U.S. WHEAT & BARLEY SCAB INITIATIVE

Fusarium Focus

Volume 9 Issue 1 Spring 2009

Highlights from 2008 National FHB Forum

Nearly 200 crop scientists, growers and wheat and barley industry representatives attended the 2008 National Fusarium Head Blight Forum, held on December 2-4 in Indianapolis, Ind.

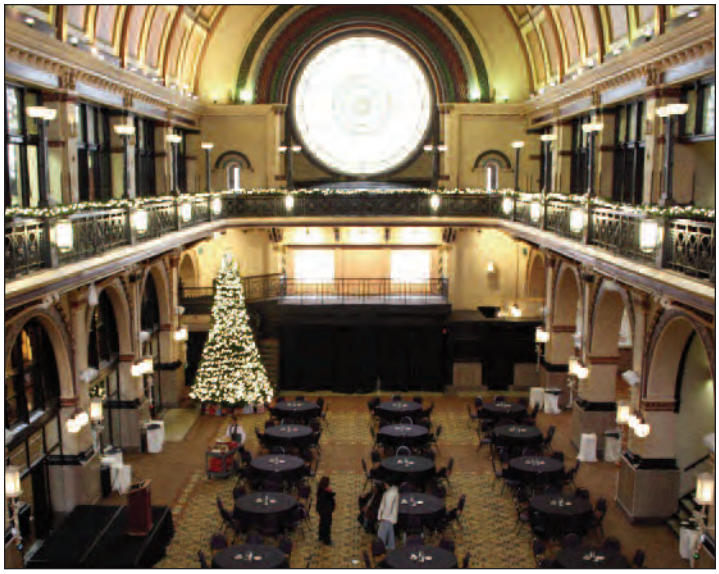
The 11th FHB Forum took place at the Crowne Plaza Hotel at Historic Union Station in downtown Indianapolis.

The event featured stakeholder and scientific speaker presentations, along with focused group discussions and evening breakout sessions. A number of scientific posters also were displayed during the Forum, with poster authors in attendance to discuss their research.

Sponsored by the U.S. Wheat & Barley Scab Initiative (USWBSI), the annual Forum serves as a venue for the reporting of the latest research findings on Fusarium Head Blight (scab) and deoxynivalenol (DON), the mycotoxin produced by scab infection in grain.

The following pages carry photos and narrative describing some of the highlights from the 2008 Forum. The event's entire proceedings can be found on the USWBSI web site: www.scabusa.org. ◆

Above: This barley contingent was one of the commodity-based focus groups that met during the 2008 FHB Forum. Others were durum and hard winter wheat.



Right: The Historic Union Station railroad station in Indianapolis provided a classic setting for the '08 Forum. This photo shows its banquet area and meeting rooms on the upper level.

Mark Your Calendar!

2009 National Fusarium Head Blight Forum

December 7-9

Wyndham Orlando Resort
Orlando, Fla.

— 2008 FHB Forum —

Ruth Dill-Macky, one of the '08 FHB Forum's invited speakers, addressed cultural control practices in the management of Fusarium Head Blight.

Dill-Macky, plant pathologist with the University of Minnesota, noted that while conservation tillage practices have been invaluable in protecting vulnerable soils, they likewise have resulted in "unanticipated changes in the prevalence of cereal diseases" — most notably, scab. *Fusarium* fungi, she explained, survive on crop residues of corn, small grain cereals and a variety of other grasses, with these residues then serving as a springboard for the release of ascospores that infect the current growing crops.

The expansion of corn acreage has contributed to the scab problem, Dill-Macky added. "*Fusarium* can readily infect the corn plant, inciting stalk and ear rots," she noted. Though *Fusarium* poses a limited threat to corn itself, "the increase in corn acreage and the reduced rate of decomposition of Bt-corn undoubtedly exacerbate the problem of FHB in wheat and barley."

