2016

Dry Edible Bean Disease Diagnostic Series

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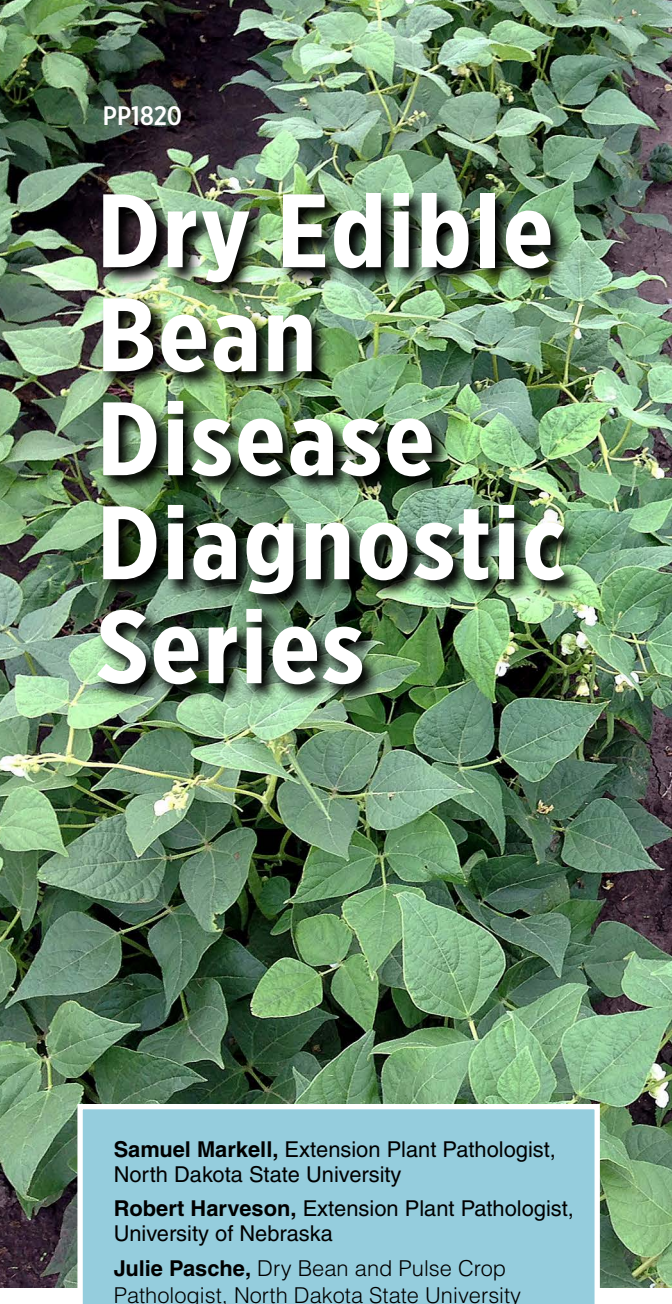

PP1820

Dry Edible Bean Disease Diagnostic Series

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NORTHARVEST BEANS

Root Diseases

Stem and Wilt Diseases

Foliar Diseases

Cover photo: Gary Stone, University of Nebraska

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

PP1820-1
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Fusarium root rot

Fusarium solani

Photo: J. Pasche, NDSU

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

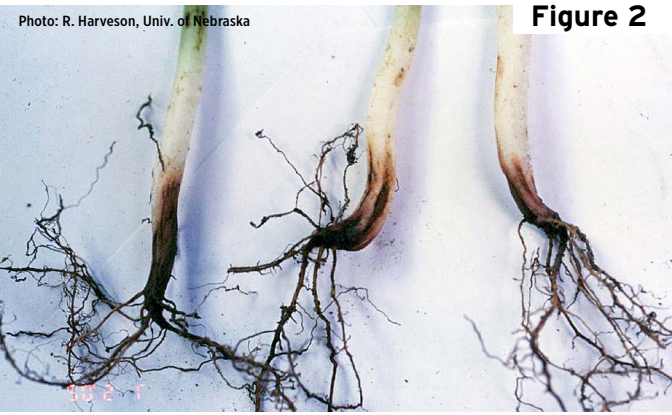

Photo: C. Tvedt, NDSU

Figure 3

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Fusarium root rot

Fusarium solani

AUTHORS: Jessica Halvorson, Chryseis Tvedt, Julie Pasche, Bob Harveson and Sam Markell

SYMPTOMS

- **Reddish-brown below-ground lesions**
- **Lesions may extend up the main root and hypocotyl**
- **Internal brown to red discoloration may be visible**
- **Yellow and stunted above-ground symptoms**

FIGURE 1 – Susceptible (L) and moderately resistant (R) bean varieties under heavy Fusarium root rot pressure

FIGURE 2 – Reddish-brown lesions on hypocotyl and roots

FIGURE 3 – Split stems with a range of internal symptom severity

FACTORS FAVORING DEVELOPMENT

- Cool and wet soils after planting
- Compacted soils and plant stress

IMPORTANT FACTS

- Soybeans and other pulse crops may be hosts
- May appear in circular patterns in a field
- Often found in a complex of other root rots
- Fungicide seed treatments may be effective early in the season
- Can be confused with other root rots and abiotic stresses

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Pythium diseases

Pythium spp.

