



Could fusarium head blight become an even more serious problem?

by Carolyn King



Symptoms of fusarium head blight symptoms in wheat.

PHOTO COURTESY OF K. TURKINGTON, AAFC.

A newly introduced variant of the fusarium head blight fungus could have serious implications for cereal growers.

The fungus *Fusarium graminearum*, the main cause of the cereal disease fusarium head blight (FHB) in Canada, is changing. Preliminary studies indicate that a new variant of the fungus is rapidly displacing the traditional type. The new variant seems to produce more of the fusarium toxin, grow faster and produce more spores. Now a three year, multi-agency project is investigating this variant to better understand its characteristics and the implications for controlling FHB.

Even the traditional form of *Fusarium graminearum* produces a devastating disease. For instance, annual losses of up to \$75 million have been reported in Manitoba due to FHB.

"FHB is the most significant cereal disease in Canada," says Dr. Kelly Turkington. He is a plant pathologist at Agriculture and Agri-Food Canada (AAFC) in Lacombe, Alberta, and has conducted research into various aspects of FHB. Turkington is leading the new project, which runs from 2007 to 2009 and is funded by the Western Grains Research Foundation.

Turkington says, "Like many other important crop diseases, FHB can cause serious yield loss and grade loss. But what sets *Fusarium graminearum* apart is that it produces mycotoxins (one of which is deoxynivalenol, or DON) which limit the use of the grain for livestock feed and human food.

Fusarium infection also compromises the quality of the seed for use in milling, baking, pasta making, malting and brewing."

In addition, FHB is very difficult to control once it becomes established in an area. Crop management practices such as crop rotation cannot completely control the disease because the fungus produces windborne spores, which are easily carried from one field to another. Although fungicide applications reduce the amount of disease, they do not eliminate it. Turkington explains, "So instead of 10 parts per million of the toxin in the harvested grain, you may have five parts per million when you

use a fungicide. Five parts per million is still very high and millers and pasta makers are not going to want the grain."

Surprising discoveries point the way

Until recently, one toxin type or chemotype of *Fusarium graminearum* – called the 15-acetyl deoxynivalenol (15ADON) chemotype – was the major cause of FHB in Canada. The discovery of a second toxin type, called 3-acetyl deoxynivalenol (3ADON), came about through joint efforts by Canadian and US researchers.

One of the scientists involved in the 3ADON discovery is Randy Clear with the Grain Research Laboratory at

Current distribution of the 3ADON chemotype

"Three-acetyl toxin-producing isolates of *Fusarium graminearum* are quite common in Europe and South America," notes Randy Clear. The genetic analysis by Ward and O'Donnell indicates that the 3ADON type was likely introduced into North America from one or more of these outside sources.

"With the worldwide movement of grain, it's not surprising that the 3-acetyl type could have been introduced accidentally into North America," says Clear. "What is surprising is that it is replacing the existing 15-acetyl population very quickly, a population that is no slouch when it comes to causing head blight in crops."

So far, the analysis of the Canadian Grain Commission's collection of *Fusarium graminearum* shows two patterns in the occurrence of the 3ADON chemotype, one in the east and the other in the west. In eastern Canada, Prince Edward Island currently has the highest proportion of 3ADON, with nearly all isolates being 3ADON. As you move west, the proportion of 3ADON gradually declines until you reach Ontario where less than 10 percent of isolates are 3ADON. In western Canada, the percentage of 3ADON is highest in Manitoba, where nearly half of the isolates are 3ADON. Again, as you move west away from that peak, the proportion of 3ADON gradually declines. ■

the Canadian Grain Commission in Winnipeg. He specializes in seedborne fungal diseases and has many years of experience studying fusarium.

Clear says, "We have been collecting isolates of *Fusarium graminearum* from 1984 right up to the present time. Over the past few years, Drs. Todd Ward and

Kerry O'Donnell have published four papers reporting on genetic diversity within *Fusarium graminearum*. Based on their analyses of global collections of FHB, in which the isolates were identified morphologically as *F. graminearum*, they discovered that these isolates actually comprised 11 genetically distinct species.

The most common one of these is still called *graminearum*; however, the others were given new names primarily

Ward and O'Donnell are internationally recognized evolutionary biologists at the United States Department of Agriculture (USDA) in Peoria, Illinois. They analyzed the Canadian collection and found that all of the samples were the *graminearum* species.

But their analysis also provided a surprise. The isolates collected in western Canada from 1984 to about 1998 were all 15ADON, as expected. But beginning in 1998, 3ADON became more and more common over the years, as the new chemotype displaced 15ADON.

