

PP1867 (Reviewed January 2024)

Soybean Disease Diagnostic Series

Samuel Markell

Professor and Extension Specialist
Department of Plant Pathology
North Dakota State University

Richard Wade Webster

Assistant Professor and Extension Specialist
Department of Plant Pathology
North Dakota State University

Dean Malvick

Professor and Extension Specialist
Department of Plant Pathology
University of Minnesota



NDSU

EXTENSION

Root Diseases

Fusarium root rot	PP1867-1
Phytophthora root and stem rot	PP1867-2
Pythium root rot	PP1867-3
Rhizoctonia root rot.....	PP1867-4
Seed and seedling rot complex	PP1867-5
Soybean cyst nematode	PP1867-6
Sudden death syndrome	PP1867-7

Stem Diseases

Anthracnose	PP1867-8
Brown stem rot.....	PP1867-9
Charcoal rot	PP1867-10
Pod and stem blight	PP1867-11
Stem canker	PP1867-12
White mold.....	PP1867-13

Leaf Diseases

Bacterial blight	PP1867-14
Bacterial pustule	PP1867-15
Bean pod mottle virus	PP1867-16
Cercospora leaf blight.....	PP1867-17
Downy mildew.....	PP1867-18
Frogeye leaf spot	PP1867-19
Phyllosticta leaf spot.....	PP1867-20
Powdery mildew	PP1867-21
Septoria brown spot.....	PP1867-22
Soybean mosaic virus	PP1867-23

Additional Diseases (not known to occur in ND/MN)

Soybean rust	PP1867-24
--------------------	-----------

Cover photo: Sam Markell, NDSU

NDSU Extension does not endorse commercial products or companies even though reference may be made to tradenames, trademarks or service names.

**For more information on this and other topics, see
www.ag.ndsu.edu/extension**

County commissions, North Dakota State University and U.S. Department of Agriculture cooperating. NDSU does not discriminate in its programs and activities on the basis of age, color, gender expression/identity, genetic information, marital status, national origin, participation in lawful off-campus activity, physical or mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, spousal relationship to current employee, or veteran status, as applicable. Direct inquiries to Vice Provost, Title IX/ADA Coordinator, Old Main 100, 701-231-7708, ndsueoaa@ndsu.edu. This publication will be made available in alternative formats for people with disabilities upon request, 701-231-7881. 2.5M-1-18, 1.484M-11-18, 250-7-21, 538-12-22, 240-1-24, 150-10-24



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

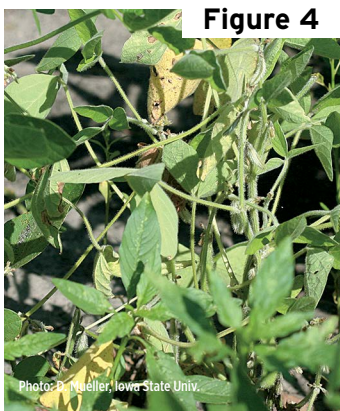


Photo: D. Mueller, Iowa State Univ.



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)

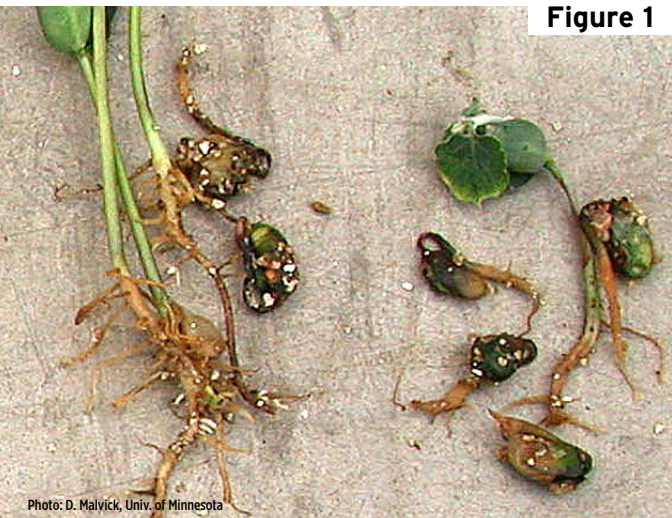


Figure 1

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)