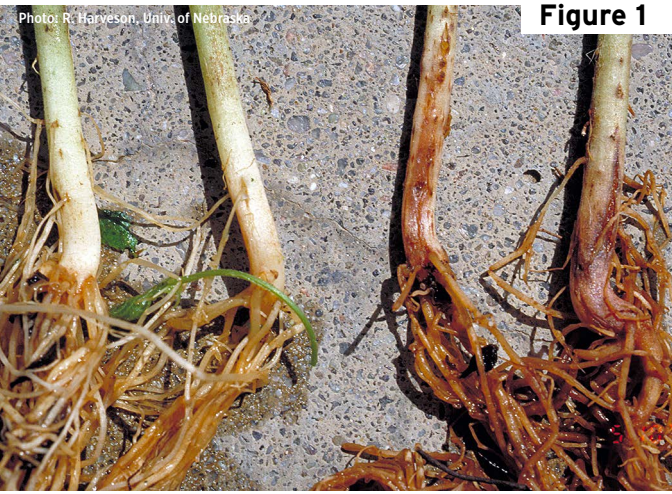

Figure 1

Figure 2

Figure 3

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Pythium diseases

Pythium spp.

AUTHORS: Bob Harveson, Julie Pasche and Sam Markell

SYMPTOMS

- **Initial root rot symptoms appear as elongated, water-soaked necrotic areas on roots or hypocotyls, sometimes extending above soil line**
- **Wilting and death of plants (damping off)**
- **Symptoms on above-ground tissues (blight phase) may occur after extended conditions of rain, irrigation, high humidity or high moisture**

FIGURE 1 – Water-soaking symptoms on roots and hypocotyls (R) and healthy root (L)

FIGURE 2 – Wilting and death of a young bean plant

FIGURE 3 – Pythium blight-phase causing necrosis of stems and petioles

FACTORS FAVORING DEVELOPMENT

- High levels of soil moisture
- Disease incidence often is greater where water accumulates in fields

IMPORTANT FACTS

- Cool-weather species (most active below 75 F) include *P. ultimum*, while warm-weather species (80 to 95 F) include *P. myriotylum* and *P. aphanidermatum*
- The pathogens survive in soil for years and can be moved with soil
- Any area of the plant in contact with the soil may become infected, resulting in water-soaked areas of the stem or upper branches (blight-phase)
- Can be confused with other root rots, wilts and white mold (blight-phase only)

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Rhizoctonia root rot

Rhizoctonia solani

Photo: R. Harveson, Univ. of Nebraska

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

Photo: J. Pasche, NDSU

Figure 3

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Rhizoctonia root rot

Rhizoctonia solani

AUTHORS: Jessica Halvorson, Julie Pasche, Bob Harveson and Sam Markell

SYMPTOMS

- **Stunting and premature death of plants in field**
- **Lesions or cankers with reddish-brown borders on roots and base of stem**
- **Internal brick-red discoloration of pith**

FIGURE 1 – Stunting, wilting and premature death

FIGURE 2 – Sunken reddish-brown cankers

FIGURE 3 – Brick-red discoloration in pith

FACTORS FAVORING DEVELOPMENT

- Moderate to high soil moisture
- Cool, compacted soil

IMPORTANT FACTS

- Soybeans, sugar beets, potatoes, pulse crops and some weeds are hosts
- Often found in a complex with other root rots
- Fungicide seed treatments may help manage disease early in the growing season
- Can be confused with other root rots and abiotic stresses

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PP1820-4
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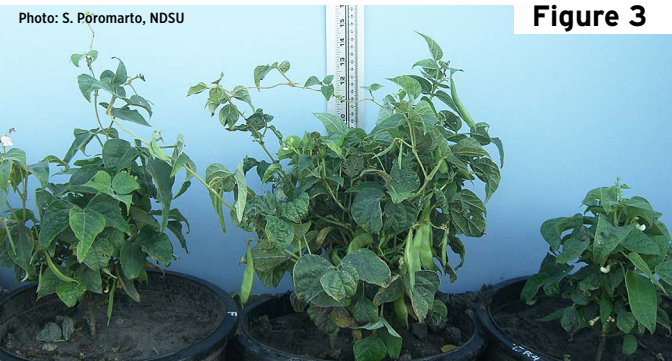
Soybean cyst nematode (SCN)

