University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Historical Materials from University of Nebraska-Lincoln Extension

Extension

1999

EC99-1877 Damping Off, Root Rots, and Vascular Disorders of Soybean

Loren J. Giesler
University of Nebraska - Lincoln, lgiesler1@unl.edu

Follow this and additional works at: https://digitalcommons.unl.edu/extensionhist

Part of the Agriculture Commons, and the Curriculum and Instruction Commons

Giesler, Loren J., "EC99-1877 Damping Off, Root Rots, and Vascular Disorders of Soybean" (1999). *Historical Materials from University of Nebraska-Lincoln Extension*. 1942.
https://digitalcommons.unl.edu/extensionhist/1942

This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

University of Nebraska Cooperative Extension EC99-1877-B

Damping off, Root Rots, and Vascular Disorders of Soybean

Loren J. Giesler,
Extension Assistant — Plant Pathology

Soybeans are grown on nearly 4 million acres in Nebraska and are threatened by several diseases, soil-borne fungal diseases being the most common (for growers in the Midwest). Early season damping off *(Figure 1)* and root rots often are followed by premature death, which in many instances is attributed to fungal infections earlier in the growing season causing root and cortical rots and vascular disorders.

Damping Off and Root Rots

Seedling diseases and early season root rot are common and evident in several ways, including damping off, poor root development and hypocotyl lesions. In many cases, large areas of a field and even entire fields have to be replanted due to early season seedling diseases. Cool, wet weather early in the growing season creates favorable conditions for many of the pathogens that attack developing soybean seedlings. There are many pathogens involved in seedling damping off. The most common genera of pathogens in Nebraska are *Fusarium, Phytophthora, Pythium* and *Rhizoctonia.* All four pathogens can kill the developing soybean seedling or cause damage that reduces yield.

Figure 1. Soybean postemergence damping off symptoms which can be due to one or more fungal pathogens. (Courtesy of D. Wysong, University of Nebraska)

Fusarium Root Rot: Fusarium root rot is caused by *Fusarium solani* and *Fusarium oxysporum*. Infections usually occur early in the season when cool temperatures favor disease development. Both *Fusarium* species are common soil inhabitants that exist as chlamydospores and mycelium in plant residue and survive between seasons better at low soil moisture. The fungus either infects the roots directly through epidermal cells or indirectly through wounds and small abrasions. The disease is most destructive when soil temperatures are between 57 and 75°F and fields are saturated with moisture (57° F optimum). Feeding by soybean cyst and lance nematodes and application of dinitroaniline herbicides predispose seedlings and young plants to infection. *Fusarium* fungi do not normally cause damage when acting alone, but from interaction with other stresses.

Symptoms: *Fusarium*-infected seed germinates poorly and results in pre-emergence or postemergence damping off or late emergence and unthrifty seedlings. Emergence can be delayed and diseased seedlings may remain stunted and weakened for the entire season. As the lower tap root is decayed, shallow fibrous roots may develop, which makes the plant

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

University of Nebraska Cooperative Extension educational programs abide with the non-discrimination policies of the University of Nebraska-Lincoln and the United States Department of Agriculture.

Figure 2. Reddish brown discoloration of rotted roots caused by Fusarium root rot. Note that root rot is more severe in the lower portion of roots. (Source unknown)

Figure 3. Mature soybean plant infected with *Phytophthora sojae* with stem rot symptoms extended up the stem from the soil line. (Courtesy of J. Watkins, University of Nebraska)

more vulnerable to periods of drought stress and can reduce yield. Discoloration of the taproot and lateral roots may occur, turning them a reddish *(Figure 2)* or dark brown color depending on the species of *Fusarium* involved. Fusarium root infections usually start at the lower portion of the root system in contrast to Rhizoctonia root rot which usually starts at the soil line and extends downward to the root system. Root systems of severely infected young plants may be nearly destroyed. Older plants are seldom killed but wilt quicker than healthy plants when soil moisture is low. Poor stands caused by *Fusarium spp.* usually are associated with poor seed quality, heavy rains, soil compaction, or wet soils after planting.