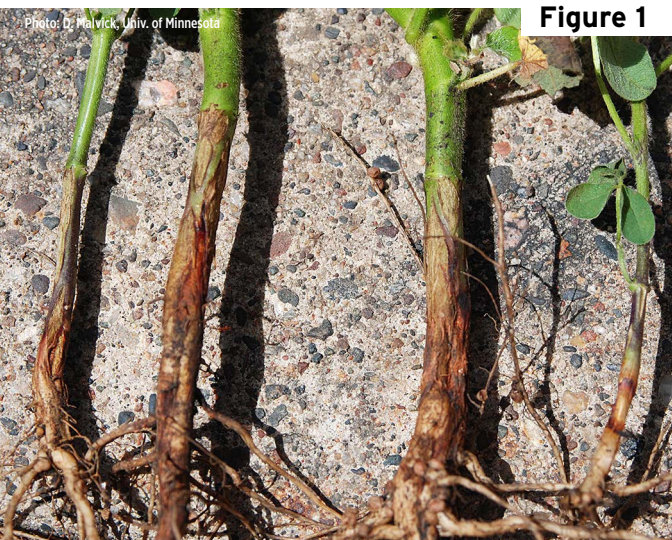


Photo: D. Malvick, Univ. of Minnesota

Figure 1



Photo: D. Malvick, Univ. of Minnesota

Figure 2

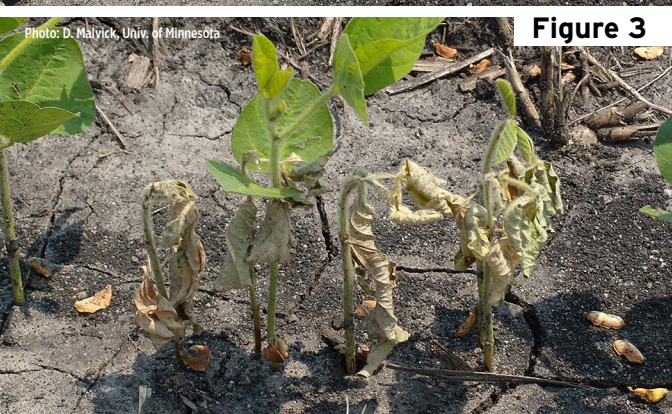


Photo: D. Malvick, Univ. of Minnesota

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

Card 4 of 24



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

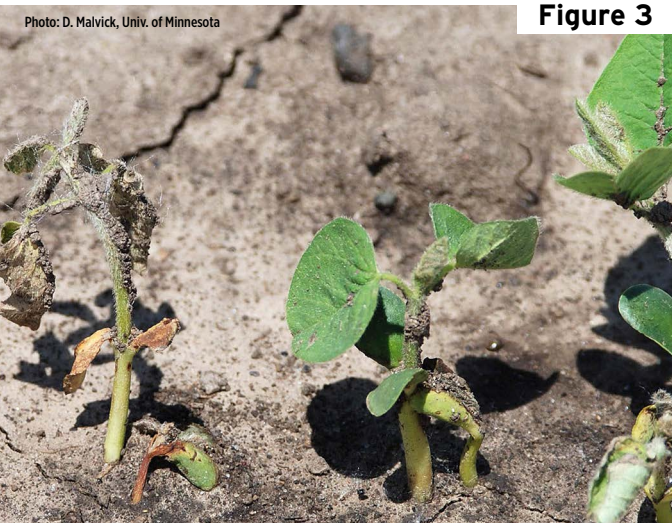


Photo: D. Malvick, Univ. of Minnesota



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

Card 5 of 24



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

Card 6 of 24



Sudden death syndrome (SDS)

Fusarium virguliforme (fungus)

Figure 1

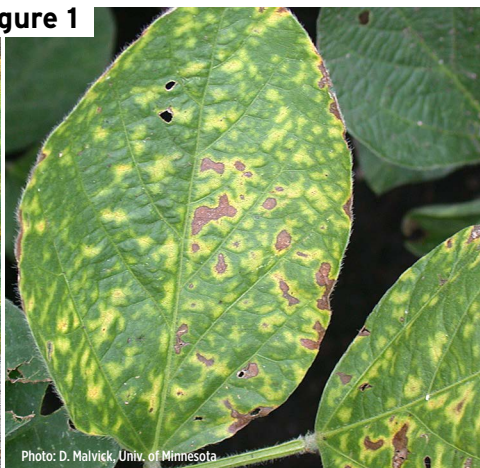


Photo: D. Malvick, Univ. of Minnesota

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

Card 7 of 24



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)