Heterodera glycines

Figure 1

Figure 2

Figure 3



Soybean cyst nematode (SCN)

Heterodera glycines

AUTHORS: Julie Pasche, Guiping Yan, Berlin Nelson, Sam Markell and Bob Harveson

SYMPTOMS

- **Plants can be infected with no above-ground symptoms**
- **Stunted or yellow areas of the field**
- **Small (1/32 to 1/6 inch) cream-colored and lemon-shaped cysts on roots**

FIGURE 1 – Yellow and stunted kidney beans with SCN

FIGURE 2 – Small cream-colored females on dry bean roots

FIGURE 3 – Stunting of pinto bean growing in pots with different levels of SCN; no SCN (C); 5,000 eggs/100cc (L); 10,000 eggs/cc of SCN (R)

FACTORS FAVORING DEVELOPMENT

- Rotation with soybeans
- Light soil texture
- High soil pH
- Warm and dry soil

IMPORTANT FACTS

- Soybeans and dry edible beans are hosts
- Dirty equipment, flooding and wind erosion are SCN dispersal mechanisms
- All market classes are hosts
- Research indicates that kidney beans are the market class most susceptible to SCN and black beans are the least susceptible

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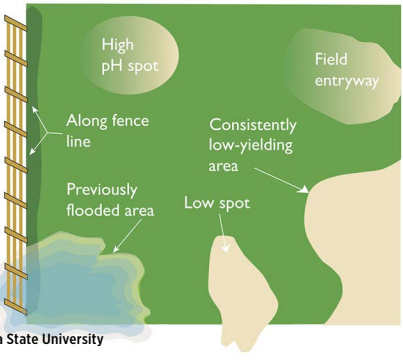
Soybean cyst nematode soil sampling

Heterodera glycines

Figure 1

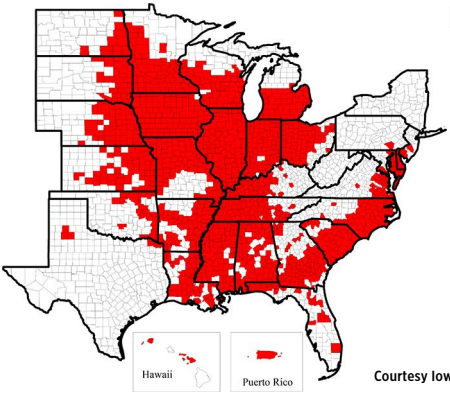


Courtesy Iowa State University

Figure 2

Photo: G. Yan, NDSU

Figure 3



Courtesy Iowa State University

Soybean cyst nematode soil sampling

Heterodera glycines

AUTHORS: Sam Markell, Guiping Yan, Berlin Nelson, Julie Pasche and Bob Harveson

WHY SOIL SAMPLE

- **SCN is a microscopic worm that lives in the soil and parasitizes roots**
- **Soil sampling is the most reliable way to detect SCN**

WHEN TO SAMPLE

- **In late summer/fall (before or after harvest), when SCN population is highest and more easily detected**

WHERE TO SAMPLE

- **Anything that moves soil can move SCN**
- **Concentrate sampling in areas where SCN is likely to be introduced or develop, *especially field entrances***

FIGURE 1 – High-risk spots for SCN

FIGURE 2 – SCN causing yellowing and stunting in kidney beans

FIGURE 3 – Counties positive for SCN (detected on soybeans) as of 2014

HOW TO SAMPLE

- Aim for the roots, dig 6 to 8 inches deep, take 10 to 20 samples, mix and send to a lab

WHAT RESULTS MEAN

- Results are presented as eggs/100 cc, which is the number of nematode eggs in approximately 3.4 ounces of soil
- Low levels (for example, 50 or 100 eggs/100 cc) could be false positives and should be viewed with caution

