

Fusarium Head Blight

Fusarium graminearum

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Fusarium Head Blight

Fusarium graminearum

SYMPTOMS

- Reddish orange- to pink discoloration with signs of mycelium in the glume.
- Bleaching of one or more spikelets.
- Grains appear shriveled and shrunken with reddish-pink discoloration sometimes visible in some of them.

Figure 1- FHB infected glumes with grey -orange-red discoloration and signs of mycelium

Figure 2- Bleached spikelets.

Figure 3- Grey and reddish-purple FHB damaged kernels

Factors Favoring Development

- Extended periods of high moisture and relative humidity greater than 90% during anthesis.
- Temperature of 59 to 86°F

Important Facts

- *Fusarium graminearum* is the common species that cause Fusarium head blight in United states and produce mycotoxins.
- Pathogen overwinters in infested crop residues.
- Sexual spores(ascospores) get discharged to 2.8-8.5mm distance horizontally with wind and start new infection.

Fusarium Head Blight

Fusarium graminearum

Fusarium Head Blight

Fusarium graminearum



SYMPTOMS

- Reddish orange- to pink discoloration with signs of mycelium in the glume.
- Bleaching of one or more spikelets.
- Grains appear shriveled and shrunken with reddish-pink discoloration sometimes visible in some of them.

Figure 1- FHB infected glumes with orange- red discoloration and signs of mycelium

Figure 2- Bleached spikelets.

Figure 3- FHB damaged kernels

Factors Favoring Development

- Extended periods of high moisture and relative humidity greater than 90% during anthesis.
- Temperature of 59 to 86°F

Important Facts

- *Fusarium graminearum* is the common species that cause Fusarium head blight in United states and produce mycotoxins.
- Pathogen overwinters in infested crop residues.
- Sexual spores(ascospores) can travel a long distance with wind and start new infection.

Ergot

Claviceps purpurea

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Ergot

Claviceps purpurea

SYMPTOMS

- Hard mass of fungal mycelium develops in the grain in place of kernel.
- Looks like grain but are elongated and black in color, white to light purple center of ergot body observable when broken or crushed.
- Often protrudes from the glumes of mature heads and are easily distinguishable.

Figure 1- Ergot grain protruding from the glumes of mature heads

Figure 2- Elongated ergot grain among healthy grains

Figure 3- Close view of ergot in Kernza®

Factors Favoring Development

- Cold winter followed by prolonged wet soils in the spring.
- Cool, moist weather prior to and during flowering.
- Poor fertility, poor pollination or copper deficiency delaying the flowering and maturity

Important Facts

- Open pollinated grasses are more susceptible to ergot infection.
- The ergot bodies have hard protective rind outside which is black in color.
- Symptoms are more evident during kernel formation.
- Ergot bodies are the over wintering structures in disease cycle.

Ergot

Claviceps purpurea

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Ergot

Claviceps purpurea

SYMPTOMS

- Hard mass of fungal mycelium develops in the grain in place of kernel.
- Looks like grain but are elongated and black in color.
- Often protrudes from the glumes of mature heads and are easily distinguishable.

Figure 1- Ergot grain protruding from the glumes of mature heads

Figure 2- elongated ergot grain among healthy grains

Figure 3- close view of ergot Kernza

Factors Favoring Development

- Cold winter followed by prolonged wet soils in the spring.
- Cool, moist weather prior to and during flowering.
- Poor fertility or copper deficiency delaying the flowering and maturity

Important Facts

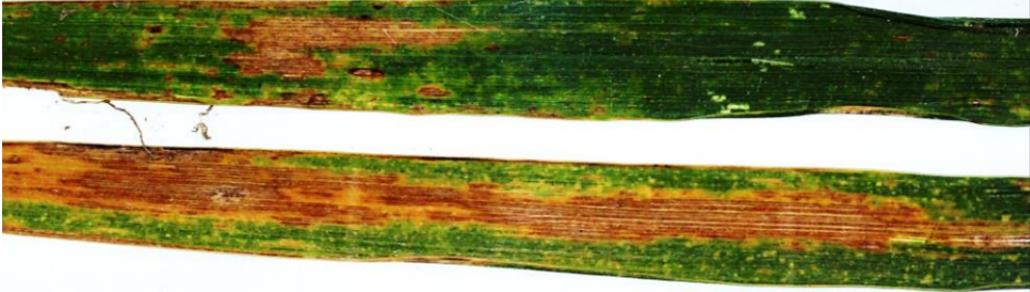
- Open pollinated grasses are more susceptible to ergot infection.
- The ergot bodies have hard protective rind outside which is black in color.
- Symptoms are more evident during kernel formation.
- Ergot bodies are the over wintering structures in disease cycle.

