

PP1867 (Revised July 2021)

Soybean Disease Diagnostic Series

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Fusarium root rot

Fusarium solani, *F. oxysporum*, *F. tricinctum*
and other *Fusarium* species (fungi)

Photo: B. Nelson, NDSU

Figure 1



Photo: Giesler, Univ. of Nebraska

Figure 2



Figure 3



Photo: J. Bienappf, Univ. of Minnesota

Figure 4



Photo: D. Mueller, Iowa State Univ.



Fusarium root rot

Fusarium solani, *F. oxysporum*, *F. tricinctum*
and other *Fusarium* species (fungi)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- **Brown to black discoloration and rot of roots, especially the taproot**
- **Plant stunting and yellowing of leaves may occur if root rot is severe**
- **Seedling damping-off**

FIGURE 1 - Dark brown/black discoloration of roots

FIGURE 2 - Root rot and dieback of tap root

FIGURE 3 - Seedling damping-off

FIGURE 4 - Plant chlorosis

FACTORS FAVORING DEVELOPMENT

- Soil compaction
- Presence of soybean cyst nematode (SCN)
- Plant stress
- Drought

IMPORTANT FACTS

- Disease can infect and kill seedlings and damage older plants
- *Fusarium* survives for long periods in soil
- Dry edible beans, corn and pulse crops are hosts
- *Fusarium* is dispersed with soil (on equipment, in water, by wind, etc.)
- Management: improve soil drainage, reduce compaction, fungicide seed treatments
- Commonly confused with other roots rots, SCN and iron deficiency chlorosis

Card 1 of 24



Phytophthora root and stem rot

Phytophthora sojae (oomycete)



Figure 1

Photo: A. Dorrance, Ohio State Univ.



Figure 2

Photo: D. Malvick, Univ. of Minnesota



Figure 3

Photo: A. Dorrance, Ohio State Univ.



Phytophthora root and stem rot

Phytophthora sojae (oomycete)

AUTHORS: Sam Markell, Dean Malvick and Berlin Nelson

SYMPTOMS

- Seeds may rot and/or seedlings may die before or after emergence (damping-off)
- Mid- to late-season symptoms include a chocolate brown stem lesion extending up from the soil line
- Leaf chlorosis, necrosis and plant wilting can develop
- Frequently occurs in patches of fields and low areas

FIGURE 1 - Close-up of lower stem lesion

FIGURE 2 - Lower stem lesion and wilting

FIGURE 3 - Severe infection in field

FACTORS FAVORING DEVELOPMENT

- Excessive moisture, saturated soil and/or flooding, especially early in the season
- Poorly drained, heavy clay or compacted soils
- Short/no crop rotation

IMPORTANT FACTS

- Can cause significant yield loss
- Causes most damage to plants in early vegetative growth stages
- The pathogen is specific to soybeans
- Management tools available include genetic resistance and seed treatments
- The pathogen has many pathotypes and many can overcome Rps genetic resistance
- Commonly confused with other root rot diseases

Card 2 of 24



Pythium root rot

Pythium ultimum
and other *Pythium* species (oomycete)



Figure 1

Photo: D. Malvick, Univ. of Minnesota



Figure 2

Photo: M. Chilvers, Michigan State Univ.



Figure 3

Photo: A. Robertson, Iowa State Univ.



Pythium root rot

Pythium ultimum
and other *Pythium* species (oomycete)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Soft, slimy rot of seeds in ground
- Light brown rot of outer part of roots (cortex)
- Damping-off of seedlings

FIGURE 1 - Seed rotting due to *Pythium*

FIGURE 2 - Damping-off of seedlings

FIGURE 3 - Light brown infected roots

FACTORS FAVORING DEVELOPMENT

- Persistent wet soil after planting
- Soil compaction, heavy soil with high clay content
- Slow growth of seedlings and plant stress

IMPORTANT FACTS

- *Pythium* survives for years in soil
- Pathogen causes most damage to seeds and seedlings, but may damage roots of older plants
- Dry edible beans, corn and other crops can be hosts
- *Pythium* is dispersed with soil (on equipment, in water, by wind, etc.)
- Management: improve soil drainage, reduce compaction, some seed treatments
- Symptoms on seed and seedlings very similar to *Phytophthora* damage
- Commonly confused with other seedling diseases



Rhizoctonia root rot

Rhizoctonia solani (fungus)



Photo: D. Malvick, Univ. of Minnesota

Figure 1



Photo: D. Malvick, Univ. of Minnesota

Figure 2



Photo: D. Malvick, Univ. of Minnesota

Figure 3



Rhizoctonia root rot

Rhizoctonia solani (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- **Rusty-brown, dry, sunken lesions on lower parts of stems**
- **Dark brown lesions than girdle the stems near the soil**
- **Plants stunted, yellow, and wilting**

FIGURE 1 - Rusty-brown lesions on soybean stems

FIGURE 2 - Soybean seedlings with girdled stems

FIGURE 3 - Seedlings dying in a row

FACTORS FAVORING DEVELOPMENT

- Warm and moist soil while plants are in early vegetative stages
- Delayed planting in spring due to rain
- High soil organic matter
- Plant stress due to physical or chemical/herbicide injury

IMPORTANT FACTS

- Dry edible beans, corn, sugar beet and pulse crops can be hosts
- Causes most damage to plants in early vegetative growth stages
- *Rhizoctonia* is dispersed with soil (on equipment, in water, by wind, etc.)
- Management: some seed treatments, crop rotation, tillage, early planting
- Soybean varieties vary in susceptibility to *Rhizoctonia*
- Commonly confused with other roots rots

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Seed and seedling disease complex