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Bacterial wilt

Curtobacterium flaccumfaciens pv. *flaccumfaciens*

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

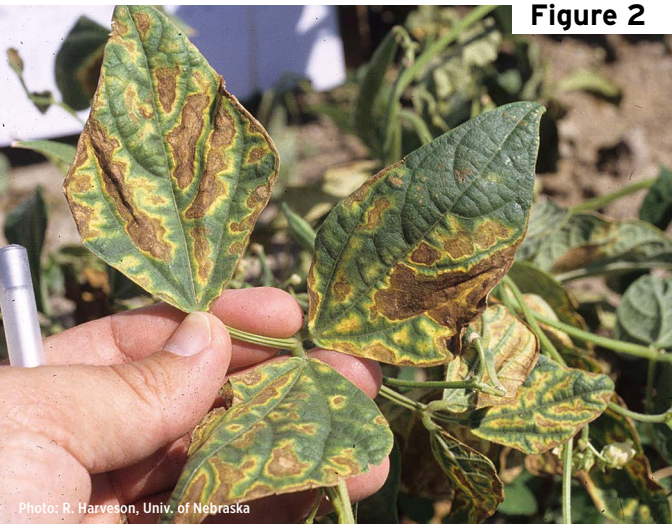

Photo: R. Harveson, Univ. of Nebraska

Figure 3

Photo: R. Harveson, Univ. of Nebraska

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Bacterial wilt

Curtobacterium flaccumfaciens pv. *flaccumfaciens*

AUTHORS: Bob Harveson, Sam Markell and Julie Pasche

SYMPTOMS

- **Leaf wilting during periods of warm, dry weather or periods of moisture stress**
- **Interveinal, necrotic lesions which may be surrounded by bright yellow borders**
- **Seeds from surviving infected plants often will shrivel and be stained yellow or orange**

FIGURE 1 – Wilting and death of infected bean plants

FIGURE 2 – Leaves with interveinal necrotic lesions surrounded by a wavy, yellow border

FIGURE 3 – Shriveled, orange-stained seeds (bottom) and healthy seeds (top) obtained from the same infected plant

FACTORS FAVORING DEVELOPMENT

- Very hot air temperatures (greater than 90 F), with wet or humid conditions

IMPORTANT FACTS

- Wilt pathogen survives in bean residue or seeds from previous year
- Infected seeds are primary mechanism of long-distance movement
- Wet weather, hail, violent rain and windstorms help the pathogen spread within and between fields
- Can be confused with root rots and other bacterial pathogens; foliar symptoms of bacterial wilt tend to be more wavy or irregular than common bacterial blight lesions and ***do not*** include water-soaking

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Fusarium yellows (wilt)

Fusarium oxysporum f. sp. *phaseoli*

Figure 1

Figure 2

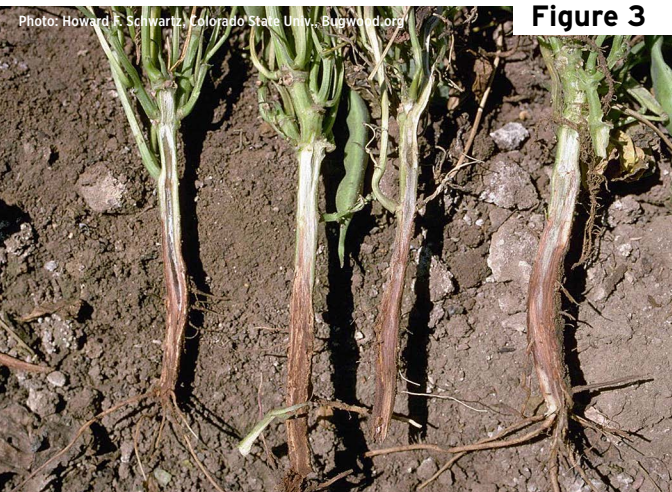

Figure 3

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Fusarium yellows (wilt)

Fusarium oxysporum f. sp. *phaseoli*

AUTHORS: Bob Harveson, Sam Markell and Julie Pasche

SYMPTOMS

- **Foliar symptoms first appear as yellowing and wilting of older leaves, followed by younger leaves if the disease progresses**
- **Severely affected plants may wilt permanently**
- **Vascular discoloration of roots and hypocotyl tissues is primary diagnostic symptom; degree of discoloration varies in intensity depending on cultivar and environmental conditions**

FIGURE 1 – Yellowing and wilting of leaves

FIGURE 2 – Permanent wilting and death of severely affected plants

FIGURE 3 – Vascular discoloration of plants affected by Fusarium wilt

FACTORS FAVORING DEVELOPMENT

- High temperature stress (greater than 86 F)
- Dry soil conditions
- Soil compaction

IMPORTANT FACTS

- Fusarium wilt often causes more dramatic symptoms than Fusarium root rot infections
- Unlike Fusarium root rot infections, Fusarium wilt seldom kills plants
- Death with wilt can occur before or after pod set
- Fusarium wilt can induce maturity two to three weeks earlier than normal
- Can be confused with other root rot and wilt diseases

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Stem rot

Unknown sterile white basidiomycete (SWB)