Phytophthora Seedling Blight and Root and Stem Rot: The fungus *Phytopathora sojae* causes Phytophthora-related soybean diseases. The pathogen survives primarily as "resting" spores (oospores) in the soil or in association with infested crop debris. The oospores germinate in wet soils, eventually forming numerous "swimming" spores (zoospores). The zoospores move through soil water to roots where they encyst and penetrate the epidermis. Disease development is most favorable at soil temperatures of 60°F and high soil moisture. It is most common in low areas of a field, on poorly drained or compacted soils, and in soils with a high clay content, although it is not limited only to these sites or conditions. It also may occur on well-drained hillsides during wet growing seasons. Trifluralin herbicide may increase disease severity by slowing seedling root growth.

Symptoms: Symptoms include stand reduction caused by seed rots or pre-emergence damping off. Infected surviving seedlings exhibit water-soaked lesions on the stems and roots, and yellowing and wilting of the leaves. The stem rot phase is easily identified by the dark brown color on the exterior surface of the stem and lower branches *(Figure 3)*. Discoloration of the stem extends from below the soil up 6 inches or more above the soil line. The taproot turns dark brown and the entire root system may be rotted. Leaves on older infected plants become chlorotic between the veins followed by general wilting and death. Withered leaves generally remain attached to dead plants. Postemergence damping off caused by *P. sojae* can be differentiated from that caused by *Pythium spp.* after the V2 growth stage as Phytopthora-infected seedlings will have brown discoloration extending up the stem from the root *(Figure 4)*, whereas Pythium damping off is found at the hypocotyl and below.

Figure 4. A seedling infected with *Phytophthora sojae*. Note the brown discoloration which extends up from the root. (Courtesy of X.B. Yang, Iowa State Univeristy)

Pythium Damping off and Root Rot: At least five species of *Pythium* cause seed decay, damping off and root rot of soybean. Although these fungi can infect the soybean plant at any developmental stage, early infections on seedlings are most damaging. Seed rot and seedling diseases caused by *Pythium spp.* develop early in the season with cool temperatures and wet soil conditions. *Pythium* species produce specialized survival structures that are well adapted to the soil environment. Pythium also is capable of colonizing plant organic matter saprophytically (living on dead or decaying organic matter). Most *Pythium* species survive in the soil or in association with plant residue. In cool (50° to 60°F) and wet soil, they, like *Phytophthora*, produce zoospores that move through soil water to seed or roots where they infect the plant. Seedlings are the most susceptible to infection and the soybean plants become more resistant as they age.

Figure 5. Postemergence damping off caused by *Pythium spp.* or *Phytopthora sojae*. (Courtesy of X.B. Yang, Iowa State Univeristy)

Symptoms: Pythium-infected seeds often rot in the soil and are soft and slimy to the touch or overgrown with other fungi and bacteria, giving the seed a fuzzy appearance. Infections that cause seedling blights occur after the seed has germinated but before or just after emergence. Infected roots are brown and appear wet, or they may have brown lesions on the hypocotyl or at the junction of the hypocotyl and the primary root. If seedlings are infected after emergence, leaves have a gray-green cast, wilt and then die within a day or so. One species of *Pythium* causes the growing point to be retarded, resulting in a baldhead symptom.

Rhizoctonia Root and Cortical Rot: *Rhizoctonia solani*, which causes Rhizoctonia root and cortical rots, is a common soil inhabitant that survives in the soil and plant residue as sclerotia or resting mycelium. It is an excellent saprophyte on many different host plants and can survive for years in the absence of soybeans. During wet soil conditions, sclerotia germinate to form mycelium or mycelium grows directly from precolonized residue to infect seeds, seedling roots and hypocotyls. The most common diseases caused by *R.solani* are pre- and post-emergence damping off and lower stem lesions (cortical rot) that may encircle the entire stem. Rainfall followed by cool and then warm (80°F and above) weather favors disease development. Although the disease is most severe on young plants, when older plants are infected they may die during drought periods if the hypocotyl and roots are sufficiently damaged to limit water uptake.

Symptoms: Typical symptoms are decay of lateral roots and localized brown to reddish-brown lesions on the hypocotyl and lower stem at the soil line *(Figure 6)*. This discoloration may extend downward to the roots *(Figure 7)* and is limited to the cortical layer and does not extend into the interior tissues of the root or stem. The reddish brown discoloration is evident immediately after the plant is removed from the soil and will fade with exposure to air. Normally,

Figure 6. Rhizoctonia root rot on a seedling. Note brown to reddish brown lesion on hypocotyl at soil line. (Courtesy of X.B. Yang, Iowa State University)

Figure 7. Rhizoctonia root rot with lesions extended from soil line downward into roots. (Source unknown)

these lesions are limited in size and do not girdle the stem. However, lesions can expand and cause a cortical rot of the lower stem which may girdle stems and cause lodging during high winds. Lower stem lesions may reduce or stop the flow of nutrients and water, which will reduce yield. The disease is first detected by the presence of wilted and dead plants when weather becomes warm early in the growing season. Affected plants may be stunted or less vigorous throughout the growing season resulting in poor pod set.