Ruth Dill-Macky

"We seem unlikely to be able to reduce the threat of FHB epidemics, the attending damage to grain from DON, or the financial devastation to the wheat and barley industries, without addressing the underlying origin of the problem — *Fusarium*-infected crop residues," Dill-Macky stated.

Tools such as host resistance, crop rotation, tillage, residue destruction and chemical and/or biological controls that specifically target *Fusarium* within crop residues may play important roles in an integrated approach to managing FHB, Dill-Macky concluded, adding that these approaches' benefit lies in "reducing the initial level of residue colonization, accelerating residue decomposition, and/or reducing the survival or inoculum production potential of the pathogen." ◆

Marcia McMullen and **Carl Bradley** were co-presenters of an invited presentation on the past, present and future of fungicides for FHB management. McMullen is extension plant pathologist at North Dakota State University, while Bradley serves in a similar capacity with the University of Illinois.

"An effective foliar fungicide is one of the crucial tools needed to help make an integrative management plan work successfully," they noted. However, it took a number of years for this tool to be identified and become available. Though fungicide testing for FHB control took place during the 1970s and 1980s, it was not until the 1990s — when scab epidemics struck major U.S. small grain production areas — that a concerted multistate effort occurred in the evaluation of fungicides for control of Fusarium Head Blight.

This testing revealed tebuconazole (Folicur®) to be the best of the group in reducing both FHB and DON. From 1998 to 2007, wheat producers in some of the states affected by FHB were able to use Folicur under Section 18 emergency exemption labels. Folicur finally received a full EPA registration in 2008.

Other fungicides were being tested and moved toward labeling during the same period. Prothioconazole (Proline®) was registered in 2007, with Prosaro® and Caramba® being labeled in 2008. "In additional fungicide tests, the mixture of tebuconazole + prothioconazole (Prosaro) was shown to provide better control of FHB and DON than either [of these fungicides] alone," McMullen and Bradley said.

"For the first time ever, in the 2009 season, wheat growers in most of the United States will have access to multiple fungicide products that have been proven to reduce FHB and DON," the university plant pathologists stated. But, they added, "there is still much room for improvement. Future fungicide evaluations for control of FHB and DON should include different mixtures of the the most efficacious triazole fungicides, mixtures of fungicides with different modes of action, and experimental fungicides." ◆

Marcia McMullen

Carl Bradley

— 2008 FHB Forum —

Karl Glover, wheat breeder at South Dakota State University, updated the 2008 Forum audience on the development of FHB-resistant spring wheat for the northern Great Plains.

Alsen, released by North Dakota State University in 2000, was the first hard red spring wheat cultivar available to growers that was known to carry the major FHB resistance known as QTL, *Fhb1*, Glover indicated. Since then, additional cultivars possessing *Fhb1* have been released by NDSU, SDSU and the University of Minnesota. Other resistance sources, such as Triticum dicoccoides (used in the development of NDSU's Steele), have been utilized as well.

Glover noted that while *Fhb1* and other resistance genes are present within most releases now coming out of the three Upper Midwest university spring wheat breeding programs, this resistance is incomplete — *i.e.*, it is not immunity. So losses caused by FHB can still be significant. "Continual germplasm screening efforts, combined with marker-assisted selection, are a requirement if further advances in resistance levels are to be realized," the SDSU breeder emphasized. All three universities continue to operate substantial FHB-resistance screening programs. ◆

Karl Glover

Carl Griffey, small grains breeder at Virginia Tech, provided an update on the characterization and development of FHB-resistant soft winter wheat cultivars in the eastern U.S. Griffey said the percentage of uniform trial entries displaying better FHB and DON resistance ratings shows that progress is being made.

During the past eight years, more than 30 soft red winter and two soft white winter wheat cultivars having resistance to FHB have been released by public and private breeding programs, Griffey related. The majority were evaluated in the Uniform Scab Screening Nurseries and have native FHB resistance.

