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Managing Fusarium Head Blight
in Virginia Small Grains

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Fusarium head blight (FHB), or scab, continues to impact small grain crops grown in Virginia. Caused primarily by the fungus *Fusarium graminearum* (also known as *Gibberella zeae*), this disease can negatively impact yield and grain quality. Grain may also contain toxins (mycotoxins) produced by the fungus and reduce the price received for grain at local mills and elevators. Corn and small grain residues remaining in the field prior to small grain planting are known to provide a place for the fungus to overwinter and proliferate during favorable environmental conditions.

SYMPTOMS

Symptoms of premature whitening or bleaching on heads **(Figure 1)** may be seen within days following infection. Heads are considered most susceptible when anthers are exposed during flowering **(Figure 2)**, although late infections can occur. Spore masses of the fungus may appear pink to orange and may be visible on infected heads **(Figure 3, 4)**. Often one-third to one-half of the head is affected, and in some cases the entire head may be colonized with the fungus. The bleached areas of the head may be sterile and contain shriveled and discolored kernels **(Figure 5)**. In barley, heads may appear to have a bleached or a brown, water-soaked appearance. Small, blue-black spore containers (perithecia) may be visible on crop residues remaining in the field and may be visible on infected heads closer to harvest.

Figure 1. Premature bleaching of wheat heads caused by FHB. *(Photo by Melissa Keller)*

SURVIVAL AND MOVEMENT OF SPORES

Crop residues may remain on the soil surface following a previous season's harvest of small grains and corn. These residues can provide an overwintering media for the fungus and allow infestation to occur on small grains planted into these fields **(Figure 6)**. When optimal weather conditions including average temperatures of 75 to 85°F, extended periods of high humidity, and frequent rainfall occur, infection of flowering small grains is likely. Spores are produced and discharged from spore containers called perithecia found on crop residue. Discharged spores may be windblown or rain-splashed onto heads of small grains. Long-distance transport of these spores is possible, thus creating the potential for infection of fields statewide. Heads are susceptible from flowering through development of kernels. When late infection occurs, symptoms may not be visible due to grain maturation.

MYCOTOXINS

The mycotoxins most often found in Virginia small grains are deoxynivalenol (also referred to as DON or vomitoxin) and

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Figure 2. Anthers emerging from wheat head during flowering. *(photo by Melissa Keller)*

Figure 3. Orange spore masses on wheat head. *(photo by Melissa Keller)*

Figure 4. Orange spore masses on barley head. *(photo by Carl Griffey)*

Figure 5. Healthy kernels (left) and diseased kernels caused by FHB (right). *(photo by Melissa Keller)*

zearalenone. The presence of DON in grain can cause symptoms of vomiting and feed refusal in non-ruminant animals. When DON is found in harvested grain, producers will typically be offered lower prices or have grain refused when attempting to sell contaminated grain at elevators or mills. Advisory levels have been established by The Food and Drug Administration (FDA) for DON in food and feed **(Table 1)**. The presence of zearalenone in grain can cause reproductive problems in animals.

FDA Advisory Levels for DON (parts per million)	End-Use Description
1 ppm	Finished grain products for human consumption
	Grain and grain by-products destined for swine and other animal species (except cattle and chickens); not to exceed 20% of the diet for swine, and not to exceed 40% for other animal species.
10 ppm	Grain and grain by-products for ruminating beef and feedlot cattle older than 4 months and for chickens; not to exceed 50% of the diet.

Table 1. FDA Advisory Levels for DON.

FHB-infected grain can be tested for mycotoxins for a fee by contacting The Virginia-Maryland Regional College of Veterinary Medicine Toxicology Lab, College of Veterinary Medicine, Virginia Tech, Blacksburg, VA, 24061 at 540-231-4835.