Pythium (oomycete), *Phytophthora* (oomycete),
Rhizoctonia (fungus), *Fusarium* (fungus)



Figure 1

Photo: D. Malvick, Univ. of Minnesota



Figure 2

Photo: D. Malvick, Univ. of Minnesota

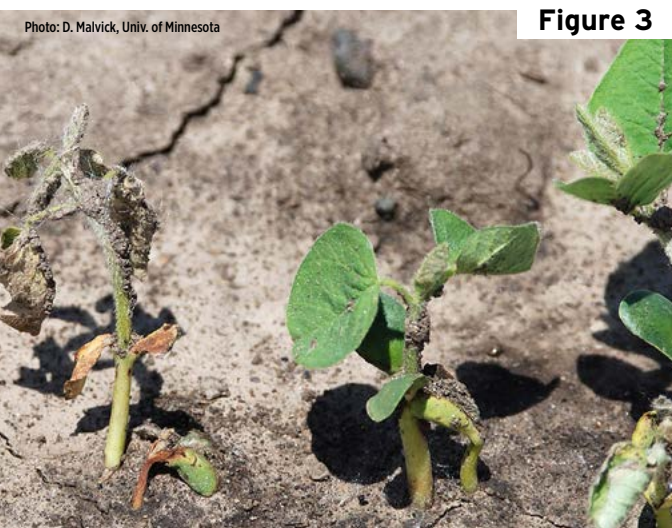


Figure 3

Photo: D. Malvick, Univ. of Minnesota



Seed and seedling disease complex

Pythium (oomycete), *Phytophthora* (oomycete),
Rhizoctonia (fungus), *Fusarium* (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Rotting of seed in the ground
- Pre-emergence death
- Post-emergence death and stunting
- Soft, tan roots with intact steel (*Pythium* and *Phytophthora*)
- Dark brown discoloration and rot of tap roots (*Fusarium*)
- Rusty-brown lesions on stem and roots (*Rhizoctonia*)

FIGURE 1 - Seedling decomposing due to infection

FIGURE 2 - Pre-emergence death of seedling

FIGURE 3 - Post-emergence death of seedling

FACTORS FAVORING DEVELOPMENT

- Wet soil
- Delayed germination and growth
- Poor-quality seed
- Plant stress

IMPORTANT FACTS

- Pathogens are favored by different conditions for infection and disease development
- Multiple pathogens often infect seeds/seedlings
- Difficult to diagnose principle pathogen
- Symptoms can look similar for different pathogens, but management may differ
- Management options: soil drainage, tillage, varieties with resistance, seed treatments
- Seed treatment ingredients vary in efficacy for different pathogens
- Commonly confused with water damage

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Soybean cyst nematode (SCN)

Heterodera glycines (plant parasitic nematode)

Photo: S. Markell, NDSU



Figure 1

Photo: S. Markell, NDSU



Figure 2

Photo: S. Markell, NDSU

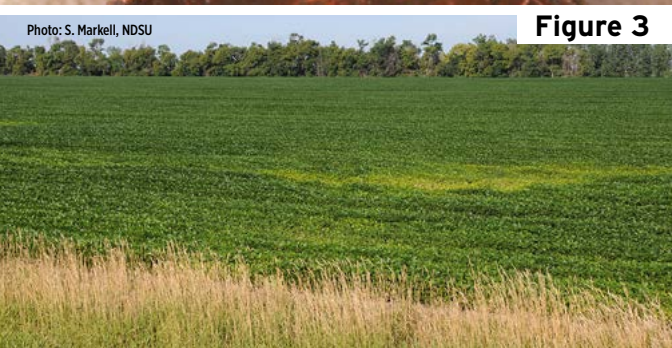


Figure 3



Soybean cyst nematode (SCN)

Heterodera glycines (plant parasitic nematode)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Small (approximately 1/32 inch) lemon-shaped female worms (cysts) on roots
- Cysts' color ranges from cream to dark brown
- Above-ground symptoms often are absent
- Soybeans can become stunted and yellow

FIGURE 1 - White SCN females (cysts) and a nodule on soybean roots

FIGURE 2 - Mature brown cysts

FIGURE 3 - Yellowed areas near field entrance caused by severe SCN

FACTORS FAVORING DEVELOPMENT

- Short crop rotation with soybeans and/or dry edible beans
- High soil pH, light soil texture
- Dry growing seasons

IMPORTANT FACTS

- SCN is the most yield-limiting disease in the U.S.
- SCN can make other diseases (sudden death syndrome, brown stem rot) worse
- Soybeans, dry edible beans and several weeds are hosts
- SCN is dispersed with soil (on equipment, in water, by wind, etc.)
- Soil testing is the most reliable way to determine if you have SCN
- Management tools available include crop rotation, variety resistance and possibly seed treatments
- SCN is overcoming PI88788 genetic resistance
- Commonly confused with roots rots, iron deficiency chlorosis, other abiotic stress

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Sudden death syndrome (SDS)

Fusarium virguliforme (fungus)

Figure 1

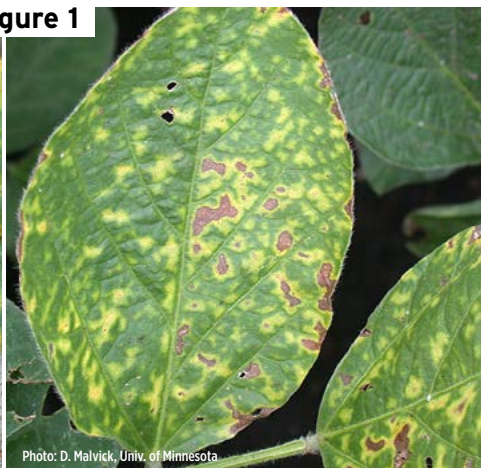


Photo: D. Malvick, Univ. of Minnesota

Photo: D. Malvick, Univ. of Minnesota

Figure 2



Photo: D. Malvick, Univ. of Minnesota

Figure 3



Photo: D. Malvick, Univ. of Minnesota

Figure 4

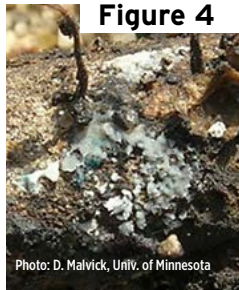


Photo: D. Malvick, Univ. of Minnesota



Sudden death syndrome (SDS)