Only a few native sources have been genetically characterized and mapped to date, he noted. "While native resistance remains the genetic base of most breeding programs for developing FHB-resistant cultivars, the goal of many programs is to pyramid unique QTL, or genes derived from both native and exotic sources, to further enhance resistance to FHB and DON toxin accumulation," Griffey said.

"Genotype assessment of the entries in the Uniform Scab Nurseries has been useful not only for determining if a particular line may carry a resistance QTL, but also in determining the potential usefulness of markers for conducting marker-assisted selection in soft winter wheat populations," he added. ◆

Carl Griffey

CJ Lin of the Mennel Milling Company provided a miller's perspective on dealing with DON-contaminated wheat.

Lin recounted the Fusarium epidemic of 1996 in the Ohio soft wheat crop. The epidemic "resulted in major financial losses to farmers and millers, raised the awareness of the dangers of FHB and DON, and changed the way we do business — from purchasing to operations to sales," Lin noted.

Now, he explained, Mennel Milling — which is the nation's seventh largest flour milling company — closely monitors the wheat crop as it develops, scouting fields and obtaining samples prior to harvest. They test every load of incoming wheat for disease and segregate as necessary. "We no longer sell [flour] ahead of harvest when the crop is at risk for FHB," Lin added.

"We have improved our cleaning houses and thus have taken defensive measures which have raised our costs of doing business — while also inconveniencing our suppliers and restricting the ability of our customers to buy forward flour when they may want to do so.

"FHB and DON in wheat continue to be major problems for the wheat flour milling industry," Lin concluded.

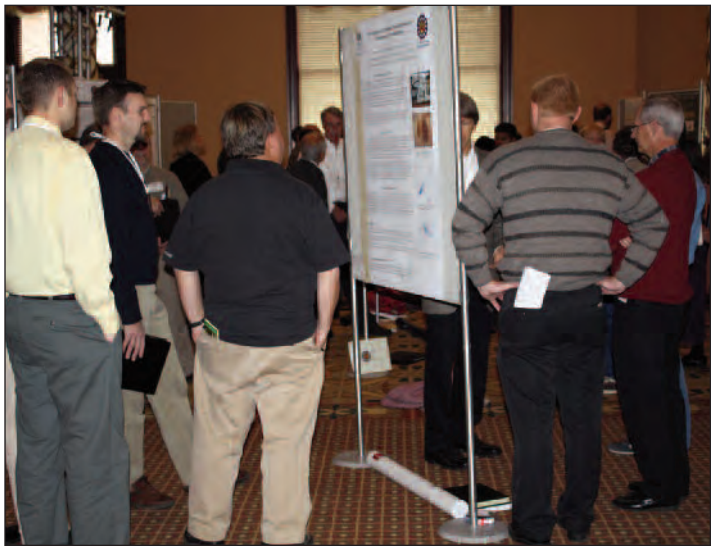
Mennel Milling, headquartered in Fostoria, Ohio, also has mills at Bucyrus, Ohio, Dowagiac, Mich., Mt. Olive, Ill., and Roanoke, Va. ◆

CJ Lin

— 2008 FHB Forum —

Above: NDSU's Marcia McMullen provided an update on the ongoing development of ScabSmart, a web-based tool designed to provide growers and others with the most current best management practices for Fusarium Head Blight (scab). McMullen showed Forum attendees a template of the proposed ScabSmart site. The home page lists the grain class of interest, along with management strategy categories (e.g., varietal resistance, fungicides, rotation, tillage). Each category can then be clicked for more-detailed information. Links to university sites will lead visitors to details on individual wheat or barley varieties. ScabSmart will also provide links to scab forecasting models, along with other relevant information. The site should be operational later this year.

Below: U.S. Wheat & Barley Scab Initiative co-chairs Art Brandli (left) and David Van Sanford pause briefly from their busy schedules during the 2008 National Fusarium Head Blight Forum. Brandli is a producer from Warroad, Minn., and Van Sanford is wheat breeder at the University of Kentucky.