For more information about Virginia mycotoxins and FDA guidelines visit the following websites:

http://pubs.ext.vt.edu/news/livestock/2009/07/APS_07-10-09_10.html
www.gipsa.usda.gov/GIPSA/documents/GIPSA_Documents/b-vomitox.pdf

EFFECTS ON YIELD AND GRAIN QUALITY

In addition to a decrease in feed consumption and/or feed refusal in livestock, *Fusarium*-damaged grain can contain kernels that are shriveled and have a low test weight causing low yields and limited marketability. The amount of kernel damage by FHB is based on the extent of infection.

For a rough estimate of yield loss:

1. randomly select 100 heads from across the field;
2. sort heads into piles for healthy heads, partially infected heads, and completely infected heads; and
3. add number of completely infected heads to 1/2 the number of partially infected heads to calculate estimated yield loss percent (Method by Kansas State University), *www.ksre.ksu.edu/path-ext/factSheets/Wheat/Wheat%20Scab.asp*

Diseased grain with high levels of mycotoxins can be mixed with healthy grain to reduce the overall mycotoxin contamination level, but often at a reduced price. In environmentally favorable years for FHB, late infection may cause grain to appear healthy, but may contain high DON levels. Milling quality is reduced by infected kernels lowering flour yield and impacting baking traits.

MANAGEMENT OF FHB

FHB epidemics occur sporadically and management is best accomplished when multiple strategies from those listed below are implemented. When environmental conditions are favorable for disease, the use of one strategy alone may prove ineffective against FHB.

Resistant Cultivars

To date, there is no cultivar of wheat or barley completely resistant to FHB. However, many cultivars with varying levels of resistance are available to Virginia growers. Resistance to disease spread within the infected head and to degradation of mycotoxins varies with each cultivar. To get current information regarding available Virginia cultivars and their trial performance ratings visit

the following website:
http://pubs.ext.vt.edu/3007/3007-1455/3007-1455.html

Tillage of Crop Residue

No-till cropping systems are widespread in Virginia and large amounts of corn and small grains residue may remain on the soil surface. These residues can provide an overwintering medium for *Fusarium* species causing FHB and improve chances for FHB infection in the subsequent small grains crop. In no-till or minimal tillage cropping practices, reducing the size and spreading the residues may allow faster decomposition and reduce potential for the fungus to overwinter and produce spores. However, the use of tillage implements may have disadvantages such as moisture loss and erosion. Tillage practices that minimize and bury residue may reduce FHB in environmentally favorable years.

Crop Rotation

Small grains crops planted following corn or a small grain may have an increased chance of FHB infection in environmentally favorable years. Small grains rotated with soybean or another non-host crop has been shown to reduce FHB infection and mycotoxin contamination.

Fungicide

Fungicides, with correct application, have the potential to reduce FHB by 50% to 60%. Fungicides are typically applied at early heading for barley and at early flowering for wheat. Proper coverage of the head is necessary and more information can be found at the link below. Fungicide trials are conducted in Virginia and recommendations are available based on these results. A multi-state FHB forecasting model is available to assist with fungicide application decisions. This model is a collaboration of multiple institutions and was developed to predict the risk of an epidemic based on weather patterns prior to the flowering of wheat. Users can select their wheat growing region, date of crop assessment, type of wheat (spring vs. winter) and a percentage of risk will be calculated. Commentary from a Virginia Cooperative Extension Agent may be available for the region chosen. Although this model is not equipped for assessments of barley at this time, barley-specific models may be available in the future.

Fungicide Application Technique:
http://www.ag.ndsu.edu/scabsmart/best%20application.html
Multi-state model: *http://www.wheatscab.psu.edu*

Seed Treatment

Kernels (seeds) colonized with the fungus may reduce stands due to poor germination. Planting certified seed or treated seed may reduce seedling blight caused by seeds colonized with the fungus. Seed with a test weight of at least 58 pounds per bushel and 90% germination is recommended. If replanting of saved seed is necessary, seed should be treated before planting if harvested from an FHB-infected field. Replanting of saved seed may illegally violate a cultivar patent. Check for patents on cultivars from which seed is saved.