Fusarium virguliforme (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Yellow and brown discoloration between leaf veins
- Tan stem under the epidermis near the soil line, while pith remains white
- Symptoms develop in plant seed fill stages (August)
- Leaflets can fall and petioles remain attached to plant
- Root rot and occasionally blue fungal growth on root

FIGURE 1 - (L) Internal stem browning; (R) Early chlorotic blotches between veins

FIGURE 2 - Severe leaf symptoms

FIGURE 3 - Severe infection in a patch in a field

FIGURE 4 - Root rot and blue fungal growth on root

FACTORS FAVORING DEVELOPMENT

- Wet soil for two to four weeks after planting
- Field history of SDS
- Compacted soil, poor drainage
- Periodic heavy rain and moist soil through mid-Aug.
- High soybean cyst nematode populations

IMPORTANT FACTS

- Common in southern and central Minnesota, less common (but increasing) in northern Minnesota and North Dakota
- Pathogen can cause root rot of dry edible bean and some other legumes
- Pathogen dispersed with soil (on equipment, in water, by wind, etc.)
- Management options include varieties with resistance to SDS and seed treatments
- Commonly confused with brown stem rot

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Anthracnose

Colletotrichum truncatum
or other *Colletotrichum* species (fungi)

Photo: D. Malvick, Univ. of Minnesota

Figure 1



Photo: S. Markell, NDSU

Figure 2



Photo: S. Markell, NDSU

Figure 3





Anthracnose

Colletotrichum truncatum
or other *Colletotrichum* species (fungi)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Symptoms usually not seen until plants reach maturity
- Dark brown patches may appear on stems, pods and petioles
- Small black fungal spots develop in irregular patterns on stems, pods and petiole
- Black, infected areas covered with tiny black spines (setae) that can be seen with a 10X hand lens

FIGURE 1 - Irregular-shaped blotches on stem

FIGURE 2 - Abundant black fungal growths of irregular arrangement and size

FIGURE 3 - Close-up appearance of fungal growths

FACTORS FAVORING DEVELOPMENT

- Warm and wet/humid weather
- Planting infected seed
- Short/no crop rotation

IMPORTANT FACTS

- A common late-season disease that rarely causes significant yield loss
- Pathogen(s) have a wide host range and may infect other legume crops and weeds
- Pathogen can be seedborne
- Commonly confused with pod and stem blight, stem canker, charcoal rot



Brown stem rot (BSR)

Cadophora gregata (fungus)

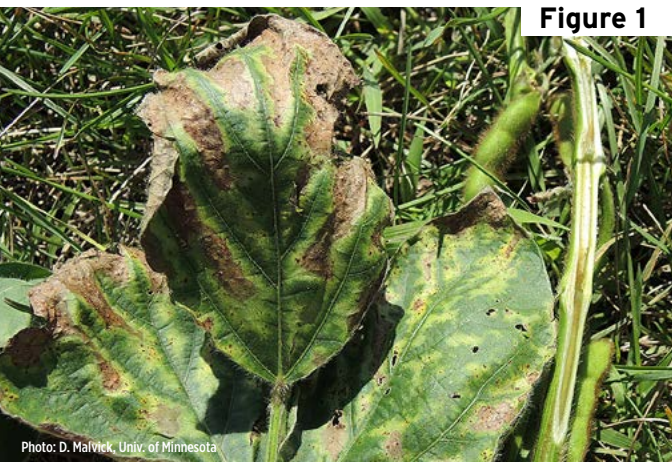


Figure 1

Photo: D. Malvick, Univ. of Minnesota



Figure 2

Photo: D. Malvick, Univ. of Minnesota



Figure 3

Photo: D. Malvick, Univ. of Minnesota

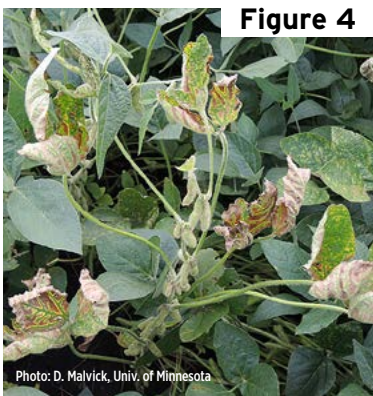


Figure 4

Photo: D. Malvick, Univ. of Minnesota



Brown stem rot (BSR)

Cadophora gregata (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- **Brown pith in stem, especially in lower stem**
- **Brown and yellow discoloration between leaf veins may be present**
- **Symptoms commonly develop in mid-August**

FIGURE 1 - Light brown discoloration in pith and leaf

FIGURE 2 - Dark brown discoloration in pith of stem

FIGURE 3 - Brown and yellow discoloration between veins

FIGURE 4 - Symptoms on leaves of whole plant

FACTORS FAVORING DEVELOPMENT

- Short/no crop rotation
- Wet and cool weather in July/August
- History of disease in a field
- Susceptible soybean varieties
- Presence of soybean cyst nematode