Bacterial Leaf Streak

Xanthomonas translucens pv *undulosa*

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Bacterial Leaf Streak

Xanthomonas translucens pv *undulosa*

SYMPTOMS

- Elongated light brown lesions that gradually turn necrotic.
- Lesions follow the veins on the leaf surface.
- Produce translucent to milky exudates on the leaves under humid conditions.
- When infection progresses, longitudinal black stripes appear on the glumes which is known as black chaff.

Figure 1- lesions coalesce together causing severe damage on the leaf surface

Figure 2- elongated lesions turning necrotic

Figure 3- black chaff on the glume

Factors Favoring Development

- Warm and humid environmental conditions.
- Disease will be severe in fields with sprinkler irrigation.

Important Facts

- Pathogen can enter plant tissues through natural openings and wounds.
- Infected seed lots are the important source of inoculum.
- Symptoms can be confused with Septoria leaf blotch.

Bacterial Leaf Streak

Xanthomonas translucens pv *undulosa*

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Bacterial Leaf Streak

Xanthomonas translucens pv *undulosa*

SYMPTOMS

- Elongated light brown lesions that gradually turn necrotic.
- Lesions follow the veins on the leaf surface.
- Produce translucent to milky exudates on the leaves under humid conditions.
- When infection progresses, longitudinal black stripes appear on the glumes which is known as black chaff.

Figure 1- lesions coalesce together causing severe damage on the leaf surface

Figure 2-elongated lesions turning necrotic

Figure 3- black chaff on the glume

Factors Favoring Development

- Warm and humid environmental conditions.
- Disease will be severe in fields with sprinkler irrigation.

Important Facts

- Pathogen can enter plant tissues through natural openings and wounds.
- Infected seed lots are the important source of inoculum.
- Symptoms can be confused with Septoria leaf blotch.

Anthracnose

Colletotrichum cereale

PC: The Land Institute

Figure 1



Anthraconose

Colletotrichum cereale

SYMPTOMS

- Elongated, chlorotic leaf spots with small, black, spore-bearing structures in the center.
- Water-soaked lesions which later become bleached and necrotic.
- Leaves die from their tips down.

Figure 1- chlorotic leaf patch on the crop stand

Factors Favoring Development

- High humidity and shade.
- Excess water on the leaf canopy for a longer period of time.
- Poor soil drainage.

Important Facts

- Fungus survives on the soil surface and in soil as mycelium and conidia on host residues.
- Fungal conidia can be spread by wind, water or human activities.
- Symptoms often appear as a patch.

Anthracnose

Colletotrichum cereale

PC: The Land Institute

Figure 1



Anthracnose

Colletotrichum cereale

SYMPTOMS

- Elongated, chlorotic leaf spots with small, black, spore-bearing structures in the center.
- Water-soaked lesions which later become bleached and necrotic.
- Leaves die from their tips down.

Figure 1- chlorotic leaf patch on the crop stand

Factors Favoring Development

- High humidity and shade.
- Excess water on the leaf canopy for a longer period of time.
- Poor soil drainage.

Important Facts

- Fungus survives on the soil surface and in soil as mycelium and conidia on host residues.
- Fungal conidia can be spread by wind, water or human activities.
- Symptoms often appear as a patch.