Management of Seedling Diseases: Because of the tremendous capacity of soybean to compensate for lowered plant densities, it is difficult to predict the economic impact of seed and seedling diseases. In soybean fields it is common to attain adequate yields even when plant stands have been reduced (i.e., up to 20 percent in some cases). The ultimate economic impact (i.e., the effect on final yield) may be dependent on the incidence of disease in the field (e.g., 5 percent of the plants affected versus 25 percent of the plants affected) as well as the spatial distribution of diseased plants (e.g., diseased plants scattered throughout the field as opposed to large areas devoid of productive plants). Knowing the history of the field can be helpful when predicting potential problem areas.

Specific management practices for damping off and root rots include:

- **Plant high quality seed:** Do not plant seed with broken seed coats.
- **Carefully manage soil moisture:** No-till will increase damping off; therefore, another form of conservation tillage may be necessary in known problem areas.
- **Use seed applied fungicides:** Know the disease you're managing and select the appropriate seed applied fungicide for your field *(Table I)*.
- **Use resistant varieties in fields with a history of *Phytophthora*:** Specific races of *Phytophthora sojae* can be identified so that you can choose a variety with resistance to races in your field. Races 1 and 3 were commonly reported in the latest Nebraska survey.

Vascular Disorders

Brown Stem Rot: Brown stem rot is a soilborne disease that occurs late in the growing season with cool temperatures. Brown stem rot is caused by the fungus *Phialophora gregatum* which survives in plant residue, producing spores from precolonized woody stem tissue which can be buried a foot or more below the soil surface. Infected plant residue is thought to be the main source of spread for the fungus. Infections occur through the roots and lower stem early in the season and the mycelium grows upward in the water-conducting xylem vessels. Water and nutrient flow is thus inhibited because the mycelium plugs the xylem vessels. Disease development is greatest between 60 and 75°F and is suppressed at temperatures above 80°F. Wet soils also favor disease development early in the growing season and moisture stress later in the season increases disease severity.

Symptoms: Infected plants may not show visible symptoms other than premature death which may be confused with early maturity or dry weather. Brown stem rot can produce both foliar and stem symptoms. Sectioned stems of infected plants reveal internal browning of the pith and vascular tissue *(Figure 8)*. Pith discoloration starts at the base of the stem and

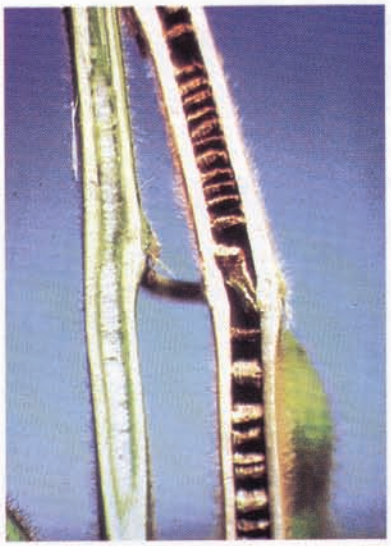

Figure 8. Split stem of healthy plant (left) and diseased plant (right) showing browning of stem pith caused by brown stem rot. (Courtesy of D. Wysong, University of Nebraska)

moves upward to the nodes and progresses into the internodal tissues during the growing season. Later in the season, infected plants may wilt and show external browning on the lower part of the stem. Severely diseased plants may lodge. Leaf symptoms may resemble high temperature "scorch" or drought stress *(Figure 9)*. Leaves on infected plants may develop

Figure 9. Scorch symptom of leaves from plant infected with brown stem rot. (Courtesy of D. Wysong, University of Nebraska)

Table 1[1]. Active ingredient and specific activity of soybean seed applied fungicides[2].