IMPORTANT FACTS

- Stems should be longitudinally split to identify BSR
- Commonly confused with sudden death syndrome
- Pathogen overwinters/survives in infected soybean stems
- BSR pathogen dispersed with soil (on equipment, in water, by wind, etc.)
- Soybean is only known definite host
- Two pathogen types: type A causes leaf and stem symptoms; type B primarily internal stem symptoms only
- Type B more common in our region
- Management options: crop rotation and varieties resistant to BSR

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Charcoal rot

Macrophomina phaseolina (fungus)



Figure 1

Photo: B. Nelson, NDSU



Figure 2

Photo: B. Nelson, NDSU



Figure 3

Photo: B. Nelson, NDSU



Figure 4

Photo: S. Markell, NDSU



Charcoal rot

Macrophomina phaseolina (fungus)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Symptoms usually not apparent until flowering or later
- Taproot and lower stem may appear gray/silver
- Numerous black fungal specks (microsclerotia) under epidermis give a “charcoal” appearance
- Premature death with wilted leaves attached
- Frequently occurs in patches in fields

FIGURE 1 - Large patches of soybean with charcoal rot

FIGURE 2 - Patch of wilting soybeans

FIGURE 3 - Infected (L and C) and healthy soybean (R)

FIGURE 4 - External gray lesion peeling away, revealing profuse “charcoal” sclerotia

FACTORS FAVORING DEVELOPMENT

- Hot temperatures
- Drought stress

IMPORTANT FACTS

- Yield loss may occur in hot, dry growing seasons
- Disease typically most severe in drought-prone areas of fields
- Very wide host range, which includes corn, sunflower, other legume crops and weeds
- Commonly confused with anthracnose, Phytophthora stem rot, pod and stem blight, stem canker



Pod and stem blight/ Phomopsis seed decay

Diaporthe longicolla (fungi) and *D. sojae*

Photo: D. Malvick, Univ. of Minnesota

Figure 1



Figure 2



Photo: D. Malvick, Univ. of Minnesota



Pod and stem blight/ Phomopsis seed decay

Diaporthe longicolla (fungi) and *D. sojae*

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Small, raised black dots (pycnidia) arranged in distinct rows on stem, pods and petioles
- Tops of plants may discolor and die, leading to plant death
- Symptoms often not apparent until plants near maturity
- Wavy, black zone lines inside infected stems and roots may occur (see stem canker)
- Seed may be cracked, shriveled, moldy and have poor germination

FIGURE 1 - Linear rows of raised black dots

FIGURE 2 - Infected (L) and healthy (R) plants

FACTORS FAVORING DEVELOPMENT

- Warm and humid weather
- Short/no crop rotation
- Planting infected seed
- Delayed harvest due to wet weather

IMPORTANT FACTS

- Yield loss and reduction in seed quality may occur
- Host range includes dry edible bean and dry edible pea
- Pathogen survives in crop residue and seed
- Pathogen is widespread, even in apparently healthy plants
- Black dots arranged in rows are diagnostic (anthracnose and charcoal rot dots are random)
- Commonly confused with anthracnose, charcoal rot and stem canker

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Stem canker

Diaporthe caulivora (northern stem canker) and
D. aspalathi (southern stem canker) (fungi)

D. Malvick, Univ. of Minnesota



Figure 1

Photo: S. Markell, NDSU



Figure 2

Photo: S. Markell, NDSU



Figure 3



Stem canker

Diaporthe caulivora (northern stem canker) and
D. aspalathi (southern stem canker) (fungi)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- **Reddish-brown lesions on the lower stem starting at branch points/nodes**
- **Lesions expand and may become sunken cankers**
- **Tiny black fungal structures may be produced on lesions**
- **Narrow black “zone lines” sometimes under epidermis, but importantly, zone lines also are associated with pod and stem blight**

FIGURE 1 - Reddish-brown stem canker lesion

FIGURE 2 - Sunken canker on lower stem of mature plant

FIGURE 3 - Zone lines beneath epidermis of sunken canker

FACTORS FAVORING DEVELOPMENT

- Extended periods of wet weather (one to four days) with moderate temperatures (70 to 85 F)
- Short/no crop rotation in fields with history of disease
- Reduced tillage

IMPORTANT FACTS

- Yield loss can occur if disease is widespread in a field and kills plants before pod fill
- Management tools include crop rotation (wheat, corn, etc.), resistant varieties and foliar fungicides
- Commonly confused with anthracnose, charcoal rot, late-season *Phytophthora* root rot, and pod and stem blight



White mold (*Sclerotinia stem rot*)

Sclerotinia sclerotiorum (fungus)



Figure 1

Photo: D. Malvick, Univ. of Minnesota



Figure 2

Photo: M. Gilley, NDSU



Figure 3

Photo: S. Markell, NDSU

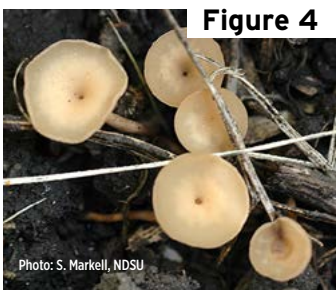


Figure 4

Photo: S. Markell, NDSU



White mold (*Sclerotinia stem rot*)

Sclerotinia sclerotiorum (fungus)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Stem lesions begin as water-soaked spots near nodes
- Lesions enlarge, fluffy white fungal growth develops on moist stems
- Infected stems become bleached white and may shred
- Hard black structures (sclerotia) form on and in infected tissue

FIGURE 1 - Lesions with white mold and sclerotia

FIGURE 2 - Severe white mold infection

FIGURE 3 - Black sclerotia among shriveled seeds

FIGURE 4 - Apothecia

FACTORS FAVORING DEVELOPMENT

- Wet soils prior to and during soybean flowering
- Frequent wetness (rain, fog, heavy dew) and cool temperatures during bloom
- Dense plant canopy, high fertility, high plant populations
- History of white mold in field

