THE UNIVERSITY OF VERMONT EXTENSION

Seed Disease and Organic Management

For Cereals Grown in the Northeast

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There are many challenges to growing cereal crops in the Northeast, not the least of which is the management of seed-borne pathogens. These pathogens can decrease yield, lower quality and can have devastating effects on grain crops. Some, like *Fusarium* head blight (FHB) and ergot, can be toxic to humans or livestock if consumed even in low doses. Others, such as loose smut, can spread rapidly and render an entire crop useless.

This pamphlet serves to assist farmers and service providers identify and understand common diseases which can be present externally or internally in small grain seed or crop residue. The first step in solving disease problems in your fields begins with proper disease identification.

Though fungicides exist that are generally effective for conventional systems, organic controls are still being developed and evaluated. The primary organic methods to minimize seed borne pathogens include planting clean disease-free certified seed, choosing resistant varieties, and implementing diverse crop rotations. Research is being conducted to identify additional control methods for organic farms, including treating seed with hot water or steam to reduce the incidence of pathogens on seed surfaces and under the seed coat. Successful management of these diseases rely on the use of several integrated pest management (IPM) strategies.

The UVM Plant Diagnostic Clinic can assist in disease identification and make management recommendations. For more information visit www.uvm.extension/pdc, email ann.hazelrigg@uvm.edu or call (802) 656-0493

The UVM Cereal Quality Testing Lab Testing tests harvested grains for deoxynivalenol (DON), a vomitoxin produced by FHB. For more information visit: www.uvm.edu/extension/nwcrops/cereal-grain-testing-lab, email uvmgrain@uvm.edu or call (802) 656-5392.

Fusarium Head Blight aka Scab

Fusarium graminearum

FHB is currently one of the most problematic diseases facing grain growers in the Northeast. FHB results in yield loss and quality reductions due to shriveled grain with low test weight. Under certain conditions, the Fusarium pathogen can produce a mycotoxin called deoxynivalenol (DON). Eating grain contaminated at levels greater than 1 ppm poses a risk to human health and is restricted from use in food products. Higher rates cause adverse effects for livestock including vomiting and feed refusal.

Time and Source of Infection:

Fusarium spores persist on plant refuse, soil and seed surfaces and can be carried on air currents from a significant distance or by splashing rain. Rainy weather, high humidity and warm temperatures during flowering can result high rates of Fusarium infection. Wheat is particularly susceptible to infection at flowering, while barley is most susceptible at heading. Spores enter the flower and infect the kernel. Seedlings grown from infected kernels can be stunted or may die completely, decreasing yields.

Symptoms:

Spikes of infected plants are bleached while the rest of the plant remains green. Infected seeds appear shriveled and tinted gray or pink. Because DON levels are tested for in parts per million, it does not take many infected seeds to exceed the threshold. With careful sorting, infected seeds can sometimes be cleaned out of the harvested grain and DON levels reduced.

Management:

A mix of practices are needed to reduce infection potential. Plant resistant varieties, rotate crops, and don't plant cereal crops following a host crop (corn and small grains). Tilling and burying residues can reduce spore populations, and chopping crop residues can allow infections to decompose more quickly. Staggering planting dates and crop varieties can minimize risk of widespread infection.

Bleached grain heads infected with Fusarium
Image source: UVM Extension

FDA advisory levels for DON contamination:

- 1 ppm for human consumption
- 10 ppm cattle over 4 months old and poultry (grain up to 50% of diet)
- 5 ppm pigs (grain up to 20% of diet)
- 5 ppm all other animals (grain up to 40% of diet)

Chalky pink seeds infected with Fusarium/DON
Image source: UVM Extension

Loose Smut

Ustilago tritici (wheat); *Ustilago nuda* (barley); *Ustilago avenae* (oats)

Loose smut is a highly destructive fungal disease and can devastate crop yields if widespread. The Northeast is highly susceptible to this disease. Smut is easy to identify. It turns grain heads into large masses of black spores which rupture and disperse easily.