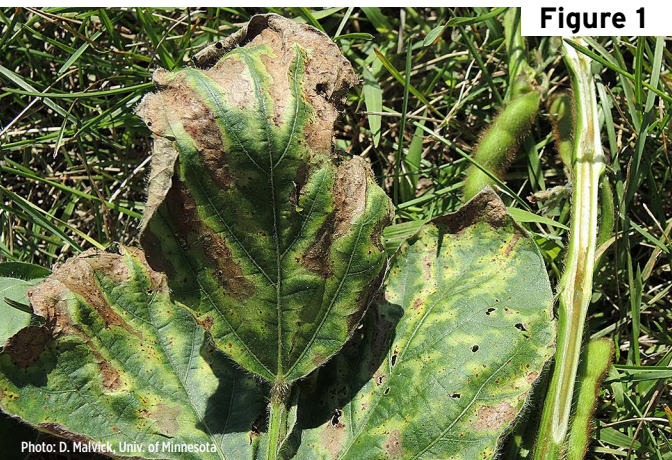


Figure 1

Photo: D. Malvick, Univ. of Minnesota

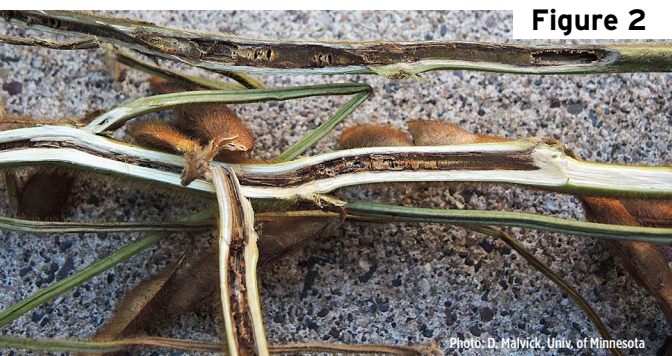


Figure 2

Photo: D. Malvick, Univ. of Minnesota



Figure 3

Photo: D. Malvick, Univ. of Minnesota

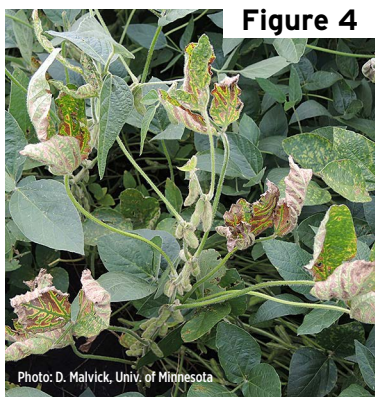


Figure 4

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

Card 9 of 24



Charcoal rot

Macrophomina phaseolina (fungus)

Figure 1



Photo: B. Nelson, NDSU

Figure 2

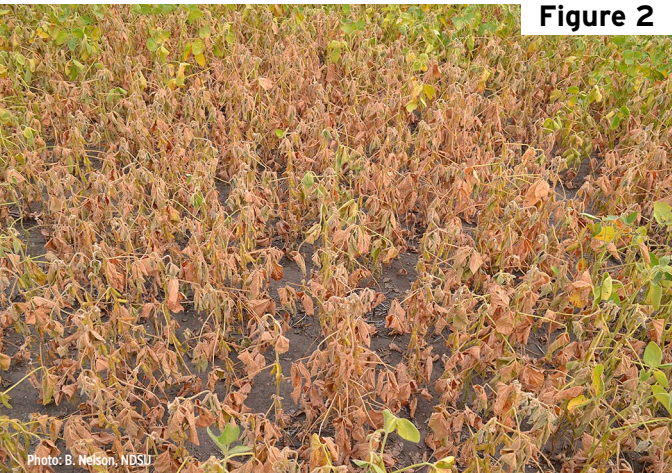


Photo: B. Nelson, NDSU

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

Card 11 of 24



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



Photo: S. Markell, NDSU

Figure 3

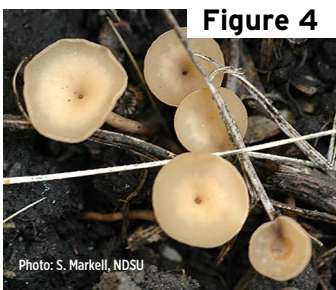


Figure 4

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

Card 13 of 24



Bacterial blight

Pseudomonas savastanoi pv. *glycinea* (bacteria)