Active ingredient	*Trade Names*	*Pythium*	*Phytophthora*	*Rhizoctonia*	*Fusarium*
Metalaxyl	Apron	excellent	excellent	no activity	no activity
Captan	many	good	poor	good	fair
Captan + PCNB + Thiabendazole	Rival	poor	poor	good	excellent
Carboxin + thiram	Vitavax 200	poor	no activity	fair	poor
Carboxin + captan	Vitavax-captan	fair	poor	good	fair
PCNB + ethazole	Terraclor Super-X Terra-Coat L-205N	good	poor	good	poor
Thiram	many	fair	poor	good	fair

[1]This table was assembled by Craig Grau, University of Wisconsin.
[2]This list is presented for information only and no endorsement is intended for products listed nor criticism meant for products not listed. **Read the label carefully before making any application.**

interveinal chlorotic (yellowish) blotches. Tissue between the veins dies and turns brown, whereas tissue next to veins remains green and is the last to die. Eventually all leaves will curl and die and will remain attached for some time after death. The interveinal symptom is also found with other diseases, such as sudden death syndrome *(Table II)* and Sclerotinia stem rot.

Management of brown stem rot:

- **Crop rotation:** Avoid planting soybeans in severely brown stem rot-infested fields for at least three years. This time allows residue to decompose and the fungus cannot survive outside of infested residue. Be aware that alfalfa and red clover also can be hosts.
- **Resistant varieties:** Brown stem rot-resistant varieties will yield higher in severely infected field. A combination of crop rotation and brown stem rot-resistant varieties is an effective option for management.
- **Tillage:** Burying infested crop residues is an effective way of reducing disease risk if no-till is not mandatory. This accelerates decomposition of the residue and destroys the pathogens' shelter.

Charcoal Rot: Charcoal rot is caused by the fungus *Macrophominia phaseolina*. Inoculum for charcoal rot is typically soilborne or seedborne as microsclerotia. The microsclerotia germinate in the spring and infect the plant through cortical tissues of the lateral roots. The fungus then grows intercellularly until it reaches the xylem. In the xylem it grows and produces microsclerotia and mycelium which clog the vascular vessels of the plant. At the end of the growing season the fungus overwinters as sclerotia imbedded in plant debris in or on the soil. These sclerotia serve as inoculum for the following year *(Figure 10)*. The pathogen can be present in both the seed and the

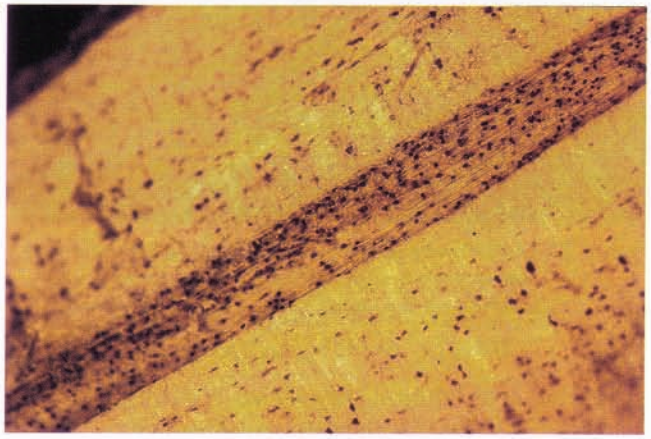

Figure 10. Microscerotia of charcoal rot imbedded in soybean stem tissue (20 X magnification). (Courtesy of L. Giesler, University of Nebraska)

plant without showing symptoms or signs (fungal structures). Limited soil moisture and soil temperatures from 83 to 95° F are favorable for disease development. The fungus does not survive longer than a few weeks in wet soil.

Symptoms: Symptoms of charcoal rot range in severity depending on environmental conditions. Symptoms are more severe in hotter and drier conditions, which is why the disease is also known as "dry-weather wilt" or "summer wilt." Symptoms appear in hot, dry weather, usually after flowering. The disease is most severe in continuous soybean fields when plants are under stress from moisture or nutrient deficiencies, soil compaction, nematodes or other pathogens. Symptoms in seedlings are a dark brown discoloration of tissues at and below the soil line and a reddish brown discoloration of the vascular tissues. Wilting of the hypocotyl and eventually a post-emergent damping off can occur. The seedling symptoms are primarily the result of toxins and enzymes produced by the fungus. Symptoms in older plants occur after mid-season and are a reddish brown vascular discoloration. As symptoms progress, the foliage

will yellow and wilt, but typically the leaves will remain attached to the plant after death. This premature death usually occurs in areas of the field where moisture is limiting. Light gray to silver discoloration of the tissues just under the outer layer of the root and lower part of the stem occurs *(Figure 11)*. Signs of the fungus on seed are small gray to black spots under the seed coat.