Time and Source of Infection:

Smut persists inside of the seed and infects the plant primarily at flowering (oats are infected at seedling stage). During spike or head emergence, diseased heads emerge slightly earlier than healthy ones and appear as a mass of dark brown spores covered with a paper-like membrane. This membrane tears easily as healthy plants begin to flower. Windblown spores infect the embryos of developing seeds in neighboring plants. After the fungus invades the grain embryo, it remains dormant until the seed is planted and germinates the following year. Upon germination, mycelium (threads of the fungus) grow upwards in the plant at the meristem and infect the grain head, repeating the cycle. Infection typically occurs when temperatures are cool and damp.

Symptoms:

Spore masses replace the grain head, producing little to no grain yield. Infected plants appear to be normal but develop smutted heads. Heavily infected seeds appear black under the seed coat; however, infected seeds can be present with little to no visible signs.

Management:

Plant certified or other high-quality, disease-free seed and rogue fields at head emergence and flowering to minimize yield losses and further contamination. Research is underway to test for steam or hot-water treatments to control the disease for organic systems.

Planting contaminated seed, especially in organic systems, can exponentially increase grain infection rates, resulting in yield reductions; 100% of the smutted heads are lost. Eating loose smut infected grain poses no harmful health effects and doesn't appear to impact baking quality.

Loose smut infected grain head
Image source: UVM Out Croppings

Loose Smut development on grain head
Image source: UVM Extension

Ergot

Claviceps purpurea

Rye is the principal small grain host for ergot, though ergot can occur in other cereals. Ergot is easily identifiable by small amber masses that develop into large black masses, called sclerotia, protruding from the grain head. Ergot can be toxic to humans and livestock, causing vomiting, hallucinations, gangrene, muscle spasms, restricted blood flow, loss of extremities and in some cases can be fatal. Rye crops should always be tested before human consumption; ergot can infect wheat and barley as well as rye.

Sclerotia masses on rye head
Image source: Northern Grain Growers Association

Time and Source of Infection:
Sclerotia overwinter on the soil surface and produce fruiting bodies in the spring. These fruiting bodies release masses of spores which are carried by wind and can infect spikelets during flowering. Infected heads can contaminate stored seed. Sclerotia can fall from the plant during harvest, remain on the soil surface through winter, and disperse spores the following year.

Symptoms:
Dark purple or black masses appear in harvested grain, often much larger than the grains themselves.

Sclerotia in stored grain
Image source: Morning Ag Clips

Management:
Plant high-quality, disease-free seed. Seed cleaning can remove some but not all contaminated seed. Rotate crops and do not replant a field with a host crop (small grain) for at least one year. Tillage can bury sclerotia resting on the soil surface, minimizing the risk of spore dispersal the following year.

Usually, ergot infestations affect the borders of rye fields first, so it is important to take note of ergot and harvest infested sections of the field separately, especially if you are saving rye seed for next year's crop.

Common Bunt aka Stinking Smut aka Covered Smut

Tilletia laevis; Tilletia caries

Common bunt is a disease that replaces grain seed with smut balls full of fungal spores. These kernels are black and rupture easily, further contaminating seed, equipment and soils. Common bunt/stinking smut is not toxic to humans or livestock but produces a fishy odor which is rejected by consumers and animals alike. Buyers will reject grain lots with too much smut.

Time and Source of Infection:

Spores persist on seed, soil and equipment surfaces and infect plant seedlings shortly after germination. Infection begins in the meristem and spreads into the grain head and embryos after head emergence. Infected grains fill with spores which contaminate other seeds during harvest. Spores can also remain dormant on the soil surface overwinter and infect seedlings the following spring.

Symptoms:

The infection spreads to embryos and fills grains with black spores. It is difficult to identify in the field but can usually be spotted after harvest. Grains appear grayish at harvest, and cracked grain releases black, fishy-smelling spores.

Management:

Planting clean, disease-free seed, rotating crops for at least one year, and thoroughly cleaning equipment are the best organic control methods. Planting contaminated saved seed will increase disease incidence the following year. Spores germinate best in cooler soil temperatures. Planting wheat when soils are warmer than 65 degrees will reduce the risk of infection.