Net Blotch

Pyrenophora teres f. teres

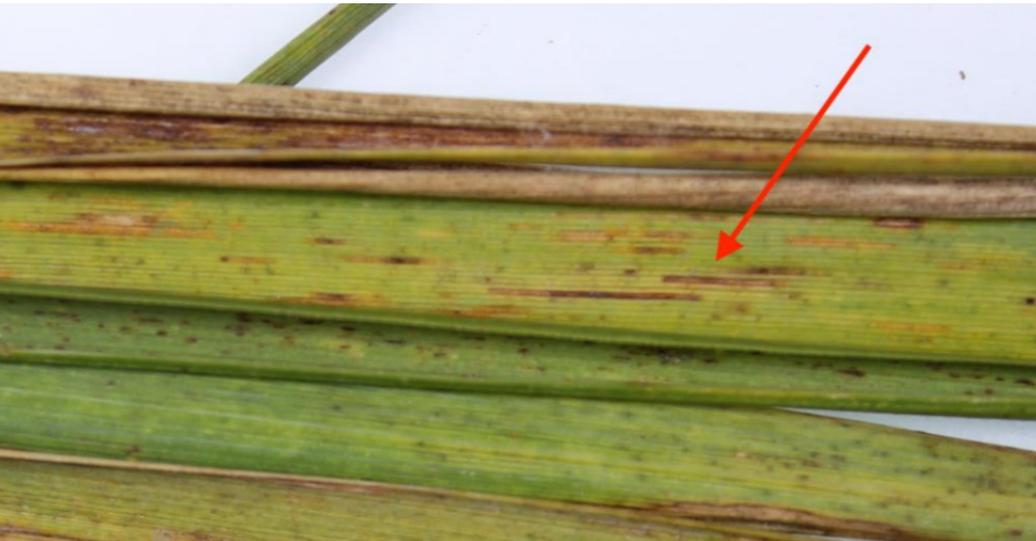
PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Net Blotch

Pyrenophora teres f. teres

Symptoms

- Tiny dark brown spots on the leaves
- Lesions are large and cigar shaped
- As the lesion expand, they become oval or square and coalesce to form a net-like pattern on the leaf.

Figure 1- lesions coalesce to become cigar shaped and net like pattern

Figure 2- coalescing lesion on the chlorotic leaf

Factors Favoring Development

- 6 hours of wetness at a temperatures between 50°F and 77 °F.
- High humidity and mild temperatures in spring and summer
- Thick crop

Important Facts

- Fungus survives saprophytically between cropping season and is present as mycelium on host crop residues
- Pathogen get dispersed by wind and water.
- Primary inoculum comes from the infested stubble in which pathogen can survive up to 3 years.

Net Blotch

Pyrenophora teres f. teres

PC: The Land Institute

Figure 1



Net Blotch

Pyrenophora teres f. teres

Symptoms

- Tiny dark brown spots on the leaves
- Lesions are large and cigar shaped
- As the lesion expand, they become oval or square and coalesce to form a net-like pattern on the leaf.

Figure 1- lesions coalesce to become cigar shaped and net like pattern

Figure 2- coalescing lesion on the chlorotic leaf

Factors Favoring Development

- 6 hours of wetness at a temperatures between 50°F and 77 °F.
- High humidity and mild temperatures in spring and summer
- Thick crop

Important Facts

- Fungus survives saprophytically between cropping season and is present as mycelium on host crop residues
- Pathogen get dispersed by wind and water.
- Primary inoculum comes from the infested stubble in which pathogen can survive up to 3 years.

PC: The Land Institute

Figure 2



Ramularia leaf spot

Ramularia collo-sygni

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Ramularia leaf spot

Ramularia collo-sygni

Symptoms

- Small brown, round spots are seen on the upper leaves at the flowering stage.
- Spots enlarge and develop into rectangular, reddish-brown necrotic spots.
- Spots are surrounded by the chlorotic halo and are restricted by the leaf veins.

Figure 1-distinct brown round spot with chlorotic halo

Figure 2- rectangular mature lesion, with chlorotic halo visible and brownish center

Factors Favoring Development

- Moist weather and leaf surface wetness for a longer period of time.
- Spring rainfall
- Infested materials

Important Facts

- Loss of green area in infected leaves which leads to yield loss
- Symptoms appear late in the growing season after ear emergence.
- Leaf becomes chlorotic starting from the tip and leaf margins.

Ramularia leaf spot

Ramularia collo-sygni

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Ramularia leaf spot

Ramularia collo-sygni

Symptoms

- Small brown, round spots are seen on the upper leaves at the flowering stage.
- Spots enlarge and develop into rectangular, reddish-brown necrotic spots.
- Spots are surrounded by the chlorotic halo and are restricted by the leaf veins.

Figure 1-distinct brown round spot with chlorotic halo

Figure 2- rectangular mature lesion, with chlorotic halo visible and brownish center

Factors Favoring Development

- Moist weather and leaf surface wetness for a longer period of time.
- Spring rainfall
- Infested materials

Important Facts

- Loss of green area in infected leaves which leads to yield loss
- Symptoms appear late in the growing season after ear emergence.
- Leaf becomes chlorotic starting from the tip and leaf margins.