Figure 1



Photo: S. Markell, NDSU

Figure 2

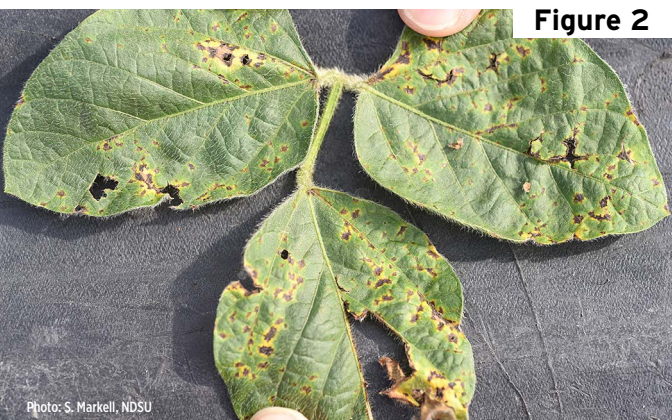


Photo: S. Markell, NDSU

Figure 3

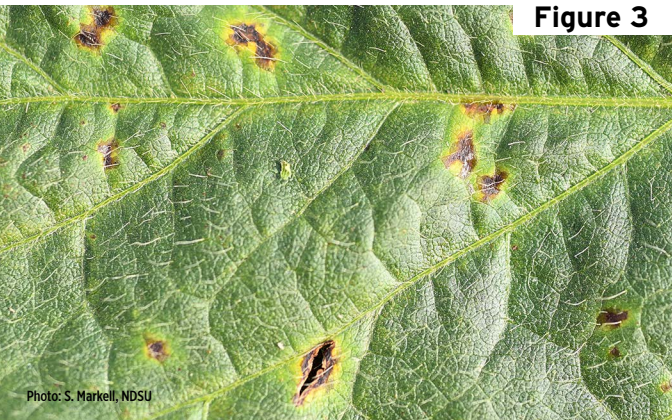


Photo: S. Markell, NDSU



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

Card 14 of 24



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

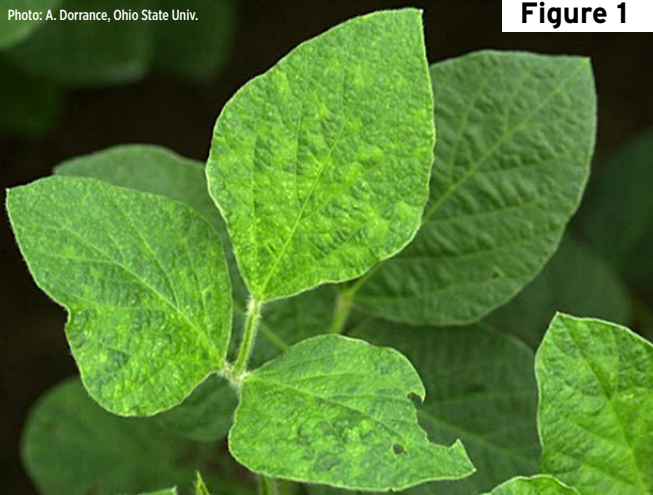


Photo: A. Dorrance, Ohio State Univ.

Figure 2



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

Card 16 of 24



Cercospora leaf blight

Cercospora kikuchii (fungus)

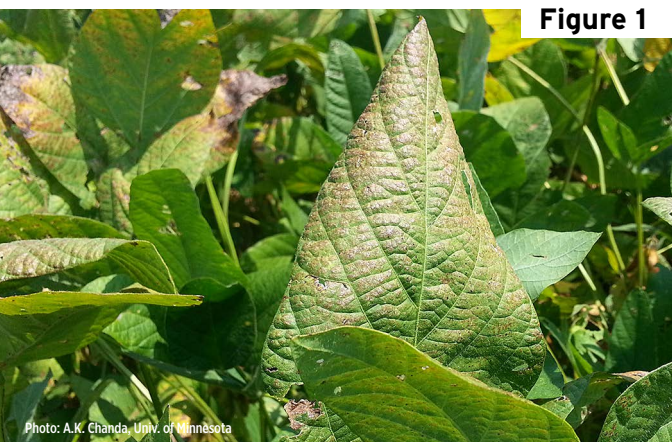


Figure 1

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)