Healthy grain (left) and smut balls (right)
Image source: UVM Extension

Smut balls
Image source: UVM Extension

Stagonospora Leaf/Glume Blotch

Parastagonospora nodorum

The Stagonospora leaf/glume blotch pathogen causes lesions on leaf surfaces, travelling upwards through the canopy to the grain head. Infected heads have discolorations on spikelets and produce shriveled seeds. This fungal disease does not have human or animal health consequences but can decrease grain yield and quality.

Time and Source of Infection:

Disease spores persist on stored grain and soil surfaces. During rainfall events, especially in warm temperatures, spores splash and land on leaf surfaces. As rain continues, spores are carried onto additional leaves in the canopy. Infection during flowering and grain fill causes seeds to shrivel, producing a low test weight. Spores can remain viable on stubble through the winter and begin to infect the following years crop during emergence.

Symptoms:

Lesions appear on leaf surfaces. The lesions are coffee-brown colored with a yellow/golden halo. Small black fruiting bodies (pycnidia) often appear within the lesions, though they are difficult to see with the naked eye. Once the infection reaches the grain head, spikelets appear grayish and sometimes pink with black spots or tips. Symptoms can sometimes be confused with fusarium infection. While heads infected with fusarium appear bleached, stagonospora infections are more chocolate brown and may show black or brown pycnidia.

Management:

Planting resistant varieties minimizes the risk of disease incidence and prevalence. Use clean, disease-free and certified seed, and clean equipment to minimize contamination. Spores can persist on host crop residues in the field. Rotating crops and not replanting the field with a host crop reduces the risk of infection from the soil.

Lesions on leaf surface, black pycnidia visible within
Image source: Purdue Extension

Infected grain heads appear chocolate brown
Image source: Purdue Extension

Common Root Rot, Spot Blotch, Black Point

Bipolaris sorokiana

Bipolaris sorokiana is a fungal pathogen which remains active in the soil and crop residues as mycelium and spores. Multiple diseases may occur as a result of infection. Common root rot on the crowns below the soil surface can reduce tillering, stunt growth, decrease grain yield or kill the plant entirely. Spot blotch on leaf surfaces can stunt growth and limit photosynthesis thus lowering grain yields. Black point occurs as the fungus infects grain heads which lowers grain quality and may cause illness in humans and livestock if consumed in large quantities. Various *Fusarium* species can also cause root rot with similar symptoms.

Time and Source of Infection:

Plants are susceptible to common root rot infection in the fall (for winter grains) if planted in warm, dry soils (over 60-65 degrees) where mycelium or spores remain on crop residues or seed surfaces.

Spot blotch occurs if infections are above the soil and wind carries spores upwards onto leaf surfaces. Spot blotch and root rot occur in drought conditions with moderate to warm temperatures.

Black point occurs during grain fill and drying if rainy or excessively humid weather persists, allowing the fungus to penetrate grain heads and kernels.

Symptoms:

Common root rot shows brown and black lesions at the base of the stem near the soil surface and in the crown roots just below the soil. The crown often exhibits large areas of dead tissue. Reduced tillering and dead plants are signs of infection. Diseased plants are easily pulled from the soil due to damaged roots. Spot blotch shows black lesions on leaf surfaces.

Management:

Plant clean, disease free seed in fields that were not planted with a host crop the previous year as spores and mycelium may remain present on soils and residues. Some varieties show resistance. Plant varieties that are adapted to the geographic area. Avoid planting when soils are above 60 degrees and moisture depleted.

Black Point visible in seed

Crown rot visible in plant stems and roots, Spot Blotch shows black and brown elongated lesions on leaf surfaces

Images source: UVM Extension

Tan Spot

Pyrenophora tritici-repentis

Tan Spot is a disease that affects leaf surfaces of most grain crops and has the potential to significantly reduce yield. The fungus can remain active on host crop residues in the field and infection from windblown spores can be high during rainy or misty weather and cool temperatures.

Time and Source of Infection:

Infection can occur from tillering through dough stage, but is more frequent during the spring prior to jointing. Spores on crop residues are activated by spring rain events and carried onto neighboring leaf surfaces. Because of these environmental factors, infection usually occurs early in the growing season unless cool, wet weather persists. The fungus can infect grains, as well. Seeds appear pinkish but not very shriveled (unlike *Fusarium* infected kernels which appear pink/gray and shriveled). Infected grain leads to quality loss and potential market rejection. Mycelium in the grain can infect the following year's crop if used for seed.