Above: Forum participants spent considerable time reviewing the approximately 100 posters that were presented in Indianapolis. Posters encompassed all of USWBSI's research areas: FHB Management; Pathogen Biology & Genetics; Food Safety, Toxicology & Utilization of Mycotoxin-Contaminated Grain; Gene Discovery & Engineering Resistance; and Variety Development & Host Plant Resistance.

Below: The USWBSI Steering Committee met immediately following the 2008 Forum. Its agenda included presentation and discussion of the FY 2009 budget, reports on focused group discussions held during the Forum, the nomination of Executive Committee members, and additions to commodity-based coordinated projects (CP) committees for 2009.

Diagnostic Markers for Scab Resistance In Soft Red Winter Wheat Cultivar 'Ernie'

By Shuyu Liu, Carl A. Griffey & Anne L. McKendry

Marker-assisted selection (MAS) for Fusarium Head Blight has been used in some wheat breeding programs. It has been successfully applied in the case of *Fhb1* on Chromosome 3BS due to availability of diagnostic markers.

Native resistant sources, such as Ernie, Freedom, Goldfield, IL94-1653, Neuse, Roane and Truman have been used widely in breeding for FHB resistance. But the lack of unique marker alleles among these parental lines for FHB QTL decreases the efficiency and accuracy of MAS for target alleles.

Identification of diagnostic markers for each resistance locus in target sources is critical for successful marker-assisted breeding. Three major QTL for type II scab resistance were mapped onto chromosomes 5A, 3BSc and 4B of Ernie.

A goal of the Small Grain Breeding Group at Virginia Tech is to identify breeder-friendly markers that produce unique alleles for specific resistant sources. Through saturation mapping and marker screening across various sources of scab resistance from China, Europe and America, better unique marker alleles linked to each scab resistance QTL in Ernie were identified. They are: 5A: gwm415 (151 bp), gwm304 (220 bp), wmc705 (133 bp), and barc180 (188 bp); 3BSc: wmc418 (247 or 263 bp), wmc471 (261 bp), gwm285 (246 bp); 4B: gwm495 (146 bp) and gwm149 (167bp).

Some of these markers have been used by the USDA-ARS genotyping center at Raleigh, N.C., to screen lines in uniform and regional wheat nurseries. Our group is using these markers to screen breeding populations having Ernie in their parentage. Other breeding programs can use these markers to tag those QTL if Ernie is in the pedigrees of breeding populations. ◆

Shuyu Liu is research scientist in Small Grains Breeding & Genetics at Virginia Polytechnic Institute & State University. Carl Griffey is professor in the Virginia Tech Crop Soil & Environmental Science Dept. Anne McKendry is associate professor in the University of Missouri Division of Plant Sciences.

Tracking FHB Pathogen in Winter Cereals in New York & Virginia

By Melissa D. Keller & David G. Schmale III, Virginia Polytechnic Institute & State University, and Katrina Waxman & Gary C. Bergstrom, Cornell University

An increased understanding of the contribution of local (within-field) and more distant inoculum sources to Fusarium Head Blight (FHB) of wheat and barley is important for developing and/or improving disease management strategies.

For the past two years, researchers at Cornell University and Virginia Polytechnic Institute & State University have conducted a unique release and recapture study of the FHB pathogen, *Gibberella zeae*. Clonal isolates of the fungus were released in small experimental plots in commercial wheat and barley fields in New York and Virginia. Mature spikes were collected at the inoculum sources and at various distances from those sources.

A molecular technique known as amplified fragment length polymorphisms (AFLPs) was used to genotype isolates recovered from these spikes and to determine the contribution of released isolates to Fusarium Head Blight at various distances from those sources.

Two years of experimentation showed that a minority of the recovered isolates had AFLP profiles that were identical to the released clones, with the majority of the recovered isolates coming from background sources. If local sources of *G. zeae* (*i.e.*, infested residues of corn, wheat or barley) contribute a significant amount of inoculum for FHB, then management of those residues may lead to significant reductions in FHB in those fields. ◆

Below: Melissa Keller collects wheat heads in Virginia above small area sources of inoculum of G. zeae.

