# Fusarium Head Blight (Scab) of Small Grains

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**Figure 1. Wheat heads showing bleached spikelets as a result of Fusarium infection.**
(Andrew Friskop, NDSU)

Fusarium head blight (FHB), or scab, is a fungal disease that can occur on all small grain crops grown in North Dakota, including spring wheat, winter wheat, durum and barley.

Significant yield loss occurs from floret sterility and the production of shriveled, light test-weight kernels. Quality reductions result from the production of fungal toxins (mycotoxins) that are unacceptable for certain end uses, and dockage can occur at the point of sale.

## Symptoms and Signs

Symptoms in wheat and durum include bleaching of the head (spike). Bleaching may occur on a portion of or the entire head (Figures 1 and 2). The fungus also may infect the stem immediately below the head (peduncle), causing a brown to purplish discoloration of the stem tissue. Signs of Fusarium infections are pink to salmon-orange spore masses often seen on infected spikelets and glumes during prolonged periods of wet weather (Figure 3).

Infected wheat and durum kernels sometimes are called “tombstones” because of their shriveled, chalky, lifeless appearance that may also look pink (Figure 4). If infection occurs late in kernel development,

**Figure 2. Susceptible durum variety with numerous grain heads with FHB.** (Andrew Friskop, NDSU)

**Figure 3. Salmon-orange spores of *Fusarium graminearum* visible on glumes of wheat.**
(Andrew Friskop, NDSU)

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**Figure 4. Healthy durum kernels (top) and Fusarium-infected durum kernels (bottom). Note chalky white to pink discoloration of infected kernels.** (Andrew Friskop, NDSU)


**Figure 5. (A) FHB symptoms on six-row barley. (B) FHB symptoms on two-row barley.** (Andrew Friskop, NDSU)

Fusarium-infected kernels may be normal in size yet still harbor mycotoxins. Infected kernels of durum often lose their amber translucence and appear chalky or opaque.

Symptoms in barley include brown, water-soaked to bleached spikelets (Figures 5A, 5B). Severely infected barley kernels at harvest may show a pinkish discoloration. Salmon-orange spore masses of the fungus can be seen on the infected spikelet and glumes in barley during prolonged periods of wet weather.

## Causal Pathogens

Fusarium head blight is primarily caused by *Fusarium graminearum* (sexual stage – *Gibberella zeae*). This fungus is the same one that frequently is associated with stalk rot and ear rot of corn. Other *Fusarium* species can also be associated with FHB.

## Survival and Spread

Wheat and durum crops are susceptible to infection from heading to the hard dough stage but are most susceptible at flowering (when anthers are present). Spores of the fungus land on the exposed anthers at flowering time and then grow into kernels, glumes or other parts of the head.

For spring barley (flowers when the head is in the boot stage), infection occurs once the head breaks through the flag leaf sheath.

Infection in either crop may continue until close to grain maturity under favorable environmental conditions for the organism(s).