IMPORTANT FACTS

- Severe yield losses can occur when July and early August are cool and wet
- Many broadleaf crops and weeds are hosts
- Pathogen survives in soil for many years as sclerotia
- Sclerotia produce apothecia (about 1/4-inch mushrooms), which produce ascospores that initiate infection
- Management options: partially resistance varieties, increase plant spacing and fungicides
- Apothecia commonly confused with bird's nest fungi

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Bacterial blight

Pseudomonas savastanoi pv. *glycinea* (bacteria)

Figure 1



Photo: S. Markell, NDSU

Figure 2



Photo: S. Markell, NDSU

Figure 3

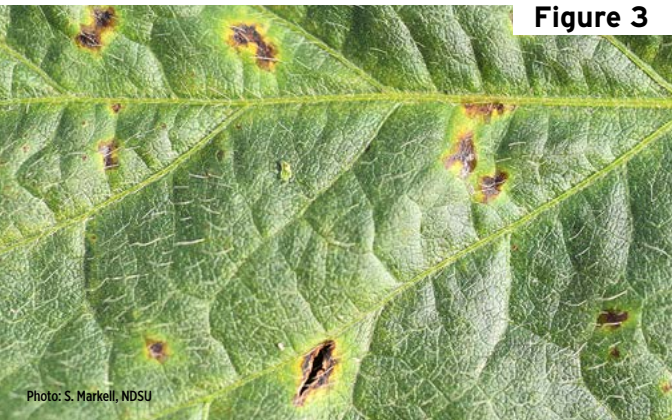


Photo: S. Markell, NDSU



Bacterial blight

Pseudomonas savastanoi pv. *glycinea* (bacteria)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Typically observed first in upper canopy in July
- Small, water-soaked and angular leaf lesions
- Lesion centers turn brown and are surrounded by a bright yellow halo
- Lesions often coalesce and leaves will tatter
- Often widespread distribution in field

FIGURE 1 - Brown angular lesions with bright yellow halos

FIGURE 2 - Coalescing lesions and leaf tattering

FIGURE 3 - Magnified lesions

FACTORS FAVORING DEVELOPMENT

- Cool temperatures, frequent rains and thunderstorms
- Weather that damages plant tissue (hail, high winds, etc.)
- Short/no crop rotation
- Planting infected seed

IMPORTANT FACTS

- Widespread but rarely economically important
- Lesions may occur on stem, petiole and pod
- Pathogen survives and can be spread with seed and infested crop residue
- Fungicides are not effective
- Commonly confused with Septoria brown spot, bacterial pustule, downy mildew

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Bacterial pustule

Xanthomonas axonopodis pv. *glycines* (bacteria)

Photo: S. Markell, NDSU

Figure 1



Photo: S. Markell, NDSU

Figure 2



Photo: S. Markell, NDSU

Figure 3





Bacterial pustule

Xanthomonas axonopodis pv. *glycines* (bacteria)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Lesions begin as small (1/16 to 1/4 inch) light green specks with yellow halos
- Lesion centers turn brown
- Raised pustules appear in lesions

FIGURE 1 - Lesions with chlorotic halos on upper side of leaf

FIGURE 2 - Lesions and pustules on underside of leaf

FIGURE 3 - Pustules (approximately 5 to 10X)

FACTORS FAVORING DEVELOPMENT

- Wet and rainy weather
- Prolonged humid conditions
- Warm to hot temperatures

IMPORTANT FACTS

- Sporadic in Minnesota and North Dakota
- Unlikely to cause yield loss
- Can be mistaken for soybean rust, a disease that has not occurred in Minnesota or North Dakota
- Commonly confused with bacterial blight or Septoria brown spot



Bean pod mottle virus

Photo: A. Dorrance, Ohio State Univ.

Figure 1

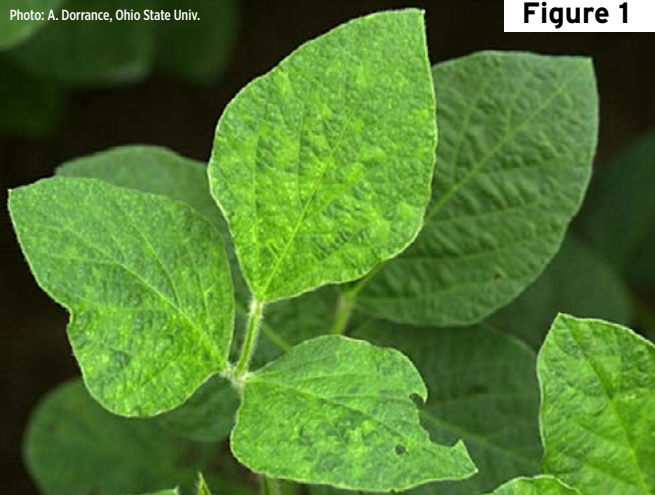


Figure 2

Photo: A. Dorrance, Ohio State Univ.



