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FUSARIUM HEAD BLIGHT IN TEXAS WHEAT AND SMALL GRAINS

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INTRODUCTION

Fusarium head blight (FHB), also known as head scab, is a disease of barley, oat, wheat, and other small grains caused by the fungus *Fusarium graminearum* and closely related *Fusarium* species. FHB is one of the most important diseases of wheat across most of the wheat-producing regions in the world. The disease occurs in susceptible durum wheat, hard red winter wheat, soft red winter wheat, and hard red spring wheat varieties and cultivars. These disease pathogens are also known to cause several other diseases in small grains, including seedling blight, root rots, and crown rots. FHB can result in yield loss from sterility in produced heads and small and shriveled kernels with low seed test weight resulting from poor fillings. Besides yield loss, economic losses from reduced grain quality due to grain contamination with secondary metabolites (mycotoxins) produced by the FHB fungi in infected grains can also occur. The FHB fungi produces mycotoxins such as deoxynivalenol (DON), also known as vomitoxin, and Zearalenone. These mycotoxins, much like aflatoxin and fumonisin, can negatively impact human and animal health and their permissible levels (Table 1) in grains, feed, and their derived products such as flour and feed are regulated in the United States by the Food and Drug Administration (US-FDA).

FHB is not a common disease of small grains in Texas because weather conditions prior to flowering (Feekes 10.5.1) through the early dough stage (Feekes 11.2) is typically not conducive for the infection and development of the pathogen. Infection is favored by mild temperatures (75°F to 85°F) along with high moisture conditions, which is often the disease-limiting factor, from either an extended period of rain or high humidity. Typically, during these periods of plant susceptibility to the pathogen, weather conditions across the High Plains, Central, and Northeast Texas are drier than what FHB pathogens require to infect wheat and other small grain crops. However, the presence of overhead irrigation can create a suitable micro-climate for FHB disease development. The FHB fungi can survive in crop residues as saprophytes between growing seasons, and consequently, incidences and severity of FHB are often severe under reduced-tillage and no-tillage cropping systems that promote the survival, increase, and spread of the FHB disease fungi in affected fields. The spread and subsequent infection of susceptible wheat plants is mainly by conidia (i.e., asexual spores), but also by ascospores (i.e., sexual spores) carried primarily by wind currents. These spores can also be moved by water splashing from rain or irrigation, as well as by insects, from infected crop residues.

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TABLE 1. THE UNITED STATES FOOD AND DRUG ADMINISTRATION (FDA) SUMMARY MYCOTOXIN REGULATORY GUIDANCE

Mycotoxin	Grains for Food	Grains for Feed+
Deoxynivalenol (DON)	1 ppm	5–30 ppm
Zearalenone	NG*	NG*
Fumonisin	2–4 ppm	5–100 ppm
Aflatoxin	0.5–20 ppb	20–300 ppb

*NG – No guidance levels, case-by-case basis
+Exact value varies depending on animal type

SYMPTOMOLOGY

FHB-infected heads are easy to spot within an affected field. Symptoms of FHB appear shortly after flowering, typically within 18 to 21 days. Under disease-favorable weather conditions, the entire head of infected glume (spikelet) initially appears light, straw-colored (or bleached) as a result of the premature death of affected tissues. The entire head initially appears light straw-colored (or bleached) as a result of the premature death of affected tissues. Under disease-favorable conditions, the FHB fungi can infect the vascular tissues (rachis) of an infected wheat head and progress downward, resulting in disruption of the flow of nutrients to the developing spikelets, subsequent death of affected spikelets, and eventually in the characteristic symptom of FHB (Fig. 1). Within 10 days after the characteristic bleaching of affected glume(s), a pink to salmon color develops near the base of the affected glume (Fig. 2). This pinkish discoloration is a mass of mycelia and spores. The spores are easily carried by wind to other spikelets on the same or new heads, as well as to new parts of the field or to nearby fields to start new infections. The straw-colored symptom of FHB-infected heads can be confused for a similar symptom due to damage caused by the wheat stem maggot. However, plant damage due to the wheat stem maggot can be distinguished from FHB by the fact that the entire head of affected plants become bleached as a result of feeding by the maggot in the uppermost stem internode, resulting in heads that can easily be pulled by the attached stem to reveal feeding damage to the stem at the upper internode point. Heads affected by the wheat stem maggots, unlike in FHB, also often do not produce any grain.

Figure 1. Bleaching of wheat glumes caused by Fusarium head blight. (*Credit: D. Tyler Mays*)

Seeds produced by spikelets infected by FHB during the early stages of development will be smaller and also shriveled, giving an appearance commonly referred to as "tombstones" (Fig. 3). The light-weight characteristics of FHB-infected kernels also results in significant loss of such kernels by the combine during harvest. Affected kernels can also range in color from light brown to pink and even a grayish-white. Grains that result from spikelets infected by FHB during the later stages of development, while appearing normal, can be contaminated with DON as well as result in new infections if planted as seeds. Plants that result from infected seeds will have reduced vigor, may succumb to seedling blights, and root and crown rots later in the season. Planting such infected seeds can also increase the risk of seeing FHB in the new crop if weather conditions are favorable for disease development. Unlike the straw-colored or "blasted" appearance of FHB-affected heads, there are no visible symptoms of DON contamination, and the level of the mycotoxin in affected heads is dependent largely on environmental conditions.