Figure 11. Gray discoloration of lower stem tissue caused by charcoal rot and tap root with pepper-like microsclerotia in the stem tissue. (Source unknown)

Management of Charcoal Rot:

- **Crop rotation:** Severely infested fields should not be planted into soybeans for three to four years. Corn and grain sorghum are also hosts, but to a lesser degree.
- **Drill soybeans or select highly branching varieties:** A heavy canopy shades the soil and will result in cooler soil temperatures and reduce the competitive ability of the charcoal rot fungus. However, a vigorous canopy may favor Sclerotinia stem rot.
- **Early planting:** Early crop canopy will result in cooler soil conditions, but early planting may increase risk of seedling damping off problems.
- **Avoid high plant populations:** Increased plant density can result in plant stress and thereby increase charcoal rot potential.
- **Fertility:** Maintain adequate fertility to reduce nutrient stress.
- **Soil moisture:** Maintain good soil moisture when possible to reduce moisture stress and thereby reduce disease potential.

Sudden Death Syndrome: Sudden Death Syndrome (SDS) is a relatively new disease of soybeans that is caused by the fungus *Fusarium solani f.sp. glycines*. The SDS pathogen is spread with soil; thus, the methods used to prevent soybean cyst nematode spread also are applicable to prevent the spread of SDS (e.g., cleaning farm equipment before moving it to another field). The primary causal agent of the disease is considered to be *F. solani*, but inoculation of soybeans with both the fungus and soybean cyst nematode has caused more severe foliar symptoms than those caused by the fungus alone. This suggests that the nematode may be involved in this disease complex. Cool, wet growing conditions favor SDS. Therefore, early planting or flooding early in the growing season favors disease development. Irrigated soybeans are more prone to SDS than non-irrigated soybeans.

Symptoms: To prevent the spread of SDS, field scouting is important. The first symptoms of SDS are scattered yellow or white spots on the leaves. In the intermediate stage, plants with SDS have leaves with interveinal necrosis. These spots eventually coalesce to form brown streaks between the veins with yellow margins surrounding the streaks *(Figure 12)*. On these leaves only the midvein and major lateral veins will remain green. SDS-infected plants also have deteriorated taproots and lateral roots. The discoloration of the root cortex is light-gray to brown and may extend up into the stem *(Figure 13)*. If soil moisture is high, bluish fungal colonies can be seen on the roots. Differentiating SDS from brown stem rot is difficult without looking at the roots. Brown stem rot does not have the associated root rot, but leaf symptoms can be

Figure 12. Advanced foliar symptoms of SDS with interveinal necrosis and green veins. (Courtesy of X.B. Yang, Iowa State University)

Figure 13. Discoloration of stem base and tap root infected with SDS (left) and healthy plant (right). (Courtesy of X.B. Yang, Iowa State University)

Figure 14. Scorch leaf symptoms of SDS with major leaf veins remaining green. (Courtesy of X.B. Yang, Iowa State University)

similar *(Figure 14)*. *Table II* is a summary of characteristics differentiating between SDS and brown stem rot.

Management of SDS:

- **Minimize spread:** Clean farm equipment before moving it from field to field in areas with a known history of SDS.
- **Variety selection:** Plant tolerant or less susceptible varieties in areas where SDS is present.
- **Planting date:** Avoid early planting in cool-wet soils in fields with a history of SDS.
- **Tillage:** Use ridge till in fields with SDS.
- **Plant health management:** Maintain good plant health with adequate fertilization and irrigation to minimize disease effects on yield.

Sclerotinia Stem Rot: Sclerotinia stem rot disease and management strategy is described in *Slerotinia Stem Rot of Soybeans*, NebGuide G95-1270.

Table II. Symptomatic differences between brown stem rot, Phytophthora root rot, and sudden death syndrome (SDS).

	Stage of first occurrence	*Interveinal chlorotic spots*	*Root rot*	*Pith browning*	*Foliar symptoms (Defoliation)*
SDS	R2	Yes	Yes	No	Severe (petiole attached)
Brown stem rot	R5	Yes	No	Yes	Leaves stay attached
Phytophthora root rot	V1	No	Yes	No	Leaves stay attached

(Modified from X.B. Yang, Iowa State University)