Symptoms:

Tan spot is easily identifiable by its brown oval shape with a yellow halo and black or dark brown spot in the center, though it can easily be confused with Stagonospora Leaf Blotch. The source of infection are host residues with fruiting bodies of the pathogen. These small black fruiting bodies can be rough to the touch, like sandpaper and will produce spores capable of infection.

Management:

Crop rotation is an effective control of tan spot infection. Spores do not typically travel far, so reducing the presence of host plants and allowing time for fungal populations at the soil level to decrease will lower the risk of widespread infection. Resistant varieties are available and should be chosen as appropriate for the geographical area.

Lesions produced by Tan Spot infection
Image source: University of Nebraska – Lincoln Extension

Fruiting bodies on wheat residues
Image source: University of Nebraska – Lincoln Extension

Organic Management Practices

Since most diseases cannot be eliminated with a single practice, the goal is to minimize the disease through the use of several IPM strategies.

Identification

Proper identification is the first and most important step to manage disease outbreaks in crops. Utilizing the Plant Diagnostic Clinic, disease guides or research materials, or contacting Extension to properly identify the disease will then allow for the development of a management strategy. In most cases, preventative measures will help reduce the initial introduction or severity of disease in a field, such as using clean seed and equipment, resistant varieties and crop rotation.

Clean Seed

Use high-quality, certified seed wherever possible. Certified seed has been inspected for disease contamination and is guaranteed free of disease and weed-seed. If saving seed or purchasing non-certified seed, inspect samples to ensure grains appear healthy. They should not appear shriveled or shrunken, should have a high test weight, and should not show signs of discoloration such as pink, gray or black.

Resistant Varieties

Some grain varieties are resistant to certain diseases. Contact Extension for information on current research results and recommendations for particular diseases. A resistant variety is less likely to become infected or severity of infection is likely to be low if a disease is present. Resistance does not mean the crop is immune from infection, or that it will not become infected if a disease is present. Research is ongoing to identify varieties that show signs of resistance to diseases in the Northeast.

Clean Equipment

When harvesting a diseased crop, it is important to thoroughly clean all equipment that the pathogen comes in contact with to minimize the risk of contaminating other fields, crops or seed stocks. Pay attention to fields during harvest. If particular sections of a field have higher severity rates, consider harvesting those areas separately and cleaning machinery after handling. Keep diseased grain separate from clean grain and seed stocks.

Crop Rotation

Rotating crops each year can be an effective means of decreasing disease presence in each field. Fungal spores or mycelium can survive on crop residues or the soil surface through the winter and attack the following year's crop if the crop is a host. Most pathogens have one specific host crop but some can infect more than one, making correct identification of the pathogen and disease very important for choosing the right crop for suitable rotations. If a host crop is planted in the same field year after year, the pathogen population can increase resulting in increased likelihood of widespread disease. If a particular disease is identified in a field, plant a non-host crop in that field the following season to minimize risk. Sometimes it can take several seasons for the threat to decrease, depending on the type and severity of disease. Contact Extension for information on potential rotation crops.

Crop Residues

Crop residues and soil surfaces can harbor disease spores or mycelium throughout the winter and, sometimes, for multiple years. If disease is present in a field, chop and bury residues to increase the rate of decomposition and minimize the risk of spores being picked up by wind and carried to neighboring fields. Inspect residues for disease presence and avoid planting a host crop into infected residues.

Heat Treatment

Experiments have been conducted and research is ongoing to test the efficacy of hot water or steam treatments to control disease contamination on seeds. If done properly, treatments have been shown to reduce disease presence on seeds and reduce impact in the field. Challenges include: identifying the proper temperature and timing that will destroy disease spores but not damage the seed itself; having access to seed treatment equipment; treating the seed; and drying treated seed to proper storage moisture. Contact Extension for more information.

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Funding

This work was funded by the National Institute of Food and Agriculture (NIFA), USDA award number 2016-70006-25830