



Fusarium Focus

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Producers Receiving Scab Mgmt. Survey

Ultimate Goal: To Better Assist Growers & Buyers of Grain in Reducing Risk of Economic Losses to Scab

More than 16,000 farmers in 17 states are receiving a mailed survey in late February focusing on the adoption — or lack thereof — of best management practices for the control of Fusarium Head Blight (FHB), or scab. The survey is a project of the U.S. Wheat & Barley Scab Initiative (USWBSI), which convened an ad hoc committee to formulate and prioritize its questions of producers. USWBSI then contracted with the USDA's National Agricultural Statistics Service (NASS) to conduct the mailing, perform follow-up phone calls and tally the data. The survey results will be delivered to USWBSI by June 30.

“Despite the development of various powerful tools for scab management, scab outbreaks remain an annual fact of life in the U.S., and it is simply a question of which region(s) of the country will be damaged in any given year,” notes Christina Cowger, North Carolina-based USDA-Agricultural Research Service plant pathologist and organizer of the survey. “Adoption of the full slate of scab management techniques is fragile, uneven and partial — particularly in the soft wheat

region.” The passage of a year or two without significant scab in a region tends to make the issue recede in the minds of producers and crop advisors, she points out, and the degree of adoption correspondingly drifts downward.

“We want to learn how to better help producers and their advisors reduce scab,” Cowger emphasizes.



‘The data will let us know which tools growers are using to manage scab — and what problems they encounter when using those tools.’

“The survey will help us determine to what extent scab management practices are being [utilized] in each of the states — and what are the main barriers to implementing those practices.” Some questions address the size of the farming operation, market class(es) of grains produced and the major varieties grown. Other survey questions deal with the use of forecasting websites, employment of fungicides for disease management and where producers obtain their information about scab management.

The answers will be analyzed at various relevant levels (e.g., nationally, by market class, region, etc.) and will be shared with crop specialists in each of the surveyed states. (All answers are anonymous; there is no identifying information about any respondent.) “The data will let us know which tools growers are using to manage scab — and what problems they encounter when using those tools,” note USWBSI co-chairs David Van Sanford and Art Brandli in an introductory letter to survey recipients. “We can then better assist growers and buyers of grain in reducing the risk of economic losses to scab.”

Producers who do not respond to the mailed survey by March 17 will be contacted by NASS surveyors to arrange for a telephone interview. Again, responses are completely confidential, as required by law, stress Van Sanford and Brandli. The USWBSI co-chairs strongly encourage wheat and barley producers to participate in this special survey, as producers are the ones whom it is intended to ultimately benefit. ❖



— 2013 FHB Forum —

Attendance 165 at 2013 Nat'l Forum

About 165 scientists, growers and wheat and barley industry representatives gathered on December 3-5 for the 2013 National Fusarium Head Blight Forum. The 16th FHB Forum took place at the Hyatt Regency Milwaukee in downtown Milwaukee, Wisc.

The event featured stakeholder and scientific invited speaker presentations, along with focused group discussions and various social venues for attendee interaction. Numerous research posters were on display as well, with primary authors present to discuss the projects and their findings. As an added feature, several graduate students participated in “Flash & Dash” sessions in which they gave mini-oral presentations on research posters they had at the Forum.

The USWBSI Steering Committee met following the Forum adjournment.

Organized and hosted by the U.S. Wheat & Barley Initiative (USWBSI), the annual Forum provides a key venue for reports on the latest research findings on Fusarium Head Blight (scab) and deoxynivalenol (DON), the mycotoxin produced by scab infection in grains.

The following pages contain photos and narrative from several of the invited speaker presentations at the 2013 Forum. Full Proceedings of the Forum are posted on the USWBSI's website, as are PDF copies of the following invited talks:

- *Local Grain and Malt: A Renaissance Being Negatively Impacted by DON* / Andrea Stanley, Valley Malt, Hadley, Mass.