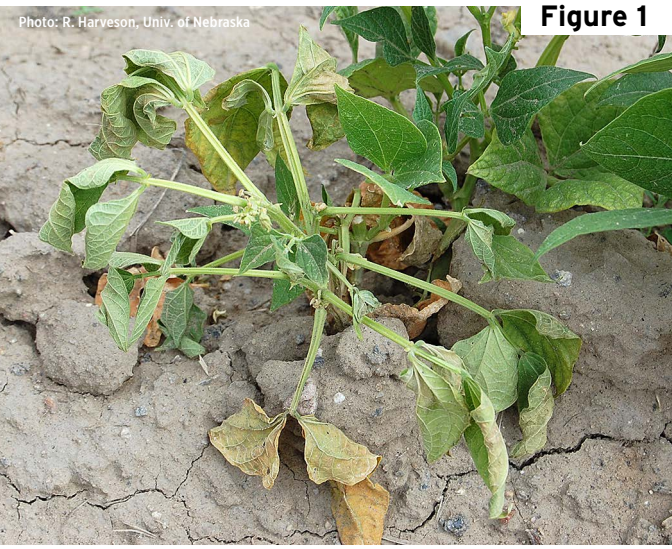

Photo: R. Harveson, Univ. of Nebraska

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

Photo: R. Harveson, Univ. of Nebraska

Figure 3

Stem rot

Unknown sterile white basidiomycete (SWB)

AUTHORS: Bob Harveson, Sam Markell and Julie Pasche

SYMPTOMS

- **Wilting and death of young plants first observed after emergence**
- **On less severely affected plants, small lesions may be on hypocotyls**
- **Severe infection also can include sunken gray to black cankers on hypocotyls and stems**
- **White mycelial strands may grow over lesions or into stem piths; soil will adhere to stems when wilted plants are removed**

FIGURE 1 – Wilting symptoms characteristic of SWB infection

FIGURE 2 – Small light brown lesions (L), moderate lesions (C) and large dark brown to black sunken lesions (R)

FIGURE 3 – White mycelial strands of SWB and soil adhering to stems of infected plants

FACTORS FAVORING DEVELOPMENT

- High soil temperatures, but has been reported to cause disease from 60 to 95 F

IMPORTANT FACTS

- Thought to have many hosts
- Can survive at least one year in soils, likely in colonized residue of weeds or other susceptible crops
- Can be confused with other root rots, wilts and white mold

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White mold

Sclerotinia sclerotiorum

Figure 1

Photo: S. Markell, NDSU

Figure 2

Photo: M. Wunsch, NDSU

Figure 3

Photo: S. Markell, NDSU

Figure 4

Photo: R. Harveson, Univ. of Nebraska

White mold

Sclerotinia sclerotiorum

AUTHORS: Julie Pasche, Bob Harveson and Sam Markell

SYMPTOMS

- **Water-soaked lesion that becomes tan as it enlarges**
- **Stem lesions will dry out, lighten in color and tissue may shred**
- **White fungal growth and hard black sclerotia may form in or on stem**

FIGURE 1 – Small tan mushrooms (apothecia) about ¼ inch in diameter emerge from hard, black structures (sclerotia)

FIGURE 2 – Enlarging tan lesions with white fungal growth

FIGURE 3 – Mature stem lesion with dried-bone appearance, white fungal growth and black sclerotia

FIGURE 4 – Severe white mold damage

FACTORS FAVORING DEVELOPMENT

- Wet soils prior to bloom; allows sclerotia to germinate and release spores
- Cool daytime temperatures (60 to 70F) during and after bloom
- Long periods of canopy wetness and/or frequent rainfall during bloom
- Lush plant growth

IMPORTANT FACTS

- All broadleaf crops and many weeds are susceptible to white mold
- Plants are only susceptible when in bloom
- Preventative fungicide applications may be economically viable
- Can be confused with wilt diseases or abiotic stress

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Anthracnose

Colletotrichum lindemuthianum

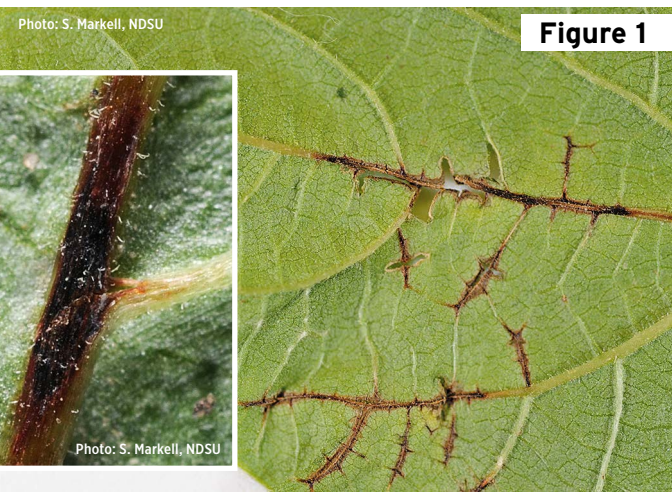

Figure 1

Figure 2

Figure 3

Anthracnose

Colletotrichum lindemuthianum

AUTHORS: Jessica Halvorson, Sam Markell, Julie Pasche and Bob Harveson

SYMPTOMS

- **Can occur on all above-ground plant parts**
- **Leaf vein and petiole lesions are dark and slender**
- **Pod lesions begin as small brown spots, enlarge to become circular and sunken**
- **Infected seeds may appear discolored and have necrotic lesions**
- **White fungal growth or cream-salmon-colored spore masses may be visible in lesions**