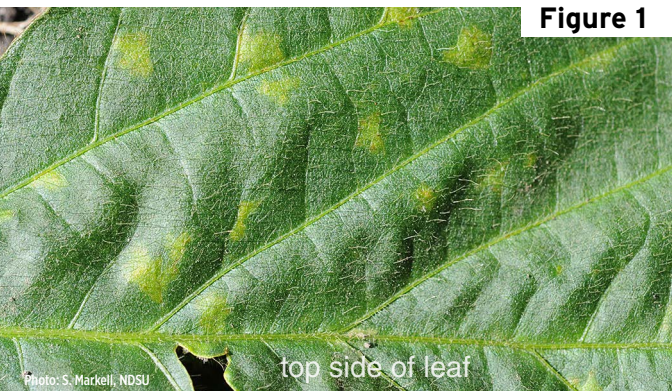


Figure 1



Figure 2

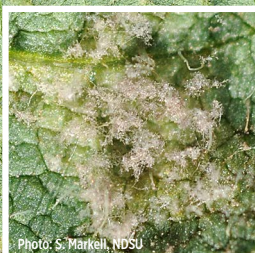


Figure 3



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)

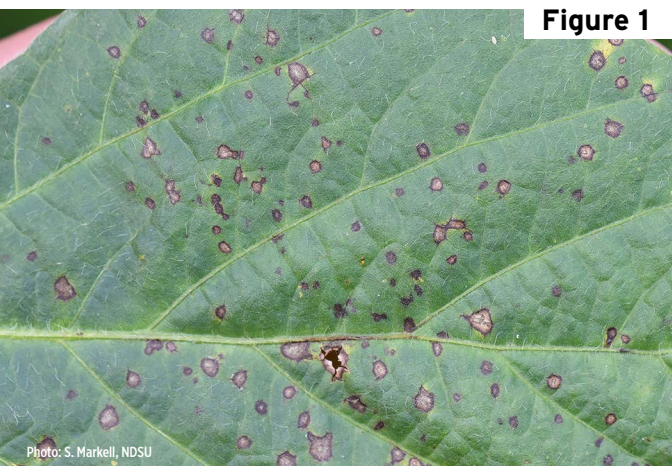


Figure 1

Photo: S. Markell, NDSU

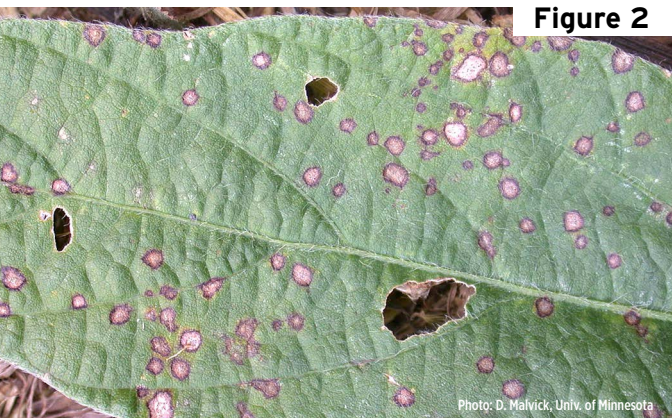


Figure 2

Photo: D. Malvick, Univ. of Minnesota



Photo: S. Markell, NDSU

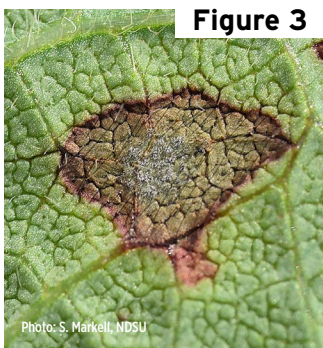


Figure 3

Photo: S. Markell, NDSU



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

Card 19 of 24



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

Card 20 of 24



Powdery mildew

Erysiphe diffusa and *E. glycines* (fungi)