Septoria Leaf blotch

Zymoseptoria tritici

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Septoria Leaf blotch

Zymoseptoria tritici

Symptoms

- Foliar lesions (broadly elliptical) with yellowish halo and contains small dark-brown to black specks (pycnidia).
- Lesions are mostly elongated with rougher edges
- A curved cirrhus extrudes from the ostiole of the pycnidium, when relative humidity is high and leaf surface is not actually wet.

Figure 1- lesions with pycnidia in them

Figure 2- presence of chlorotic halo on the lesions

Factors Favoring Development

- Cool, moist weather for at least 48 hours.
- Temperature between 50°F to 68°F.
- High relative humidity and moist leaves.

Important Facts

- Symptoms is more prominent in the early growing season during stem elongation to flag leaf emergence.
- More common on lower leaves.
- Fungus overwinters as mycelium or pycnidia on infected plants, seeds or plant debris.

Septoria Leaf blotch

Zymoseptoria tritici

PC: The Land Institute

Figure 1



Septoria Leaf blotch

Zymoseptoria tritici

Symptoms

- Foliar lesions (broadly elliptical) with yellowish halo and contains small dark-brown to black specks (pycnidia).
- Lesions are mostly elongated with rougher edges
- A curved cirrhous extrudes from the ostiole of the pycnidium, when relative humidity is high and leaf surface is not actually wet.

Figure 1- lesions with pycnidia in them

Figure 2- presence of chlorotic halo on the lesions

PC: The Land Institute

Figure 2



Factors Favoring Development

- Cool, moist weather for at least 48 hours.
- Temperature between 50°F to 68°F.
- High relative humidity and moist leaves.

Important Facts

- Symptoms is more prominent in the early growing season during stem elongation to flag leaf emergence.
- More common on lower leaves.
- Fungus overwinters as mycelium or pycnidia on infected plants, seeds or plant debris.

Stagonospora leaf and nodorum blotch

Parastagonospora nodorum

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Stagonospora leaf and nodorum blotch

Parastagonospora nodurum

Symptoms

- Presence of dark-brown flecks or spots with prominent yellow halo.
- As lesions enlarge, they become dark brown and centers turn grayish-white in color causing leaf blotch.
- Light brown pycnidia may develop but are not easy to see with the naked eye like in Septoria blotch.
- Purple brown or grayish streaks will be often seen on the heads which is known as glume blotch.

Figure 1- dark brown lesion with grayish-white center

Figure 2- infection on glumes

Figure 2- grayish- white center in focus

Factors Favoring Development

- High humidity and extended period of leaf wetness.
- Warm temperature between 68°F to 81°F .

Important Facts

- Symptoms are predominantly seen on the upper leaves.
- Fungus infects seed and is seed-borne.

Stagonospora leaf and nodorum blotch

Parastagonospora nodurum

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



PC: The Land Institute

Figure 3



Stagonospora leaf and nodorum blotch

Parastagonospora nodurum

Symptoms

- Presence of dark-brown flecks or spots with prominent yellow halo.
- As lesions enlarge, they become dark brown and centers turn grayish-white in color causing leaf blotch.
- Light brown pycnidia may develop but are not easy to see with the naked eye like in Septoria blotch.
- Purple brown or grayish streaks will be often seen on the heads which is known as glume blotch.

Figure 1- dark brown lesion with grayish-white center

Figure 2- infection on glumes

Figure 2- grayish- white center in focus

Factors Favoring Development

- High humidity and extended period of leaf wetness.
- Warm temperature between 68°F to 81°F .

Important Facts

- Symptoms are predominantly seen on the upper leaves.
- Fungus infects seed and is seed-borne.

Tan spot

Pyrenophora tritici-repentis

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Tan spot

Pyrenophora tritici-repentis

Symptoms

- Lesions appear as tan to brown flecks which later expand to form irregular oval or lens shaped lesions with a yellow or chlorotic halo and a dark fleck in the center.
- Oval to diamond shaped spots on the leaf.
- Absence of dark fruiting bodies.
- Black pseudothecia will be visible in the stubble that feels like coarse sandpaper to the touch.