Figure 3



Photo: Univ. of Illinois



Bean pod mottle virus

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Green to yellow mottling of young leaves
- Leaves may become puckered and wrinkled
- Symptoms may not be visible during high temperatures or after pod set
- Seed may become mottled with dark stains

FIGURE 1 - Light green to yellow leaf mottling

FIGURE 2 - Wrinkling, puckering and light green mottling

FIGURE 3 - Leaf puckering and wrinkling

FACTORS FAVORING DEVELOPMENT

- High populations of bean leaf beetle (or other beetles) early in the season
- Cool weather

IMPORTANT FACTS

- Not thought to be common in Minnesota and North Dakota
- Virus can be transmitted by bean leaf beetle or other leaf feeding beetles
- Infection primarily occurs early in the season
- Host range includes dry edible bean, clovers and other legumes
- Management options: delay planting, seed applied insecticides
- Commonly confused with other viruses and possibly herbicide injury

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Cercospora leaf blight

Cercospora kikuchii (fungus)



Figure 1

Photo: A.K. Chanda, Univ. of Minnesota



Figure 2

Photo: A.K. Chanda, Univ. of Minnesota

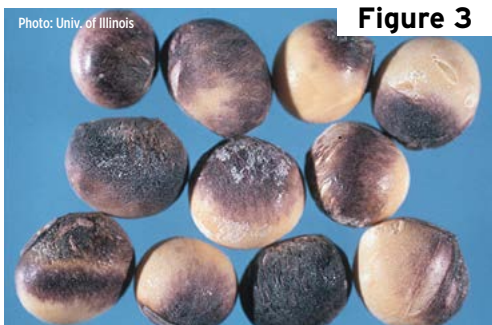


Figure 3

Photo: Univ. of Illinois



Cercospora leaf blight

Cercospora kikuchii (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Purple to bronze discoloration of upper leaf surfaces
- Red-brown spots on both leaf surfaces
- Large necrotic areas can develop on leaves, followed by leaf drop
- Seed coats can develop purple discoloration

FIGURE 1 - Purple discoloration of leaf

FIGURE 2 - Bronze discoloration and death of leaf tissue

FIGURE 3 - Purple seed stain

FACTORS FAVORING DEVELOPMENT

- High humidity and warm temperatures
- Lack of crop rotation

IMPORTANT FACTS

- Disease is more common and severe in southern U.S.
- Pathogen overwinters on infested soybean debris and seed
- Plants susceptible from flowering to maturity
- Management options: pathogen-free seed, susceptible varieties, crop rotation and fungicides
- Commonly confused with sunscald



Downy mildew

Peronospora manshurica (Oomycete)

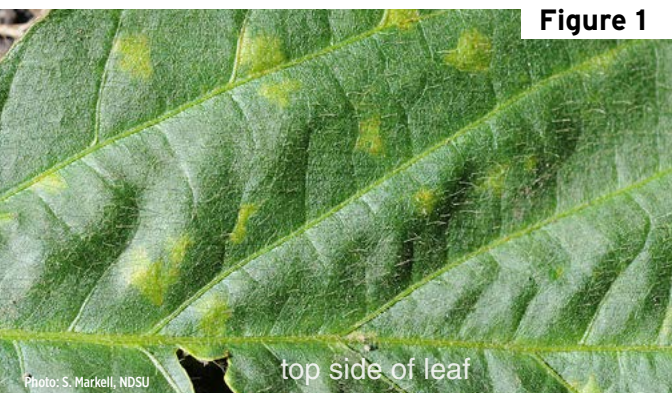


Figure 1

Photo: S. Markell, NDSU



Figure 2

Photo: S. Markell, NDSU

Photo: S. Markell, NDSU



Figure 3

Photo: D. Helland, Wilbur Ellis



Downy mildew

Peronospora manshurica (Oomycete)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Lesions begin as discrete pale green to light yellow spots on top side of leaves
- Fluffy tan tufts of fungal growth occur opposite lesions on underside of leaves
- Lesions become brighter yellow and turn brown with age

FIGURE 1 - Discrete lesions

FIGURE 2 - Fungal growth opposite lesions (inset: magnification of fungal growth)

FIGURE 3 - Severe infection

FACTORS FAVORING DEVELOPMENT

- Frequent and prolonged periods of high humidity or free moisture (dew)
- Moderate temperatures
- Short crop rotation
- Planting infected seed or field history of downy mildew

IMPORTANT FACTS

- Yield loss thought to be rare; however, severe outbreaks have occurred in North Dakota and Minnesota
- Pathogen is specific to soybeans and will not cause downy mildew of other crops
- Can be confused with Septoria brown spot, powdery mildew and bacterial diseases



Frogeye leaf spot

Cercospora sojina (fungus)

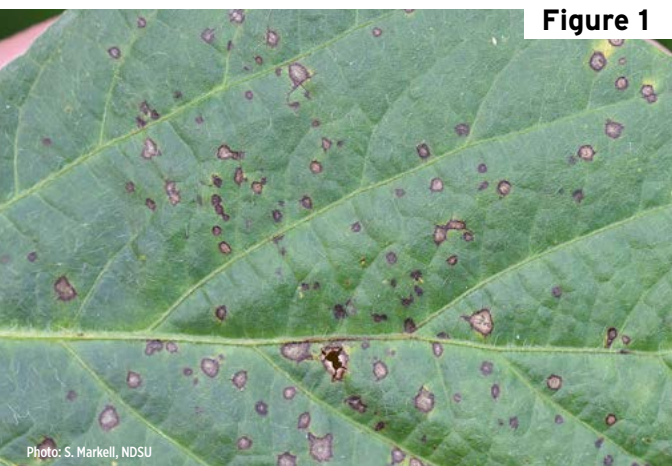


Figure 1

Photo: S. Markell, NDSU



Figure 2

Photo: D. Malvick, Univ. of Minnesota



Photo: S. Markell, NDSU

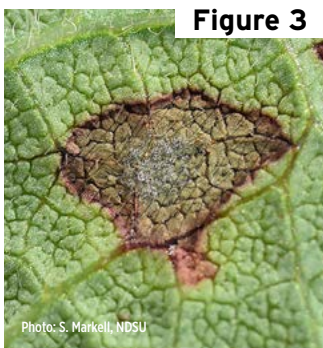


Photo: S. Markell, NDSU

Figure 3



Frogeye leaf spot

Cercospora sojina (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Lesions begin as dark spots that vary in size
- Center of lesions become tan to gray and surrounded by a reddish-brown to purple ring
- Fuzzy gray mold may occur in lesion centers
- Spots may coalesce, fall out and kill large parts of leaves

FIGURE 1 - Lesions of various size and stages of development

FIGURE 2 - Spots and patterns of lesion development on leaf

FIGURE 3 - Upper and underside of lesion with fuzzy gray mold.