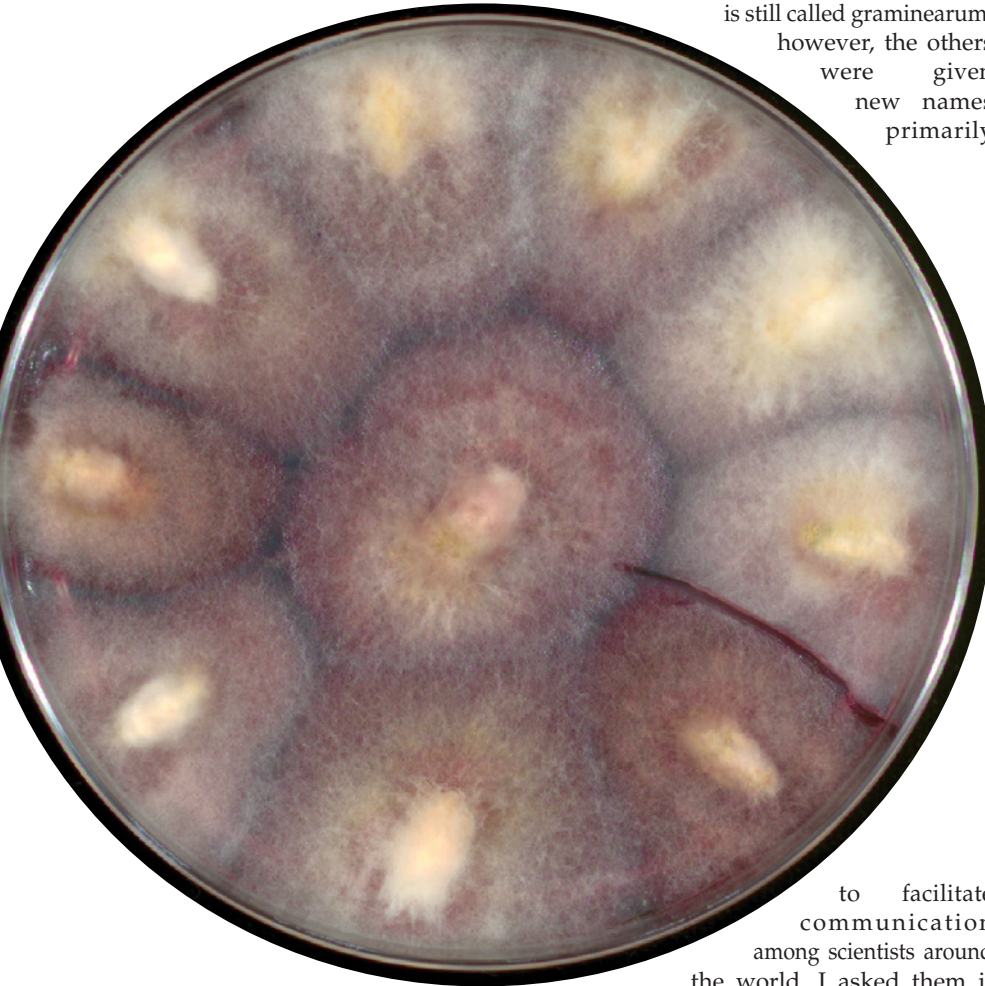
Because of the unexpected findings, Clear and his colleagues at the Grain Research Laboratory grew samples of the isolates in the laboratory to confirm the genetic analysis. They confirmed the findings, but they also found some surprises. The most startling result was that the 3ADON samples produced considerably more of the DON toxin in the laboratory than the 15ADON samples. As well, the 3ADON chemotype seemed to grow faster and produce more spores.

"Since then, and that was about 2004, we've collected a lot more isolates each year from all across Canada, except Newfoundland and British Columbia," says Clear. "The USDA has identified the chemotypes for us and we've grown some of them out. The pattern of the 3ADON chemotype producing more of the DON toxin in the lab has held true for all the isolates that we have tested from across Canada."

The serious implications of a possibly more toxigenic and more aggressive chemotype prompted the researchers to set up this new project.

Seeking out answers to key questions

AAFC's Turkington speculates about the possible implications of these preliminary findings: "It could potentially



Laboratory culture of the fungus Fusarium graminearum.

PHOTO COURTESY OF R. CLEAR, CANADIAN GRAIN COMMISSION.

to facilitate communication among scientists around the world. I asked them if they would be willing to look at our collection to determine if the isolates are *graminearum* or one of the other species."

be more difficult to manage FHB with crop management, like crop rotation and so on. If it's more aggressive and produces higher levels of mycotoxin, you could potentially have greater severity of disease on the crop, which could increase economic losses due to the disease. It may have implications for how useful fungicides are in terms of reducing disease and mycotoxin contamination in grain. And it may mean that we need to look at a combination of strategies to deal with this disease issue."

By analyzing about 3000 isolates of the fungus found in wheat, oat and barley samples collected in 2005, 2006 and 2007, the project will comprehensively document the changes occurring in *Fusarium graminearum* in Canada. It will also explore the effects of these changes on toxin production, fungicide sensitivity and disease spread and severity.

The project is aimed at answering questions like: How widespread is the 3ADON type? How prevalent is it in comparison to 15ADON? Why is 3ADON able to spread so rapidly? Is 3ADON a more prolific producer of DON in a crop as it is in the laboratory experiments? Is this chemotype more virulent on some of our more resistant crop varieties, compared to the older chemotype? Do the two chemotypes respond differently to fungicides? What are the implications for this shift to 3ADON in terms of sustainable management of fusarium head blight?

The project's multi-disciplinary research team includes national and international leaders in diverse aspects of fusarium research. Along with Turkington, Clear, Ward and O'Donnell, the other team members are Dr. Jeannie Gilbert and Dr. Andy Tekauz at AAFC's Cereal Research Centre in Winnipeg, and Tom Nowicki of the Grain Research Laboratory.

The team members each have responsibility for the aspect of the project that involves their specific area of expertise:

- Isolation of the fungus from grain samples and laboratory assessments to compare the chemotypes in terms of their toxin production, growth rates and spore production (Clear).
- Identification of the toxin potential of the isolate chemotypes and determination of the distribution of each chemotype across Canada (Ward and O'Donnell).
- Laboratory assessments to compare the chemotypes in terms of their toxin production (Nowicki).

- Comparison of the chemotypes in terms of their ability to cause disease on actual crop material in growth chambers (Tekauz and Gilbert).

- Laboratory assessments to compare the chemotypes in terms of growth rates, spore production and their sensitivity to fungicides (Turkington).

With Canadian and US researchers working together, the project will contribute to a broader picture of how the distribution patterns of

15ADON, 3ADON and any other chemotypes of the fungus are changing in North America (see *Current distribution of the 3ADON chemotype*).

Clear says, "Without doubt there are changes happening within the diverse populations of *Fusarium graminearum* in North America. We want to find out why there are changes and what the impacts could be." ■