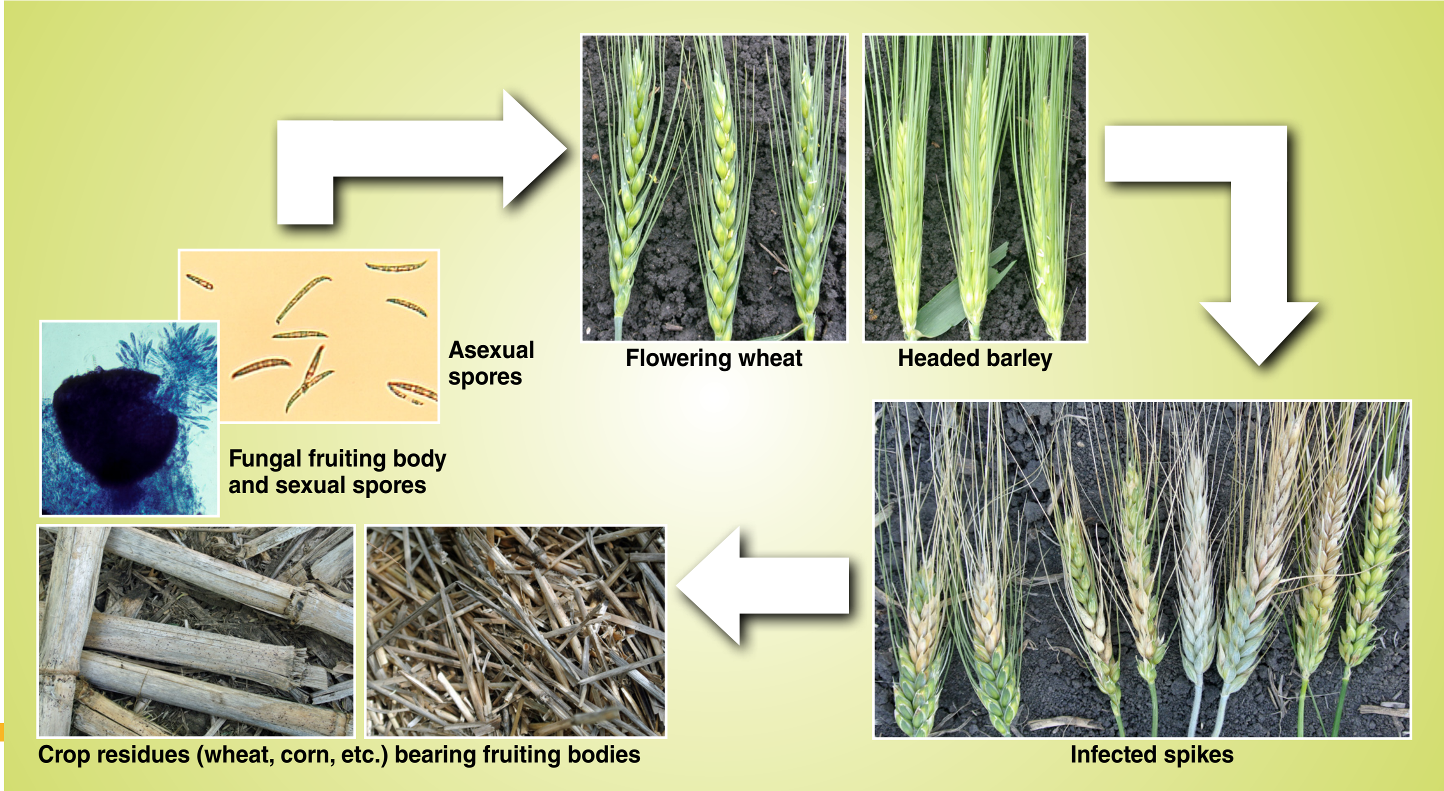


**Figure 6. Fusarium head blight disease cycle.** (Andrew Friskop and Shaobin Zhong, NDSU)

The most favorable conditions for infection are prolonged periods (48 to 72 hours) of high humidity and warm temperatures (75 to 85 F). Infection can occur at cooler temperatures when high humidity persists for longer than 72 hours. Pre-existing infections on the main stem may produce additional spores, which are responsible for the secondary spread of the pathogen on tillers, especially if the crop has uneven flowering.

Because FHB development depends on favorable environmental conditions, disease occurrence and severity vary from year to year. A combination of factors that may lead to significant yield and quality losses are: abundant inoculum, prolonged or repeated wetness and high humidity prior to and during flowering (head emergence in barley), and the seeding of susceptible cultivars.

# Management

***FHB is best managed by integrating multiple management tools. The use of a single tool often fails when the environment favors severe disease development. Management strategies to reduce FHB should include a combination of as many of the following practices as possible:***

## Resistance

No available small grain cultivars are immune to *Fusarium* infection, but differences in reaction to FHB do occur. Resistance can occur by reducing the number of initial infections (Type I resistance) and/or restricting the spread of the fungus in infected tissue (Type II resistance).

Several varieties of hard red spring wheat have improved FHB resistance. However, the level of FHB resistance is much lower in durum. Barley has natural Type II resistance (reduces the spread of the fungus in infected tissue), and some varieties accumulate lower levels of DON.

Producers in areas of high risk for FHB should select cultivars that have above average resistance to FHB (rating of 5 or less). The latest information on cultivar response to FHB is available in current NDSU variety trial results and selection guides) and available at NDSU Extension county offices.

## Seed Treatment

A fungicide seed treatment will not protect against Fusarium head blight. If a scabby seed source is used, make sure to clean the seed source thoroughly, consider using a fungicide seed treatment, conduct a germination test and adjust plant populations accordingly.

## Residue Management

Tillage practices that bury residue from small grains or corn reduce the inoculum potential of the fungus. In minimum- or no-till practices, effective spreading and distribution of chaff and other residue may allow faster decomposition of the chaff, reducing inoculum potential. Chopping and grinding corn residue to reduce the size of the remaining stalk pieces also may favor decomposition of infected tissue.

## Crop Rotation

Crop rotation is effective in reducing FHB risk within a field. Rotating to a nonhost crop or planting small grains in a field that previously was planted to a broadleaf crop is recommended. The greatest risk of FHB is when small grains are planted on last year's corn residue or small-grain residue.