- *Fusarium Head Blight in South America: An Argentinian Perspective of Breeding for Resistance and Future Prospects* / Virginia Verges, Don Mario Semillas, Chacabuco, Buenos Aires



2013 FHB Forum Photo Credits: Dave Hane

Above: Attendees at the 2013 FHB Forum represented a variety of scientific disciplines and commercial entities, from USDA and university research and extension personnel, to grain growers and agribusiness. Also present were a number of graduate students whose research projects involved FHB and/or DON.

Province, Argentina.

- *Lifelong Learning: What We Have Learned Breeding for Scab Resistance* / P. Stephen Baenziger, University of Nebraska-Lincoln.

- *University-Industry Collaborations: Potential Ways to Work Together to Further Scab Resistance*

Research / William Berzonsky, Bayer CropScience, Lincoln, Neb.

- *11,000 Phenotypes for Fusarium graminearum* / Yin-Won Lee, Center for Fungal Pathogenesis, Seoul National University, Korea

- *Saying Good-Bye to Gibberella zeae* / John Leslie, Kansas State University, Manhattan.

- *DON Induces Genes That Increase Wheat Susceptibility to Fusarium Head Blight in Wheat* / Therese Ouellet, Agriculture and Agri-Food Canada, Ottawa, Ont.

- *Targeting Host Defense and Susceptibility Mechanism for Engineering FHB Resistance* / Jyoti Shah, University of North Texas, Denton, Texas.

- *Local Corn Debris Management: What Does It Contribute to Head Blight and Mycotoxin Reduction?* / Gary Bergstrom, Cornell University, Ithaca, N.Y.

Mark Your Calendar!
2014 National Fusarium Head Blight Forum
December 7-9
Hyatt Regency St. Louis
At the Arch
St. Louis, Mo.



— 2013 FHB Forum —

Andrea Stanley, co-owner with her husband, Christian, of Valley Malt of Hadley, Mass., was a keynote speaker at the 2013 FHB National Forum. The title of her presentation was “Local Grain and Malt: A Renaissance Being Negatively Impacted by DON.”

Stanley explained that the micro-malting sector has grown significantly in the past few years, with much of this growth being spurred by burgeoning demand for craft beer made from local ingredients. “Within the next five years, dozens of craft maltsters will be opening up shop all over North America, trying to meet the consumer demand for more locally sourced ingredients,” Stanley stated.

In 2013, a group of eight micro-maltsters from several states formed the Craft Maltster’s Guild. Its mission is to promote and educate the general public about the tradition of craft malting in North America, to provide educational opportunities for its members, and to improve and uphold the highest quality and safety standards for craft malt.

Craft Maltster’s Guild members are based, however, in parts of North



America where Fusarium and DON levels in grain are a major concern – places such as New England, North Carolina, Quebec, Pennsylvania and Michigan. “For all the challenges we face, the largest is finding a reliable source of quality grains,” Stanley observed. “Good malt starts in the field. [But] for many of us, finding the correct varieties to grow in our region is a huge hurdle.” Since there are no FHB-resistant barley or wheat vari-

eties bred specifically for the New England region, for example, planting seed is brought in from other regions of the country. Still, Fusarium “is the number-one reason why we reject an otherwise suitable lot of grain,” Stanley reported. “We have seen DON levels over 8.0 ppm, and many times these numbers discourage farmers from trying to grow grains again.”

For craft maltsters in regions like New England, adequate management of FHB and DON will require a holistic approach, Stanley advised – one that includes regional development of resistant varieties, improvements in the malting equipment and techniques employed, legislation favorable to the industry – and better education of both the farmer and craft maltster. “With all of the positive goodwill going into these emerging grain and malt industries, we cannot forget that all of it could be dampened out by the threat of DON,” Stanley said. Funding for the researching of resistant varieties and improved cultural practices is a critical component for the continued health and growth of the craft malting sector, she concluded. ❖



“Innovation and Impact” — USWBSI co-chair Dave Van Sanford encouraged attendees to keep these words in mind. Though the FHB Forum is largely a scientific meeting, “We always have to remember the stakeholder,” Van Sanford reminded participants.

