Crop Management to Reduce Fusarium Head Blight and Associated Toxins

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Fusarium head blight (FHB) is a disease that can have devastating effects on cereal production here in the eastern prairies. In 1993, there was an epidemic that rendered much of the wheat crop unmarketable. For more than a decade there have been negative effects from this disease, not just to primary producers but to the agricultural industry as a whole – despite best efforts to manage it.

The negative effects are not attributed solely to yield loss from shrunken kernels. In fact, although the literature reports yield reductions of up to 70%, it is unlikely in Manitoba to lose even 30% to FHB. Just as important are the effects of infected kernels in an otherwise "healthy" grain sample. Fusarium damaged kernels (FDK) are shrunken and light-colored. They are easily detected visually and very small quantities lead to rapid downgrading. For example, as little as 0.25% FDK, on a weight-by-weight basis, drops hard red spring wheat to a No.2 and 1% means a No. 3.

The reason that a low level of infected grain has so drastic an effect on grade is the toxins produced by the causal fungi. In particular, the toxin deoxynivalenol (DON) is a concern for livestock producers, millers, maltsters and even ethanol producers. The general guidelines for swine suggest that no more than 1 part per million of that toxin be allowed in rations. Maltsters have a zero tolerance for DON. To be economically viable, ethanol production relies on the sale of the by-product known as dried distillers' grain. Because DON is heat stable, it actually becomes concentrated in the by-product.

Biology – Disease Life Cycle

To discuss management, it's important to understand the biology of the pathogen – how and when it infects its cereal hosts. As with all diseases, infection occurs with the coincidence of three essential elements – a susceptible plant (host), an infectious agent (pathogen) and environmental conditions that favor the pathogen. Simply put, head blight occurs when there is rainfall just prior to heading and sufficient heat and humidity throughout the flowering period. The year 2003 represented a reprieve from FHB infection, with drier conditions prevailing from mid-July through harvest.

There are a several species of Fusarium that can cause head blight of which a subset produce a range of mycotoxins. In Manitoba, *Fusarium graminearum* predominates and the principal toxin that it produces is DON. The pathogen can live quite successfully on the residues of infected crop and can cause root infections when the next cereal crop is planted. Seed-borne infection can also lead to root rot but the pathogen is not systemic

within the plant and root rot does not automatically lead to head infection (as happens with some smuts).

There are two types of spores that can be involved in head blight infection – asexually produced macroconidia which are released and spread short distances by rainsplash and sexually produced ascospores which are released some time after rainfall, but have greater potential for long range spread by air. While the crop is flowering, infection occurs whenever temperature is in the ideal range (15 – 30º C) and humidity approaches 100%. Manitoba's clay soils, so common in the Red River Valley, can retain a substantial amount of moisture and strongly influence humidity when the crop canopy is established. When the risk of infection is significant, it is often important to intervene with a fungicide to reduce FDK. The window during which the crop is susceptible is very brief but successful management can only be accomplished in that short interval. Knowing the risk and anticipating when flowering will occur are critical.

Management

Prevention: cultivars, rotation, seeding practices

Genetic resistance is arguably the long term solution to disease management. Unfortunately, we are far from reliably resistant cultivars that have established market qualities. In hard red spring wheat, AC Barrie with only **F**air resistance to FHB has been for some time the standard for Manitoba. Older cultivars like Roblin, with essentially no resistance, were all but abandoned during the epidemics of the early 1990s. Some great hopes have been put forward such as the US cultivar Alsen and the high-yielding HY644, but these have been denied registration because of inferior quality characteristics or issues of kernel visual distinguishability (KVD). At the most recent Registration Recommending Committee the first bread wheat with **G**ood resistance to FHB was granted approval – 5602HR. Until it is commercially available, the best producers can rely on, in areas prone to FHB, are cultivars with at least fair resistance.

Rotation with non-cereal crops is another recommendation for the reduction of Fusarium inoculum. One crop on which inoculum builds and resides longer is corn. Despite low levels of FHB in small grains in 2003, there was significant incidence of stalk rot in corn and this still represents a risk to the 2005 crop. Producers who have followed corn with wheat have generally had disastrous results.

By doubling the standard seeding rate in wheat, it is possible to reduce the amount of tillering thereby shortening the length of time that the crop is susceptible. And because high risk environmental conditions rise and fall throughout the season, staggering seeding dates of cereal crop can also reduce the risk of all of the crop being affected. If high risk conditions are prolonged, this practice might allow timely fungicide application to more acres.

Intervention: forecasting FHB and fungicides

With leaf diseases of cereals, it is possible to follow development before making a decision to intervene. With Fusarium head blight, there is no such luxury. The decision to intervene must be made before any visual indication is available. This situation is one in which mathematical forecasting of the conditions that favor infection can be very useful. Through trial and error, a collaboration between pathology, ag meteorology and GIS (geographical information systems) has produced a model that generates a risk forecast map, posted daily on the internet throughout the time the wheat crop is vulnerable. It is a simple model that shows graphically the ebb and flow of FHB risk. Producers and agronomists can gauge FHB risk and the necessity of fungicide intervention as a particular crop nears the window of vulnerability.

Two fungicides – Folicur® (tebuconazole) and Bravo® (chlorothalonil) – have been available to Manitoba producers but, in practical terms, it is the former (through Emergency Use registration) that has been the product-of-choice. Many research trials have reported a more consistent reduction in the amount of DON although complete control cannot be expected. At best, a 50% reduction in FDK and DON compared with the untreated control is more the norm. Under conditions of *extreme* risk, this may still result in an unacceptable level of disease. Producers must also consider the risk of losses to other cereal diseases and determine which is more significant. Cost often precludes the use of two fungicide application in one season but, when that occurs, it is critical to rotate products to prevent the development of fungicides resistance.

Special adaptations in sprayer technology, *e.g.* forward and backward angled nozzle, have been examined to improve coverage on a hard-to-reach target (the cereal head) and hence the level of control.

Harvest Management

In many years, despite following all recommended practices, producers are faced with a level of FHB in their fields that will still affect the "bottom line." A visual assessment 2-3 weeks after flowering will give an idea of what might be expected in the harvested grain. However, because infected kernels are often shriveled and lightweight, they do not all end up in the bin. The level of FDK will likely be somewhat less than the Visual Rating Index – a measure of the disease prior to harvest.

The shrunken, lightweight grain provides one more opportunity to harvest a marketable product. Leaving the crop standing longer, preferably for straight combining, will lead to more complete deterioration of infected grain. Adjusting combine settings, especially increasing wind speeds, can blow lighter kernels out with the chaff. And finally, as long as FDK that remain in the harvested sample are smaller than healthy hard vitreous kernels, it is possible to clean out and destroy them prior to delivery.

Because Fusarium head blight is a complex disease with far-reaching implications in the industry, producers must do all they can with these limited options to manage its impact while the improvement of these tools continues.