Below: Katrina Waxman inoculates a research plot in New York with corn stalk pieces infested with G. zeae.

Upcoming USWBSI Research-Based Planning Meetings

Persons interested in participating in any of these meetings are encouraged to contact the meeting's coordinator.

Spring Wheat Parents Coordinated Project (VDHR-SPR) Planning Meeting

Date: TBA (postponed due to floods in the Fargo area)
Location: Fargo, N.D.
Purpose: Review progress associated with the current SPR-VDHR-CP and make plans for creating another CP proposal to be submitted later this year.
Coordinator: Karl Glover - Karl.Glover@sdstate.edu.

Hard Winter Wheat Coordinated Project (HWW-CP) Planning Meeting

Date: May 4, 2009
Location: Manhattan, Kan.
Purpose: Review the progress for each of the USWBSI-funded research projects and plan for the next two-year cycle of USWBSI funding for the region.
Coordinator: Bill Berzonsky - William.Berzonsky@sdstate.edu.

Barley Coordinated Project (BAR-CP) Planning Meeting

Date: May 27, 2009
Location: St. Paul, Minn.
Purpose: Review progress of the current USWBSI Barley Coordinated Project and begin drafting a two-year proposal.
Coordinator: Kevin Smith - smith376@umn.edu

Forum Proceedings Reminder

The complete proceedings of the 2008 National Fusarium Head Blight Forum are available online. To view and/or download, go to www.scabusa.org.

USWBSI Steering Committee

The above photo of the USWBSI Steering Committee (SC) was taken during its April 2008 meeting in St. Paul, Minn. The SC met as well during the 2008 National FHB Forum, with its next meeting scheduled for May 28 in the Minneapolis area.

The USWBSI Steering Committee exists to ensure comprehensive input from all stakeholders in the scab issue. It seeks to forge consensus strategies for the the scientific, organizational and budgetary aspects of the war on scab. Together, SC members represent all areas of the scab-affected community — including wheat and barley growers, wheat millers, the pasta sector, the malting and brewing industry, crop protection, the seed industry, and public researchers and extension personnel.

For a complete listing of current Steering Committee members, go online to http://www.scabusa.org/comm_steer.html.

Fusarium Laboratory Workshop

The 2009 Fusarium Laboratory Workshop will be held on June 21-26 at Kansas State University, Manhattan.

The workshop will be taught by eight international Fusarium experts. Participants will be introduced to standard morphological, genetic and molecular biological techniques used to identify and characterize strains of Fusarium. They will learn to use morphological characters to identify the most common Fusarium species, how to make tests for vegetative compatibility groups (VCGs) and cross-fertility, and how to extract, PCR amplify DNA, and how to analyze NSA sequences.

More than half the workshop time will be spent in the laboratory, working with standard strains.

For workshop or course information, contact Dr. John Leslie at (785) 532-6176 or email jfl@ksu.edu.

Registration questions should be directed to the KSU Conference Registration Office: (800) 432-8222 or (785) 532-5569. Or, go online to www.plantpath.k-state.edu and click on Fusarium Laboratory Workshop.

Understanding Practical Outcomes

From Implementing Integrated Fusarium Head Blight Management Strategies On Malting Barley in Minnesota

By Charla Hollingsworth, Chris Motteberg & Linnea Skoglund

The objective of this two-year experiment was to determine grain yield and kernel quality benefits from treating four commercially available 6-rowed malting barley cultivars and four advanced 6-rowed malting germplasm lines with different fungicide-based disease management strategies to manage Fusarium Head Blight (FHB).

Specifically, lines in the test represent germplasm with increased resistance to FHB compared with present varieties. Placing the test in a commercial field environment allowed us to determine whether genetic resistance would support increased disease management after a "second generation" fungicide (Prosaro) was used. If sufficient management of FHB could be achieved, successful malt barley production might once again be possible in the Red River Valley.

