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Cover photo: Sam Markell, NDSU

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Fusarium root rot

*Fusarium solani, F. oxysporum, F. tricinctum* and other *Fusarium* species (fungi)
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
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 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
- 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
Pythium root rot

*Pythium ultimum*
and other *Pythium* species (oomycete)
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 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)
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
- *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
Seed and seedling disease complex

*Pythium* (oomycete), *Phytophthora* (oomycete), *Rhizoctonia* (fungus), *Fusarium* (fungus)
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
- Cool soil that delays 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
Soybean cyst nematode (SCN)

*Heterodera glycines* (plant parasitic nematode)

Photo: S. Markell, NDSU
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 sampling is the most reliable way to determine if you have SCN
- Management tools available include crop rotation, variety resistance and possibly seed treatments
- Commonly confused with roots rots, iron deficiency chlorosis, other abiotic stress
Sudden death syndrome (SDS)

*Fusarium virguliforme* (fungus)
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, rare in northern Minnesota, not yet confirmed in North Dakota (2017)
- Pathogen can cause root rot of dry edible bean and other legumes
- Pathogen dispersed with soil (on equipment, in water, by wind, etc.)
- Management options: varieties partially resistant to SDS, seed treatments
- Commonly confused with brown stem rot
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 lesions may appear on stems, pods and petioles
- Small black fungal patches 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)
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 only stem symptoms
- Type B thought to be more common in our region
- Management options: crop rotation and varieties resistant to BSR
Charcoal rot

*Macrophomina phaseolina* (fungus)
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
- May be more severe when soybean cyst nematode is present

**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 sojae and Diaporthe longicolla* (fungi)
Pod and stem blight/Phomopsis seed decay

*Diaporthe sojae* and *Diaporthe longicolla* (fungi)

**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
Stem canker

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

**Figure 2**

**Figure 3**

**Figure 4**
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 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
- Disease history 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
- Apothecia commonly confused with bird’s nest fungi
- Management options: partially resistant varieties and fungicides
Bacterial blight

*Pseudomonas savastanoi pv. glycinea* (bacteria)
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
Bacterial pustule

*Xanthomonas axonopodis pv. glycines* (bacteria)
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

**IMPORTANT FACTS**
- Uncommon 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

Figure 1

Figure 2

Figure 3
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
Cercospora leaf blight

*Cercospora kikuchii* (fungus)
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)
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: approximately 5 to 10X)
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

Figure 2

Figure 3

Photo: D. Malwick, Univ. of Minnesota
Frogeye leaf spot
*Cercospora sojina* (fungus)

**AUTHORS:** Dean Malvick and Sam Markell

**SYMPTOMS**

- Brown leaf spots surrounded by a darker reddish-brown or purple ring
- Centers of spots become tan as they age and develop black specks
- Spots may coalesce, fall out and kill large parts of leaves

**FIGURE 1** - Spots and patterns of lesion development on leaf
**FIGURE 2** - Infected leaf
**FIGURE 3** - Close-up of spots and holes in leaves

**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 in southern Midwest is insensitive to Strobilurin (QoI, FRAC 11) fungicides
- Commonly confused with bacterial blight, Septoria brown spot
Powdery mildew

*Erysiphe diffusa* and *E. glycines* (fungi)
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

![Image of leaf with brown spots]

Photo: D. Malvick, Univ. of Minnesota

Figure 2

![Image of leaf with brown spots and yellowing]

Photo: D. Malvick, Univ. of Minnesota

Figure 3

![Image of plant with brown spots on leaves]

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** - Trifoliate 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

Figure 1

Photo: A. Tenuta, OMAFRA, Ontario, Canada

Figure 2

Photo: A. Tenuta, OMAFRA, Ontario, Canada
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

Photo: D. Malvick, Univ. of Minnesota
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.