FACTORS FAVORING DEVELOPMENT

- Warm and humid weather
- Highly susceptible soybean varieties

IMPORTANT FACTS

- Disease more common in southern areas of the Midwest
- Pathogen overwinters in infected soybean residue and seed
- Management options: crop rotation, tillage and fungicides
- Pathogen resistance to strobilurin (QoI, FRAC 11) fungicides is common in Minnesota and North Dakota
- Commonly confused with bacterial blight, *Phyllosticta* leaf spot and *Septoria* brown spot

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Phyllosticta leaf spot

Phyllosticta sojicola (fungi)



Figure 1

Photo: K. Bissonnette



Figure 2

Photo: K. Bissonnette



Figure 3

Photo: K. Bissonnette



Phyllosticta leaf spot

Phyllosticta sojaicola (fungi)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- May occur anytime in growing season
- Leaf lesions begin as pale green spots
- Lesions become gray to tan with a narrow dark purple to brown margin
- Lesions may be oval, circular, irregular or V-shaped
- Small black specs (pycnidia) may appear in lesion centers
- Lesions also may occur on petioles, stems and pods

FIGURE 1 - Gray irregular-shaped lesions with dark narrow margins

FIGURE 2 - V-shaped lesion with small black specs (pycnidia)

FIGURE 3 - Large lesion with numerous pycnidia

FACTORS FAVORING DEVELOPMENT

- Cool temperatures
- Wet conditions
- Short crop rotations
- Infected seed

IMPORTANT FACTS

- Minor soybean disease that rarely impacts yield
- Appears to be uncommon in Minnesota and North Dakota
- Pathogen survives in infested crop residue and seed
- Commonly confused with frogeye leaf spot, bacterial blight, Septoria brown spot

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Powdery mildew

Erysiphe diffusa and *E. glycines* (fungi)



Figure 1

Photo: D. Malvick, Univ. of Minnesota

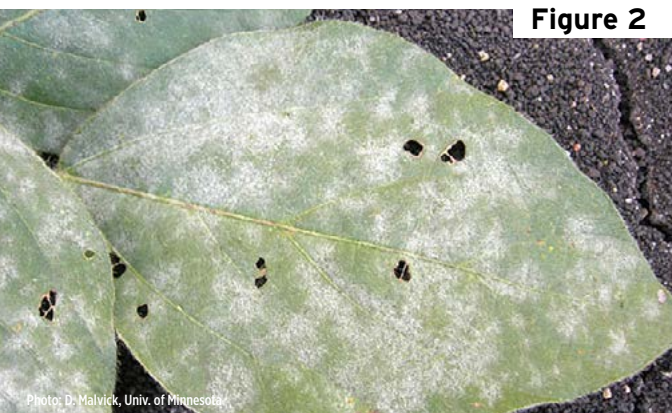


Figure 2

Photo: D. Malvick, Univ. of Minnesota



Figure 3

Photo: D. Malvick, Univ. of Minnesota



Powdery mildew

Erysiphe diffusa and *E. glycines* (fungi)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Powdery white tufts of fungal growth on upper side of leaf
- Fungal growth may look like white flour sprinkled on the leaves
- Fungal growth can expand and may cover entire leaf surface
- Small black specs in growth may be observed late in season
- White fungal growth can be rubbed off leaf easily

FIGURE 1 - White tufts of fungal growth

FIGURE 2 - Severe infection covering leaf

FIGURE 3 - Infection spreading in hot spot

FACTORS FAVORING DEVELOPMENT

- Temperatures from 64 to 75 F
- Low humidity with periods of limited leaf wetness
- Late-planted soybeans

IMPORTANT FACTS

- Yield loss is rare in Minnesota and North Dakota
- Usually occurs late in growing season
- The pathogen also may infect dry edible beans and field peas
- Commonly confused with downy mildew



Septoria brown spot

Septoria glycines (fungus)



Figure 1

Photo: D. Malvick, Univ. of Minnesota



Figure 2

Photo: D. Malvick, Univ. of Minnesota

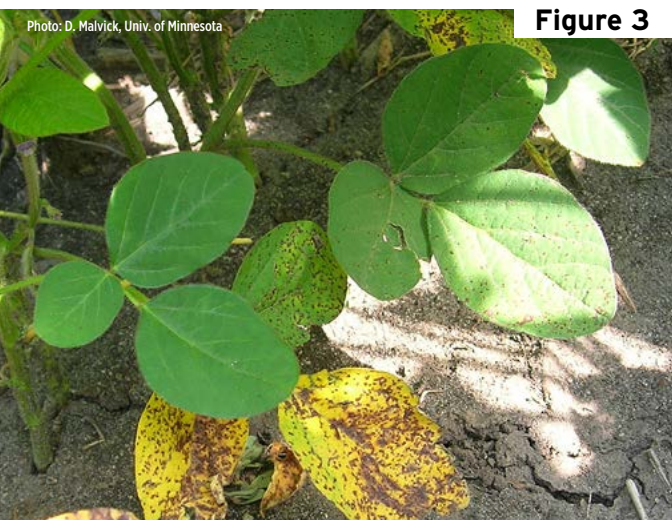


Photo: D. Malvick, Univ. of Minnesota

Figure 3



Septoria brown spot

Septoria glycines (fungus)