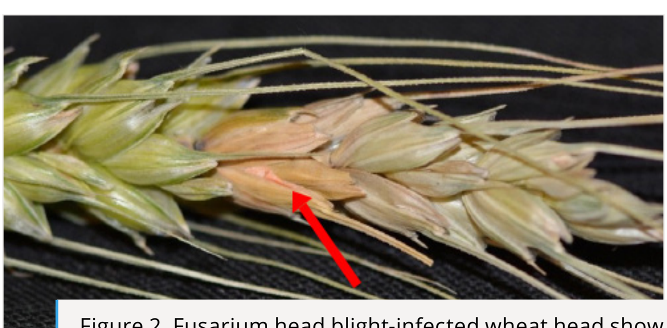

Figure 2. Fusarium head blight-infected wheat head show the salmon to pink discoloration. (*Credit: D. Tyler Mays*)

Figure 3. FHB-infected kernels ("tombstones") on the left, compared to healthy wheat kernels on the right. (*Credit: Bob Johnston, Montana State University, Bugwood.org*)

FUSARIUM HEAD BLIGHT AND DON MANAGEMENT

The wide distribution, broad host-range, and ability of FHB causative fungi to utilize diverse substrates as food sources can make managing this group of fungi challenging. Their management is further complicated by the lack genetic tolerance among cultivated wheat varieties and cultivars. However, it is possible to reduce the incidence and severity of FHB through a combination of strategies that takes advantage of knowledge of the disease, as well as the life cycle of the causative fungi. Such strategies include:

Residue Management and Crop Rotation

Incorporating all susceptible host crop residues into the soil, especially residues from previously infected crops, can help to significantly reduce the amounts of infectious inoculum (i.e., spores) of FHB fungi that can infect subsequent crops. This is largely because only aboveground or surface inoculum can produce new infections. Reduced tillage or no-tillage on the other hand may create conditions that not only favor the survival of FHB fungi between cropping seasons, but also promote infection of new, susceptible hosts in subsequent seasons. Where reduced tillage or no-tillage practices are preferred, rotation of susceptible host crops with non-susceptible crops can provide some level of management of the disease through starvation of the fungi of food source. Therefore, by implication, the longer the rotation cycle to a susceptible host crop, the better the desirable outcome.

Resistant Varieties

Selecting a variety that has some resistance to FHB is one of the major strategies for minimizing the impact of FHB. Currently, there are no commercial varieties that have a high level of resistance to FHB, but varieties with a moderate level of resistance do exist. In Texas, FHB resistance ratings are not published since it is not a common disease in the state. Therefore, this information will have to be obtained from the seed company or the seed sales representative being used. Additionally, just because a variety is said to have moderate resistance to FHB, does not mean FHB infection cannot be seen because under favorable environmental conditions and heavy disease pressure, this resistance can easily be overcome by the pathogen.

Seed Quality

Planting high-quality and FHB-free certified seeds can help to ensure a healthy crop. FHB-infected seeds generally have reduced vigor and have greater risk of seedling blight and root and crown rot infections, which in turn can increase susceptibility to FHB infection later in the growing season. Planting fungicide-treated seeds can also help to reduce the incidence and damage from Fusarium seedling blight, and in-turn, reduce the inoculum load for latter portions of the growing season. However, seed treatments typically provide little to no protection past about 28 days after planting.

Fungicides

There are several fungicides that are labeled for FHB management and they vary in their level of protection. To effectively manage FHB with fungicides, they need to be applied at the right time and rate (specified on label) and achieve adequate coverage of the heads. Research conducted in the U.S. Midwest found that fungicides are most effective when applied at early flowering (Feekes 10.5.1), and that triazole-based fungicides such as tebuconazole and propiconazole are the most effective. A list of fungicides that have been evaluated for their effectiveness in managing FHB can be found at the following link: *https://varietytesting.tamu.edu/files/wheat/otherpublications/2019-Registered-Fungicides-Wheat.pdf*.

If weather prohibits fungicides from being applied at the early flowering stage, fungicides can still be applied and still provide some protection against FHB if weather conditions remain conducive for disease development. Fungicides with formulations based on the quinone outside inhibitor (QOI), such as azoxystrobin and pyraclostrobin, should not be used for disease management, as there is suggestion that they might increase the risk of DON contamination. Before applying fungicides, it is important to read, understand, and follow the label directions, including the product's pre-harvest interval (PHI).

Implementation of a combination of any of these management strategies can significantly help reduce DON contamination in harvested grain and avoid getting docked at the elevator. Other steps that can be taken to manage DON contamination levels in harvested grains include: 1) setting up the combine to where the tombstones are blown out the back of the combine instead of making it into the grain tank and 2) minimizing post-harvest contamination by storing grains separately that are suspected to be or are contaminated from healthy, non-contaminated grain. For instance, this can be done by harvesting FHB-infected fields last and placing the grain into its own grain bin. Alternatively, FHB-infected sections of the field can be harvested separately so the grains from this area do not get blended with grains from FHB-free sections. However, this method requires in-depth knowledge of where FHB-infected heads are located across the field and represents the least feasible option as it would require scouting the entire field, which for the majority of production fields is impractical because of their relatively large sizes.

RISK MANAGEMENT

The United States Wheat and Barley Scab Initiative has developed a risk indicator map in collaboration with scientists from Kansas State University, Ohio State University, and Penn State University. This risk indicator map shows the potential for disease or risk level based on local weather conditions around the date of assessment and variety susceptibility. Currently, Texas is not included in this map, but neighboring states Arkansas, Louisiana, and Oklahoma are included. If regions around Texas are indicating a high-risk level, it is assumed that the risk level in the High Plains, Central, and Northeast Texas are conducive for disease development. However, local weather conditions should be evaluated to ascertain more accurately the risk level for disease development. This risk management tool can be found at: *http://www.wheatscab.psu.edu/*.