The 2007 experiment was planted into soybean residue at a test location near Warren, Minn. Four commercially available varieties (Drummond, Legacy, Robust and Tradition) were planted, as well as four barley germplasm entries (Celebration and 6B01-2513 (BARI), M122 (University of Minnesota) and ND20448 (North Dakota State University). All entries were exposed to a fungicide treatment (Table 1) at an early heading crop growth stage.

Likewise, the 2008 experiment tested the same varieties and germplasm entries as before with the same fungicide treatments. Test locations were in commercial field sites near Warren and Mahnomen, Minn. Data from the three experiment years were analyzed together — with one exception. Deoxynivalenol (DON) levels in grain developed sufficiently at only one of the three sites, so DON data from the Mahnomen-08 test location were analyzed singly.

Charla Hollingsworth and Chris Motteberg are extension plant pathologist and plant pathology scientist, respectively, with the University of Minnesota-Crookston. Linnea Skoglund is a plant pathologist formerly with Busch Agricultural Resources, Inc.

Table 1. FHB Disease Management Strategies Tested on Eight 6-rowed Malting Barley / Three Locations / 2007-08.

Trt.	Fungicide product	Active ingredient	Application Rate*
1	Nontreated control	—	—
2	Folicur	tebuconazole	4.0 fl oz/A
3	Prosaro	tebuconazole & prothioconazole	6.5 fl oz/A
4	Prosaro	tebuconazole & prothioconazole	8.2 fl oz/A

**Treatments 2 through 4 included 0.125% Induce, a nonionic surfactant. Fungicide applications were made at early heading.*

— Disease Management —

FHB disease development and associated losses were minimal at our test sites. Disease incidence was significantly less for germplasm entries compared with varieties (P = 0.0096), but differences weren't detected for FHB severity. Similarly, FHB index (= severity x incidence / 100) was higher for variety than germplasm whether fungicide was applied or not. Fungicide application had no effect on yield, with one exception. Varieties responded to a Folicur application (strategy 2), resulting in an increase of 5.81 bu/A (P = 0.0279) over the germplasm entries.

During 2008, DON means ranged from 0.21 to 1.26 ppm at the Mahnomen site. The three germplasm entries (Celebration, ND20448 and M122) had the lowest DON levels, while Legacy had the highest. From this single-site, single-year data set, the no-fungicide control and Folicur treatments were less effective at reducing DON than either Prosaro treatment. When fungicide treatment and entry were analyzed together, however, the Prosaro treatments didn't significantly reduce DON levels in Celebration, ND20448 or M122 when compared with the no-fungicide or Folicur treatments, indicating that resistance level, rather than fungicide application, is key in managing the toxin.

— Overview —

Breeding for FHB resistance in barley is an ongoing effort. Using an integrated disease management approach that includes disease resistance, fungicide application and rotation was investigated in this two-year research effort.

Our results indicate that varietal resistance, rather than fungicide treatment, is most critical for managing FHB. While fungicides appear to benefit barley production in general, the effects were often not statistically significant in low disease years.

— Acknowledgements —

This project was funded, in part, by Busch Agricultural Resources, Inc., and the U.S. Wheat & Barley Scab Initiative. It was supported by NDSU, UM, Bayer CropScience and the UM Mycotoxin Lab. The authors appreciate the support from grower-cooperators Dwight and Cindy Anderson (Warren, Minn.), and Kelly and Perry Skaurud of Skaurud Grain Farms (Gary, Minn.).

This material is based upon work supported by the USDA under Agreement No. 59-0790-8-070. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Opinions, findings, conclusions or recommendations expressed are those of the authors and do not necessarily reflect the view of USDA. ◆

A Government Agency Listens to Grower Logic

(With an Assist from the USWBSI)

By Laird Larson

Note: Laird Larson farms near Clark, S.D. He is a member of the South Dakota Wheat Commission and the U.S. Wheat & Barley Scab Initiative Steering Committee.