FIGURE 1 – Leaf lesions; note sunken necrotic canker (inset)

FIGURE 2 – Sunken circular pod lesions

FIGURE 3 – White fungal growth and sunken lesions on discolored seed

FACTORS FAVORING DEVELOPMENT

- Infected seed
- Cool (55 to 80 F) temperatures
- Frequent rain or thunderstorms

IMPORTANT FACTS

- Pathogen is seed-borne and wind-dispersed
- Spread can occur by splashing water
- Pathogen can spread by animals, people or machinery moving through fields when foliage is wet
- Planting certified disease-free seed is best way to prevent the disease
- Can be confused with bacterial blights

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Bacterial brown spot

Pseudomonas syringae pv. *syringae*

Photo: R. Harveson, Univ. of Nebraska

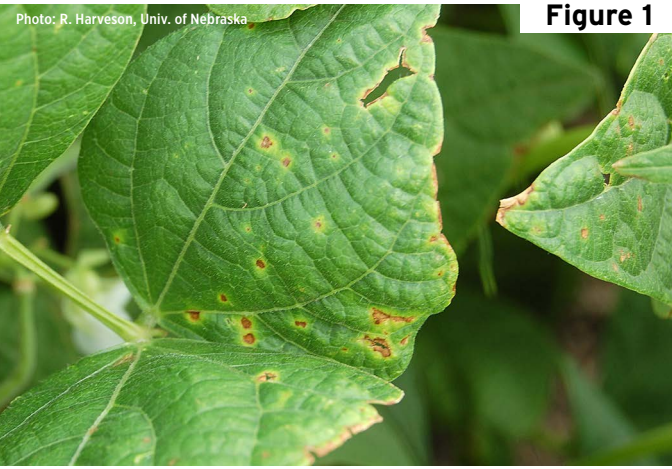

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

Photo: R. Harveson, Univ. of Nebraska

Figure 3

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Bacterial brown spot

Pseudomonas syringae pv. *syringae*

AUTHORS: Bob Harveson, Sam Markell and Julie Pasche

SYMPTOMS

- **Small, circular, brown lesions, often surrounded by a narrow yellow zone (not always present)**
- **Lesions may coalesce to form linear necrotic streaks between leaf veins**
- **Centers of old lesions dry and fall out, leaving tattered strips or "shot holes"**
- **May infect leaves, pods and seeds**

FIGURE 1 – Small circular necrotic lesions with yellow margins

FIGURE 2 – Small necrotic lesions coalescing, forming large necrotic areas between veins

FIGURE 3 – Older lesions with holes after necrotic tissues fell out

FACTORS FAVORING DEVELOPMENT

- Warm air temperatures (80 to 85 F) with wet or humid conditions
- Storms that damage plants (hail, high wind)
- Planting infected seeds favors early infection and disease spread

IMPORTANT FACTS

- Pathogen survives in seed, residue and on other living hosts
- Wet weather, hail, violent rain and windstorms spread the pathogen
- Can be confused with other bacterial blights: necrotic area is similar in size to halo blight but smaller than common bacterial blight; yellow margin (halo) is narrow and bright as with common blight, but halo blight's is larger, faint

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Bean common mosaic

Bean common mosaic virus (BCMV)