Planting Date

FHB infection depends on the amount of rainfall before and during flowering of small grains. Staggering planting dates or planting multiple cultivars will allow for different flowering dates

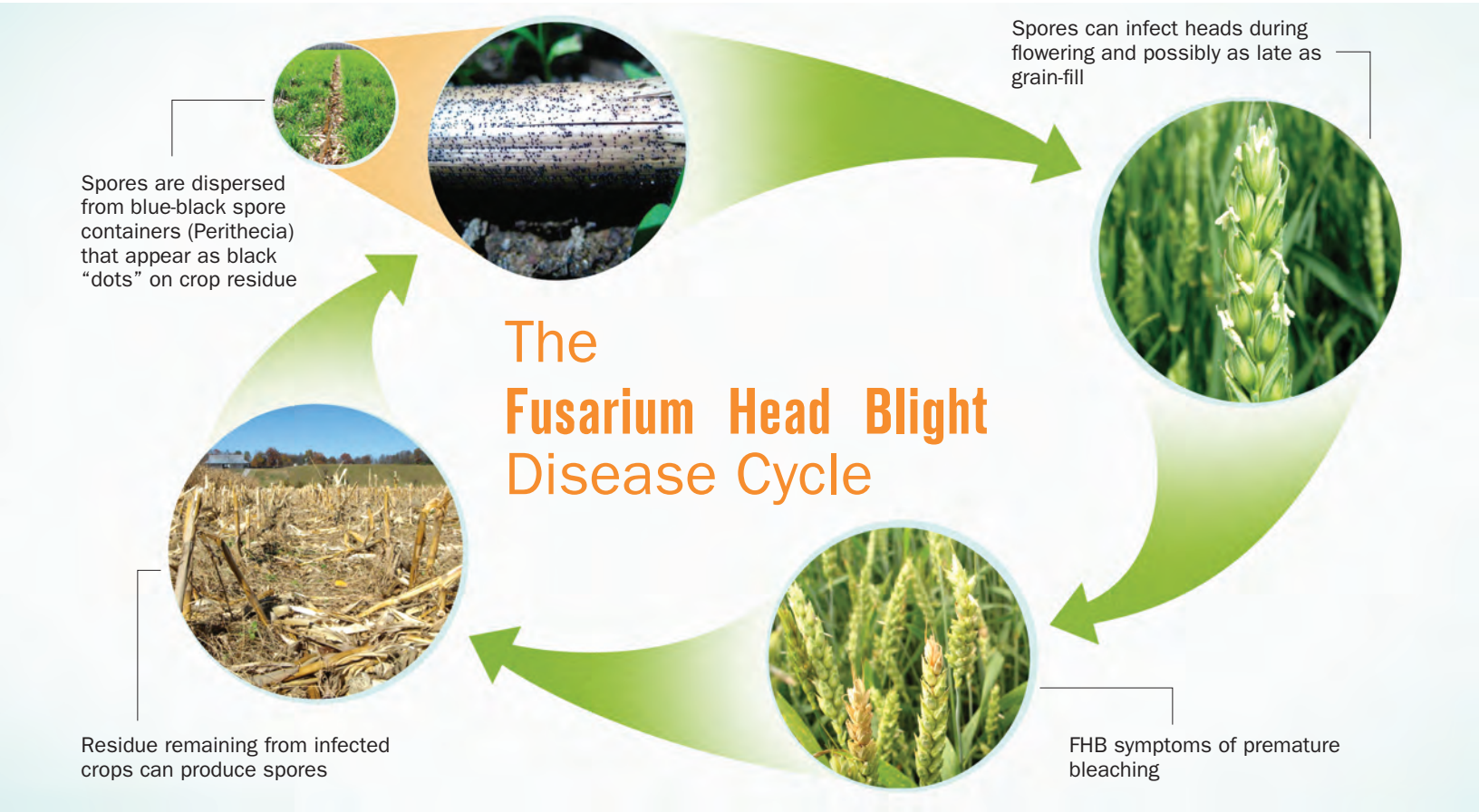

Figure 6. FHB disease cycle. *(photos by Melissa Keller)*

and thus different timing for FHB susceptibility.