Figure 1- oval or diamond shaped lesions with chlorotic halo

Figure 2- dark fleck visible in the center of the lesion

Factors Favoring Development

- Rainy, misty and foggy weather lasting for 24 hours.
- Free moisture on the leaf surface.

Important Facts

- Lesions are observed in more mature leaves during tillering and jointing.
- When spots are abundant, leaves may yellow giving the field a yellow overcast.
- Fungus survives in crop residue and native prairie grasses.

Tan spot

Pyrenophora tritici-repentis

Tan spot

Pyrenophora tritici-repentis

Symptoms

- Lesions appear as tan to brown flecks which later expand to form irregular oval or lens shaped lesions with a yellow or chlorotic halo and a dark fleck in the center.
- Oval to diamond shaped spots on the leaf.
- Absence of dark fruiting bodies.
- Black pseudothecia will be visible in the stubble that feels like coarse sandpaper to the touch.

Figure 1- oval or diamond shaped lesions with chlorotic halo

Figure 2- dark fleck visible in the center of the lesion

Factors Favoring Development

- Rainy, misty and foggy weather lasting for 24 hours.
- Free moisture on the leaf surface.

Important Facts

- Lesions are observed in more mature leaves during tillering and jointing.
- When spots are abundant, leaves may yellow giving the field a yellow overcast.
- Fungus survives in crop residue and native prairie grasses.

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Spot Blotch

Bipolaris sorokiniana

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Spot Blotch

Bipolaris sorokiniana

Symptoms

- Small spots at the infection point and grows to oblong light brown lesions with brown margins
- Leaf spots will continue to elongate and coalesce covering the entire leaf during severe infection.

Figure 1- distinct black specks visible on the leaf

Figure 2- dirty blotch spread all over the leaf

Factors Favoring Development

- Warm temperature of 16-24°C and high relative humidity.
- High residual soil moisture.
- Pathogens transmits through infected seeds, stubble and soil, and secondary infection takes place through air.

Important Facts

- It can infect leaves, stem, roots, rachis and seeds.
- It produces toxin helminthosporol and sorokinianin.
- No chlorotic margin like tan spot.

Spot Blotch

Bipolaris sorokiniana

PC: The Land Institute

Figure 1



PC: The Land Institute

Figure 2



Spot Blotch

Bipolaris sorokiniana

Symptoms

- Small spots at the infection point and grows to oblong light brown lesions with brown margins
- Leaf spots will continue to elongate and coalesce covering the entire leaf during severe infection.

Figure 1- distinct black specks visible on the leaf

Figure 2- dirty blotch spread all over the leaf

Factors Favoring Development

- Warm temperature of 16-24°C and high relative humidity.
- High residual soil moisture.
- Pathogens transmit through infected seeds, stubble and soil, and secondary infection takes place through air.

Important Facts

- It can infect leaves, stem, roots, rachis and seeds.
- It produces toxin helminthosporol and sorokinianin.
- No chlorotic margin like tan spot.

Brome Mosaic Virus



Brome Mosaic Virus

Symptoms

- Light yellow to white longitudinal streaks on the upper surface of leaves.
- Leaves are broader and different than the normal leaves
- Stunted growth, chlorotic and necrotic patches.

Figure 1: Individual leaves infected with BMV

Figure 2: Virus symptoms on the crop stand

Factors Favoring Development

- Mechanical transmission in the field.
- Transmission may occur by flea beetle, cereal leaf beetle, bird cherry-oat aphid, Russian wheat aphid.

Important Facts

- BMV can infect a wide range of hosts.
- It is not known to cause disease in humans or animals.
- It can be controlled through sanitation, avoiding using infected material for propagation and use of resistant cultivars.

Brome Mosaic Virus



Brome Mosaic Virus

Symptoms

- Light yellow to white longitudinal streaks on the upper surface of leaves.
- Leaves are more broad and different than the normal leaves
- Stunted growth, chlorotic and necrotic patches.

Figure 1: Individual leaves infected with BMV

Figure 2: Virus symptoms on the crop stand

Factors Favoring Development

- Mechanical transmission in the field.
- Transmission may occur by flea beetle, cereal leaf beetle, bird cherry-oat aphid, Russian wheat aphid.

Important Facts

- BMV can infect a wide range of hosts.
- It is not known to cause disease in humans or animals.
- It can be controlled through sanitation, avoiding using infected material for propagation and use of resistant cultivars.