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

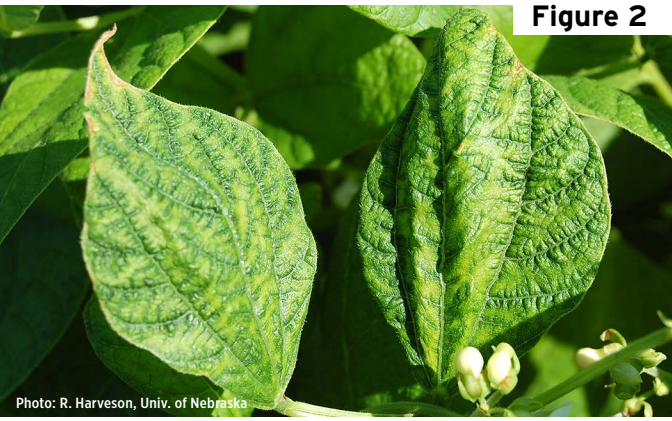
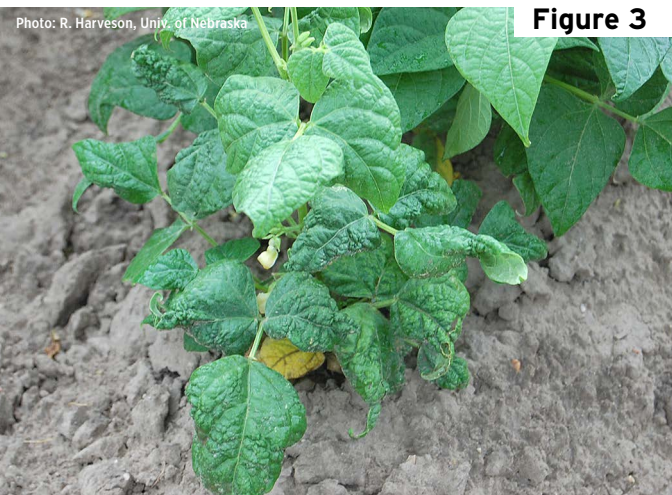


Photo: R. Harveson, Univ. of Nebraska

Photo: R. Harveson, Univ. of Nebraska

Figure 3



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Bean common mosaic

Bean common mosaic virus (BCMV)

AUTHORS: Bob Harveson, Julie Pasche and Sam Markell

SYMPTOMS

- **Light and dark green mosaics and/or leaf malformation**
- **Downward rolling or cupping of leaves**
- **Vein banding, and stunting, necrosis or premature death**

FIGURE 1 – Mosaic, blistering and distortion (elongation) of leaves of affected plants

FIGURE 2 – Vein banding of leaves on an infected plant

FIGURE 3 – Blistering and downward cupping of rugose leaves of infected plant

FACTORS FAVORING DEVELOPMENT

- Disease development dependent on susceptibility of cultivars and presence of aphids as vectors
- Yield losses more severe after early infections

IMPORTANT FACTS

- Type and severity of symptoms depend on host cultivar, virus strain and environment
- BCMV is spread among production areas by planting infected seed
- Several aphid species transmit BCMV
- More than 10 strains of BCMV are known
- Can be confused with other viruses, herbicide damage or plant stress

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PP1820-13
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Common bean rust

Uromyces appendiculatus

Figure 1

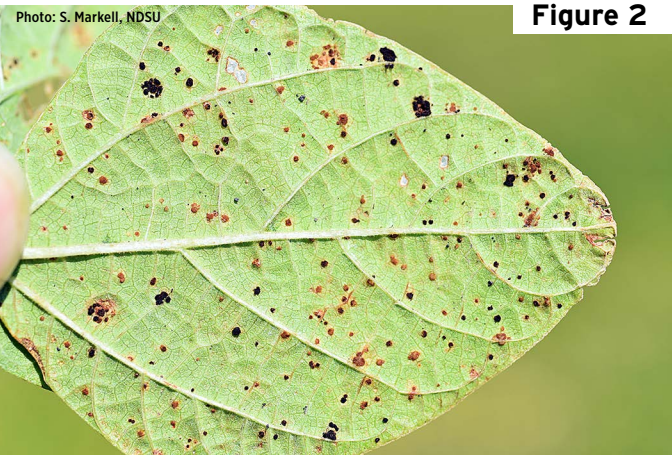

Figure 2

Figure 3

Common bean rust

Uromyces appendiculatus

AUTHORS: Sam Markell, Bob Harveson and Julie Pasche

SYMPTOMS

- **Small (1/16 inch) cinnamon-brown pustules that may have a yellow halo**
- **Pustules turn black at end of growing season**
- **Usually first observed in areas of a field with concentrated infection, called "hot spots"**

FIGURE 1 – Rust hot spot

FIGURE 2 – Cinnamon-brown (uredinia) and black (telia) rust pustules

FIGURE 3 – Dusty cinnamon-brown spores rubbed off pustule with yellow halo

FACTORS FAVORING DEVELOPMENT

- Close proximity to a field that had rust the previous year
- Frequent heavy dews
- Moderate to warm temperatures (65 to 85 F)
- Factors favoring wet microclimates: lush plant growth, close to shelter belts, etc.