Figure 1

Photo: D. Malvick, Univ. of Minnesota

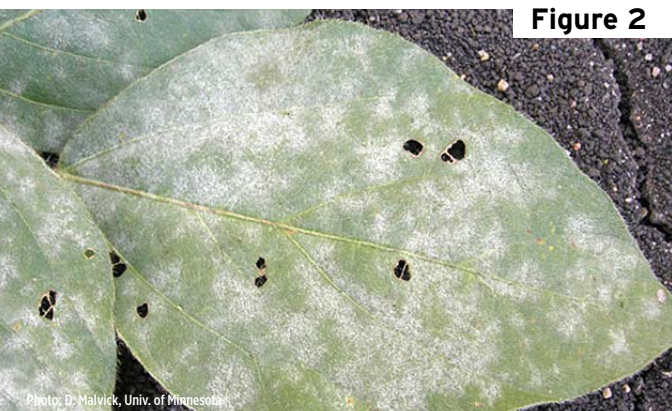


Figure 2

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

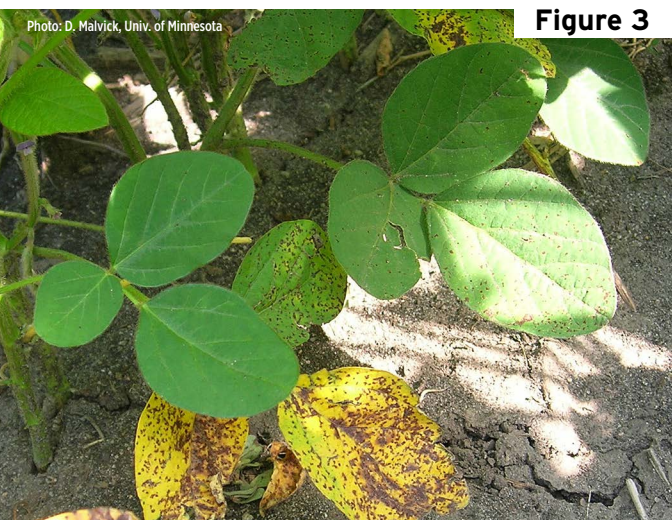


Figure 3

Photo: D. Malvick, Univ. of Minnesota



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

Card 22 of 24



Soybean mosaic virus

Photo: A. Tenuta, OMAFRA, Ontario, Canada

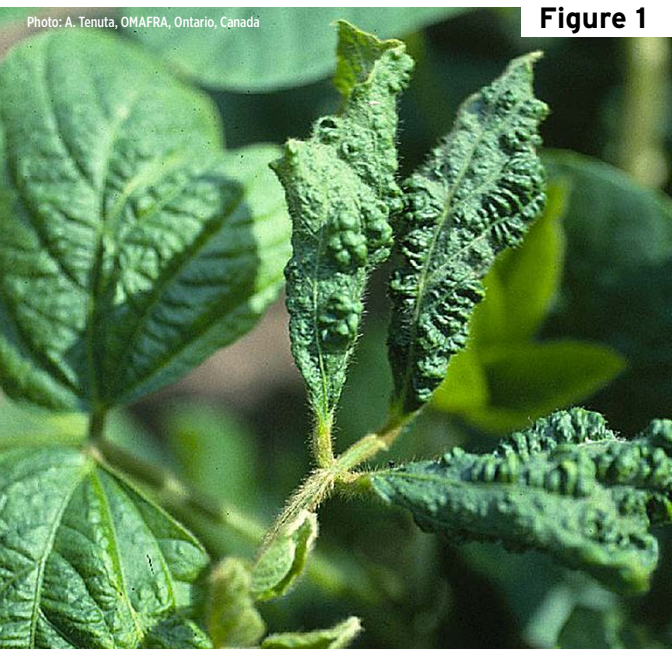


Figure 1

Photo: A. Tenuta, OMAFRA, Ontario, Canada

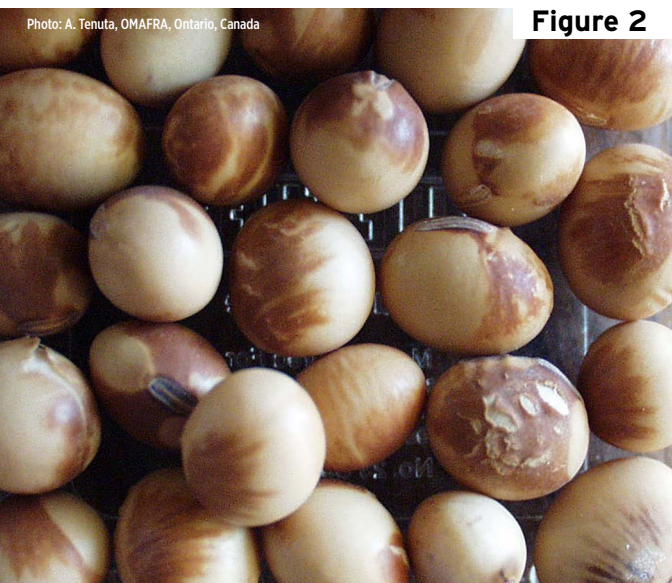


Figure 2



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.