/.
Kelly, H.M. and Stewart, S. Southern stem canker. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Hershman, D.E. 2013. Stem canker of soybean. Plant Pathology Fact Sheet. PPFS-AG-S-07. University of Kentucky. http://plantpathology.ca.uky.edu.
Giesler, L.J. 2011. Bacterial diseases of soybean. G2058. NebGuide. University of Nebraska. http://www.soybeanresearchinfo.com/.
Malvick, D. 2018. Sclerotinia stem rot (white mold) on soybean. University of Minnesota Extension. https://extension.umn.edu/.
Smith, D. White mold of soybean (Sclerotinia stem rot). Wisconsin Field Crops Pathology. University of Wisconsin-Madison. https://fyi.extension.wisc.edu/.
Malvick, D. 2018. Stem canker on soybean. University of Minnesota Extension. University of Minnesota. https://extension.umn.edu/.
Kleczewski, N. 2017. Stem canker on soybeans. Field Crops Disease Management. http://extension.udel.edu/.
Geisler, L.J. Anthracnose. CROPWATCH. University of Nebraska – Lincoln. https://cropwatch.unl.edu/.
Malvick, D. Anthracnose on soybean. University of Minnesota. https://extension.umn.edu/.
Westphal, A., Abney, T.S., and Shaner, G. 2006. Brown stem rot. Diseases of Soybean. BP-41-W. Purdue University. https://www.extension.purdue.edu/.
Melvick, D. 2018. Charcoal rot on soybean. University of Minnesota Extension. https://extension.umn.edu/.
Hershman, D.E. 2011. Charcoal rot of soybean. Plant Pathology Fact Sheet. PPFS-AG-S-02. University of Kentucky. http://plantpathology.ca.uky.edu.
Kelly, H.M. and Stewart, S. Frogeye leaf spot. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Faske, T. 2016. Soybean disease update and management: Frogeye leaf spot. University of Arkansas. http://www.arkansas-crops.com/.
Kelly, H.M. and Stewart, S. Target leaf spot. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Faske, T. and Kirkpatrick, T. Target spot of soybean. University of Arkansas. https://www.uaex.edu/.
Kelly, H.M. and Stewart, S. Southern stem canker. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Coker, C., Hurst, K., Kirkpatrick, T., Rupe, J., Tingle, C., and Trent, M. 2005. Asian soybean rust. FSA7531. Agricultural and Natural Resources. University of Arkansas. https://www.uaex.edu/.
Kelly, H.M. and Stewart, S. Brown spot. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Faske, T. and Kirkpatrick, T. Brown spot of soybean. University of Arkansas. https://www.uaex.edu/.
Kelly, H.M. and Stewart, S. Cercospora leaf blight. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Hershman, D.E. 2009. Cercospora leaf blight in Kentucky. Plant Pathology Fact Sheet. PPFS-AG-S-20. University of Kentucky. https://plantpathology.ca.uky.edu.
Kelly, H.M. and Stewart, S. Sudden death syndrome. Institute of Agriculture. The University of Tennessee. https://guide.utcrops.com.
Spurlock, T. 2015. Sudden death syndrome of soybean found. Arkansas Row Crops. University of Arkansas. http://www.arkansas-crops.com.
Kelly, H.M. and Stewart, S. Downy mildew. Institute of Agriculture. The University of Tennessee https://guide.utcrops.com.
Faske, T. and Kirkpatrick, T. Downy mildew of soybean. University of Arkansas. https://www.uaex.edu/. Zhou, J. and Tzanetakis, I.E. Soybean mosaic virus. University of Arkansas. https://www.uaex.edu. Giesler, L.J. Bean pod mottle virus. CROPWATCH. University of Nebraska. https://cropwatch.unl.edu.
Malvick, D. Bean pod mottle virus on soybean. University of Minnesota. https://extension.umn.edu/.
Smith, D. Bean pod mottle virus. Wisconsin Field Crops Pathology. University of Wisconsin. https://fyi.extension.wisc.edu/.

Mueller, D. 2013. Soybean vein necrosis virus identified in Iowa. Integrated Pest Management. Iowa State University. https://crops.extension.iastate.edu/.
Byamukama, E., Dorrance, A., Jardine, D., Malvick, D., Markell, S., Nachappa, P., Sisson, A., and Sweets, L. 2015. Soybean vein necrosis virus. Soybean Disease Management. CPN-1003. Crop Protection Network. www.soybeanresearchinfo.com/.
Zhou, J. and Tzanetakis, I.E. Soybean vein necrosis virus. University of Arkansas. https://www.uaex.edu/.
Joyce, A. and Thiessen, L. 2019. Root knot nematode of soybean. Soybean disease information. North Carolina State Extension. North Carolina State University. https://content.ces.ncsu.edu/.
Web sites verified 7/17/19.

Legal Statements