In February 2008, while preparing for for another year's crop insurance enrollment by the March 15 deadline, I uncovered a couple discrepancies that would affect many spring wheat producers.

While reviewing the Loss Adjustment Manual for wheat quality issues that have been added over the last few years, I discovered what looked like a typographical error. "Allowable vomitoxin levels" was listed in the table as a *percentage* rather than *parts per million* (ppm). This concerned me, because if interpreted thusly in the rules, we would rarely, if ever, be able to collect for damages — even in a severe outbreak.

I was informed by my insurance agent that it would be helpful if I, rather than the agent, tried to get that changed. With help from Rick Vallery of South Dakota Wheat, Inc., and Daren Coppock of the National Association of Wheat Growers, USDA's Risk Management Agency (RMA) was notified — and the potential problem was corrected to read ppm rather than percentage.

The other concern I discovered had to do with the procedure used in determining vomitoxin levels. The rules clearly stated that samples would need to be collected by RMA representatives from the field or before going into storage. I knew from attending many scab forums that sampling is one of the biggest problems in determining DON levels. We have been told that the more samples drawn, the more accurate the test.

My concern was that a 100-acre field would not be accurately field sampled — and results could be damaging to either the producer or the insurance company. Also, would there be enough manpower to stand by each bin all day, collecting proper samples from each load before going into the bin? This possibly would need to be done even in those years when scab wasn't obvious.

Again, Rick Vallery and Daren Coppock went to work. Also, because of my involvement with the U.S. Wheat & Barley Scab Initiative, I asked co-chairs David Van Sanford and Art Brandli if they would assist in correcting this problem.

After agreeing to help, David sent a letter (signed by Art as well) to RMA, asking for a review of policy and procedures.

Due to the timing (this was taking place in March), it appeared not much was going to get done for the 2008 crop year. So I did what I could to inform producers to be aware of the situation wherein samples would need to be collected *before* wheat goes into the bin.

I am now pleased to report that this past November, sampling procedures were changed to allow samples to be taken from the bins. I believe this matter was corrected because of the letter David Van Sanford sent to RMA, stating the facts and referencing the people who could back up the stated evidence. Though initially the response letter from RMA suggested the change would be difficult, the reputation of the USWBSI came through with another example of the great work and credibility it represents.

Here are just a couple relevant paragraphs from David's letter to RMA:

"If the grain has been dried prior to storage, DON levels will not change during storage. . . . Infected grain that is too wet for proper storage in the first place might be at risk for post-harvest fungal growth in the bin with potential increases in DON concentration. However, the scientific evidence indicates that in wheat grain that has been properly prepared for storage, DON levels will be stable. . . .

"Sampling variation is one of the biggest impediments to accurate estimates of DON in wheat grain, no matter the source of the sample. In fact, USDA-GIPSA has specific recommendations for probe sampling of truck lots of barley and wheat for DON and subsequent cleaning, dividing and grinding of samples. You will find a paper on [the USWBSI] website that summarizes the issues pertaining to sampling for accurate DON estimation.

"The scientific evidence indicates the sampling variation in DON estimates will be lower if grain is sampled from truckloads, endgates or bins rather than in the field. For these reasons, we urge USDA-RMA to adopt protocols that will allow loss adjustors to base their assessments on grain samples taken from trucks at harvest or from bins rather than head samples taken from the field prior to harvest." ◆

Fusarium Focus

Fusarium Focus is an online newsletter published periodically by the U.S. Wheat & Barley Scab Initiative. The USWBSI is a national, multi-disciplinary and multi-institutional research system whose goal is to develop as quickly as possible effective control measures that minimize the threat of Fusarium head blight (scab), including the production of mycotoxins, for the producers, processors and consumers of wheat and barley. Contact information is as follows:

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