IMPORTANT FACTS

- Pathogen is specific to edible beans
- Infection may occur at any time and spread very quickly
- Fungicides applied after detection may be economically viable
- Pathogen has different races, which may overcome resistance
- Can be confused with soil splash, brown spot and halo blight

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Common bacterial blight

Xanthomonas campestris pv. *phaseoli*

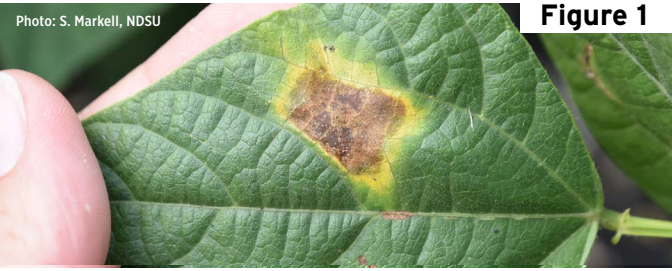

Figure 1

Figure 2

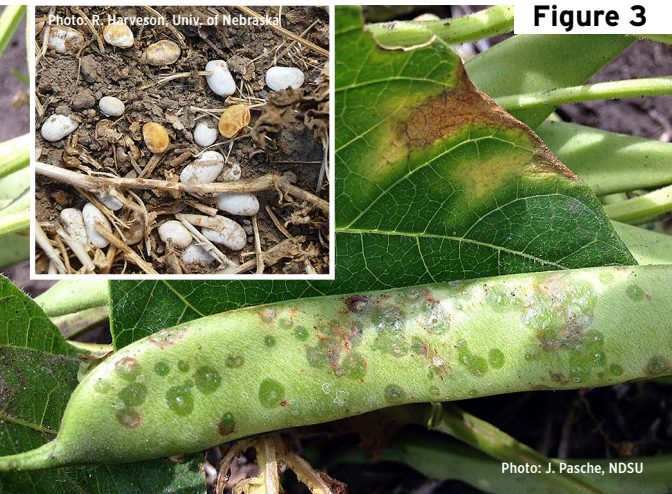

Figure 3

Common bacterial blight

Xanthomonas campestris pv. *phaseoli*

AUTHORS: Bob Harveson, Julie Pasche and Sam Markell

SYMPTOMS

- **Leaves, pods and seeds can be infected**
- **Initial symptoms: small water-soaked spots on the underside of leaves**
- **Spots enlarge and coalesce to form large necrotic areas with a narrow, bright yellow border**
- **Severely damaged leaves appear burned and remain attached at maturity**

FIGURE 1 – Large necrotic lesions with narrow yellow borders

FIGURE 2 – Severely damaged leaves appearing burned or scorched

FIGURE 3 – Infected pod, leaf and seeds (inset)

FACTORS FAVORING DEVELOPMENT

- Warm air temperatures (80 to 90 F) with wet or humid conditions
- Storms that damage plants (hail, high wind)
- Planting infected seeds favors early infection and disease spread

IMPORTANT FACTS

- Bacteria survive in fields on infected seed or bean tissues
- Pathogen can spread by animals, people or machinery moving through fields when foliage is wet
- Can be confused with anthracnose (pod infection) and bacterial diseases; yellow margin (halo) is similar in color and brightness to bacterial brown spot but necrotic area is larger

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NDBEA
North Central IPM Center
Northern Pulse Growers
Nebraska Dry Bean Commission
University of Nebraska Lincoln

PP1820-15
Dry Edible Bean Disease Diagnostic Series

Halo blight

Pseudomonas syringae pv. *phaseolicola*

Figure 1

Photo: R. Harveson, Univ. of Nebraska

Figure 2

Photo: J. Pasche, NDSU

Figure 3

Photo: R. Harveson, Univ. of Nebraska

PP1820-15
Dry Edible Bean Disease Diagnostic Series

Halo blight

Pseudomonas syringae pv. *phaseolicola*

AUTHORS: Bob Harveson, Julie Pasche and Sam Markell

SYMPTOMS

- **Begins with small water-soaked spots that become necrotic**
- **Broad yellow-green halo may develop around necrotic spots**
- **In severe cases, a general systemic chlorosis may develop in infected plants**
- **Also may infect pods and seeds**

FIGURE 1 – Small water-soaked spots on underside of leaf

FIGURE 2 – Broad yellow-green halo surrounding small necrotic spot

FIGURE 3 – Severe infection and the beginning of a systemic chlorosis in plants

FACTORS FAVORING DEVELOPMENT

- Cool air temperatures (68 to 72 F) with wet or humid conditions
- Planting infected seeds favors early infection and disease spread
- Storms with high winds, rain or hail will damage plants and spread pathogen from plant to plant

IMPORTANT FACTS

- Yellow-green chlorotic halo more pronounced at cool temperatures, less noticeable above 75 F
- Pathogen can spread by animals, people or machinery moving through fields when foliage is wet
- Can be confused with other bacterial blights; necrotic area is similar in size to bacterial brown spot but halo is much larger and a fainter yellow-green

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