AUTHORS: Dean Malvick and Sam Markell

SYMPTOMS

- Dark brown spots (less than 1/8 inch diameter)
- Brown spots coalesce into large brown areas
- Irregular brown and yellow patches on one side of leaf
- Symptoms first develop in lower part of plant, then move up

FIGURE 1 - Brown spots and chlorosis

FIGURE 2 - Trifoliolate with brown spots and chlorosis

FIGURE 3 - Common pattern of symptoms developing in lower canopy

FACTORS FAVORING DEVELOPMENT

- Wet and warm weather
- High plant density
- Continuous soybean planting
- Minimum tillage

IMPORTANT FACTS

- Typically does not cause yield loss
- Under severe conditions, defoliation and yield loss can occur
- Pathogen survives on infected residue and may be transmitted by seed
- Soybean varieties may vary in susceptibility
- Management options: crop rotation and fungicides
- Commonly confused with bacterial blight



Soybean mosaic virus

Photo: A. Tenuta, OMAFRA, Ontario, Canada

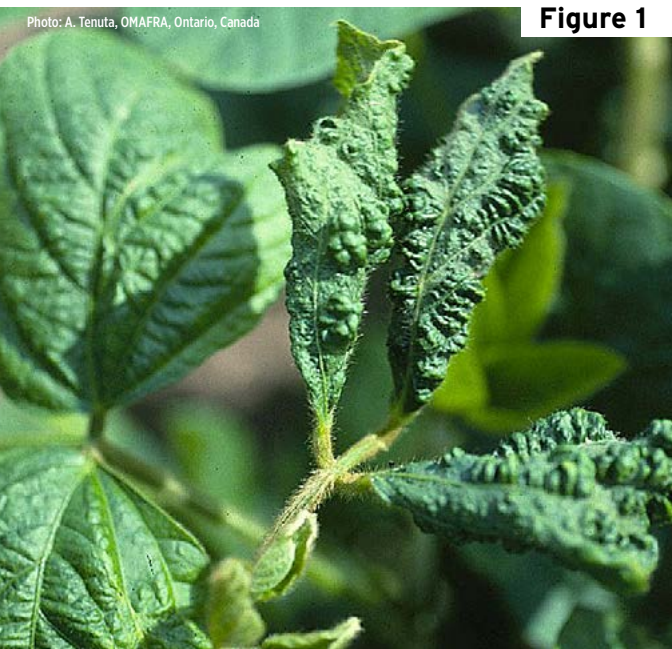


Figure 1

Photo: A. Tenuta, OMAFRA, Ontario, Canada



Figure 2



Soybean mosaic virus

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Light and dark green mottling of leaves
- Leaf puckering and downward curling
- Symptoms most severe on youngest leaves
- Flattening of pods, reduced seed size, seed discoloration and stunting may occur
- Infected plants can be asymptomatic

FIGURE 1 - Leaf mottling and curling

FIGURE 2 - Discolored seed

FACTORS FAVORING DEVELOPMENT

- Planting infected seed
- Aphid infestation

IMPORTANT FACTS

- Not thought to be common in Minnesota or North Dakota
- Virus is seedborne and aphid-vectored
- Commonly confused with herbicide injury and bean pod mottle virus



Soybean rust

Phakopsora pachyrhizi (fungus)

Photo: S. Markell, NDSU



Figure 1

Photo: S. Markell, NDSU



Figure 2

Photo: D. Malvick, Univ. of Minnesota

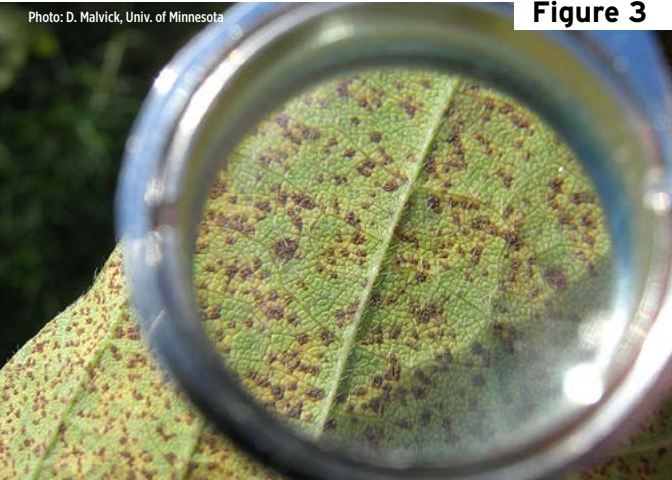


Figure 3



Soybean rust

Phakopsora pachyrhizi (fungus)

AUTHORS: Sam Markell and Dean Malvick

SYMPTOMS

- Very small gray-green, tan and/or red-brown spots on leaves
- Very small pustules on underside of leaf (hand lens needed)
- Leaf chlorosis and defoliation may occur

FIGURE 1 - Pustules visible on leaf wrapped around finger (approximately 5 to 10X)

FIGURE 2 - Profuse sporulation and leaf chlorosis

FIGURE 3 - Magnified pustules

FACTORS FAVORING DEVELOPMENT

- Proximity to areas that do not freeze (southern Florida, Louisiana, Texas)
- Storms traveling from south to north that may bring spores showers (for example, hurricanes)
- Prolonged leaf wetness and moderate temperatures

IMPORTANT FACTS

- *Soybean rust has never been recorded in Minnesota or North Dakota*
- Dry edible beans may be a host
- Can cause significant yield loss
- Commonly confused with bacterial pustule and other foliar diseases.