Harvest Considerations

Increasing the fan speed of combines can remove light-weight FHB kernels with the chaff. It should be noted that these diseased kernels may germinate and provide a source of FHB. Kernels affected by late FHB infections may not exhibit shriveling and low test weight and therefore may not be removed. Fan speed may not remove diseased barley and oat kernels as easily as diseased wheat kernels.

QUALITY STANDARDS OF GRAIN MILLS AND ELEVATORS

The Federal Grain Inspection Service (FGIS) has been an agency of the U.S. Department of Agriculture since 1974. In 1994, a reorganization of departments led to the merging of FGIS and the Packers and Stockyards Administration to form the Grain Inspection, Packers and Stockyards Administration (GIPSA). FGIS now acts as a program within GIPSA. The national inspection of grain is conducted by federal, state, and private laboratories under the direct supervision of FGIS.

The FGIS grade is determined by test weight, heat damage, total damaged kernels, foreign material, shrunken or broken kernels, and total defects. Numerical grades U.S. No. 1 through U.S. No. 5 are assigned with U.S. No. 1 representing the highest quality. The moisture and mycotoxin levels of the grain do not affect the FGIS grade, but are still used in the determination of quality. Falling number (FN) is used to determine amount of kernel sprouting. FN of 300 seconds or higher usually indicates minimal sprouting damage.

Two special grade requirements might require observations of garlicky and smutty grain. If more than two green garlic bulblets or an equivalent quantity of dry or partially dry bulblets are found, the grain is considered garlicky. Smutty grain may contain smut balls, portions of smut balls, or spores of smut in a 250 g portion.

Sour, musty, or other commercially objectionable foreign odors (COFOs) from the grain may result in price reductions or rejection. Sour odors are described as rancid and sharp and are generally caused by insect waste and/or fermenting grain.

Quality Standards for Wheat	Requirements*
FGIS Grade	No. 2 or better
Moisture	13.5% or below
Vomitoxin (DON)	2 ppm or below
Falling Number (FN)	>250 seconds
Smut Ball	None
Garlic Ball	None
Infestation	None
Pesticide Residue	None

*Any wheat exceeding the above limits will be subject to rejection or market discount.

Table 2. Quality Standards of The Mennel Milling Company, Roanoke, Virginia. *(Courtesy of C.J. Lin, The Mennel Milling Co.)*

Quality Standards for Barley	Recommended Requirements*
FGIS Grade	No. 2 or better
Test weight	46 lbs.
Moisture	13% or below
Vomotoxin (DON)	2 ppm or below
Thins	15%
Total Damage	4%
Heat Damage	0.3%
Garlic	Less than 3 bulbs
Sound	94%
Foreign material	2%
Infestation	None
Musty Odor	None
Sour Odor	None
COFO	None
Smutty	None
Heating	None
Damage/Stained material	None

*Barley not meeting the recommended requirements will be subject to market discount or rejection due to the feed requirements on Barley Protein Meal (BPM), the feed co-product from ethanol production.

Table 3. Quality Standards of Osage Bio Energy, Hopewell, Virginia. *(Courtesy of Bill Scruggs, Osage Bio Energy)*

Musty odors are generally earthy and moldy while COFOs include any other odors not typically found in grain such as odors of fertilizer, smoke, skunk, or decaying animal or plant material.

Heating of grain is common in grain that is spoiling and will not only have a high temperature, but may also have a sour odor. Heating can be caused by insect infestation or other microorganisms. Sound grain is warm due to storage in bins or other containers in hot weather.

Optional assessments may include insect infestation, pesticide residue, and heavy metals. Grain is also tested for mycotoxins such as DON, zearalenone, and others (see Mycotoxins section for more information). Thin-layer chromatography (thins) may be used to detect the presence of toxins within grain. Examples of quality testing for Virginia grain are shown **(Table 2 & Table 3)**. Quality of grain is determined by standardized testing discussed on the GIPSA website:

http://archive.gipsa.usda.gov/reference-library/standards/810wheat.pdf
http://archive.gipsa.usda.gov/reference-library/standards/810barley97.pdf

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