## Planting Date

Staggered planting of the small-grain crop or planting cultivars differing in days to maturity is advised. This reduces the risk of a producer's entire crop flowering or heading during a period favorable for FHB development.

## Fungicide

Fungicides containing the active ingredients of prothioconazole, metconazole and pydiflumetofen provide a good level of efficacy (50%-60%) against FHB. Tebuconazole is considered a fair fungicide with FHB suppression around 20%. The best time to apply a fungicide in wheat and durum is at early flowering and up to seven days later (Figure 7). In barley, the best time is at full head and up to seven days later (Figure 8).

When making late applications, be sure to consider the harvest restriction interval for the fungicide that is used.

Application studies have shown that spray coverage and disease control with these fungicides is improved when the sprays are directed at an angle forward and backward toward the grain head, using a low boom height, coarse spray quality (i.e., droplet size) and 10 gallons per acre (gpa) or greater water volume. Use a shallower angle for a forward-facing spray (e.g., 30 degrees from vertical) and a steeper angle for a backward-facing spray (e.g., 70 degrees from vertical). For additional information, see NDSU publication Ground Fungicide Application for FHB Suppression (AE1314).

Multistate and North Dakota forecasting models are available to help predict the risk of Fusarium head blight during the growing season. The use of these forecasting models helps in the decision whether to use fungicides. The websites for these models are:

- Multistate model: www.wheatscab.psu.edu
- North Dakota model: www.ag.ndsu.edu/cropdisease

## Harvest

At harvest, the combine may be adjusted so that lightweight FHB kernels are removed along with the chaff. However, this will not remove all FHB kernels because some Fusarium infections occur late in kernel development, and these infected kernels still will be fairly plump.

Infected barley kernels are not removed easily in the combining process. The Federal Grain Inspection Service considers visible FHB damage as part of total kernel damage and, if excessive, will lower the market grade. Severely affected grain may be graded "feed" rather than "milling" for wheat or "malting" for barley.

After the harvest of wheat, gravity table grain separation may be very effective in removing lightweight, FHB-damaged kernels. The resultant product may have a high enough test weight to pay for the cost of the clean-out process.

## Mycotoxin

Fusarium-infected grain may contain fungus-produced toxic substances called mycotoxins. The most common mycotoxin associated with Fusarium-infected grain in the northern Great Plains is deoxynivalenol or DON (vomitoxin). This mycotoxin may cause vomiting and feed refusal in nonruminant animals, such as pigs.

The presence of this toxin may result in substantial price discounts at the market and even refusal to purchase if DON toxin levels are high. In the case of barley used by the malting and brewing industry, DON level requirements are very low, generally less than 0.5 part per million (ppm; milligrams/kilogram).

The presence of Fusarium-infected grain does not automatically mean mycotoxins are present. The occurrence, amount and kind of mycotoxins may depend on several factors, including environment, species of fungus present, severity of infection and the variety or kind of crop. Fusarium-infected grain may be tested for DON and other mycotoxins at properly equipped laboratories.

Contact a veterinarian or feed specialist for further information on safe livestock feeding levels. The risk of human exposure to DON ingestion is minimal under the Food and Drug Administration (FDA) guidelines (see table), but producers and elevator operators need to be aware that moldy grain can cause allergy and breathing problems. Producers and elevator operators should wear a good-quality dust mask when working around grain with high amounts of scab or other molds.

**The FDA has established the following advisory levels for DON in food and feed:**

- 1 ppm for finished grain products for human consumption
- No standard for raw grain going into milling process
- Cattle more than 4 months old: 10 ppm (providing grain at that level doesn't exceed 50% of diet)
- Poultry: 10 ppm (providing grain at that level doesn't exceed 50% of diet)
- Swine: 5 ppm (not to exceed 20% of diet)
- All other animals: 5 ppm (providing grains don't exceed 40% of diet)

**Figure 7. Wheat growth stages from left are three-fourths spike emergence, full spike, early flowering, one to three days after early flowering and three to seven days after early flowering.** (Andrew Friskop, NDSU)

**Figure 8. Barley growth stages from left are boot stage, one-half spike emergence, full spike, one to three days after full spike and three to seven days after full spike.** (Andrew Friskop, NDSU)

*This publication was originally authored by Marcia P. McMullen, former NDSU Extension cereal pathologist; Shaobin Zhong, Wheat Pathologist, Department of Plant Pathology; and Stephen Neate, former NDSU barley pathologist, 2008.*

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