Bob Brunick, barley breeder with MillerCoors at Burley, Idaho, spoke to the topic “Breeding Malting Barley for the West: What About Fusarium?” He noted that western states have been among the last significant U.S. grain growing regions to be impacted by Fusarium Head Blight — one key reason being the arid climate. But the situation is beginning to change in concert with the expanded use of center-pivot irrigation among the region’s producers, and a number of local elevators now view this disease with increasing concern.

“Breeders in the West need to get started breeding for FHB resistance if they have not already,” Brunick emphasized. He has initiated a disease screening program and is intro-



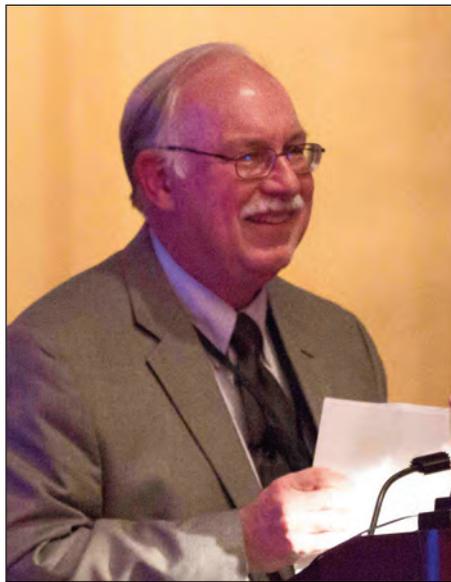
gressing resistant alleles coming out of the University of Minnesota barley program. ❖



— 2013 FHB Forum —

“Lifelong Learning: What We Have Learned Breeding For Scab Tolerance” was the subject of **P. Stephen Baenziger**’s presentation at the 2013 National FHB Forum. Baenziger is winter wheat breeder and professor at the University of Nebraska-Lincoln.

After outlining the nature of the problem (*i.e.*, FHB and DON), Baenziger noted that Great Plains winter wheat breeding programs have developed and released several lines with superior FHB tolerance – lines such as Lyman, Overland, Art, Hitch and Everest, all based on native resistance. “Building upon this native resistance, hundreds of crosses have been made to putative native resistance germplasm sources from other regions,” the Nebraska wheat breeder pointed out. However, “few of these cross have led to new cultivars.” One reason why, he said, may be the length of time (up to 12 years) required to release a new cultivar. But “a more likely reason for the low success rate is that the germplasm was too diverse (hard to find and use of minor genes)



in crosses and that our field assays were unable to separate small differences in segregating populations.”

The situation calls for a new approach, Baenziger stated, including backcrossing derived lines of Wesley *Fhb1*. These lines “have been used extensively as parents, and their prog-

eny are advancing through our selection process at a much higher rate than lines from unadapted native resistance sources,” he reported. “Furthermore, new backcrossing efforts are underway to put *Fhb1* into backgrounds like Overland that have native resistance in hopes the QTL and native resistance can be combined.”

Looking ahead, the goal remains that of developing and releasing agronomically exceptional winter wheat varieties with strong FHB resistance. Such cultivars will be, Baenziger emphasized, the result of extensive public and private collaboration on a regional basis, not just within individual states. The continued support of the U.S. Wheat & Barley Scab Initiative will remain essential in this endeavor, he added.

“Finally, we recognize that genetics can only take you so far,” the Nebraskan concluded. “A robust fungicide and crop management program is necessary to meet our goals of low-DON whole grain flour.” ❖



Left: The traditional poster sessions once again were a popular venue at the National FHB Forum. A total of 58 posters were available for attendees to review at various times during the 2013 Forum, with most authors present for questions and discussion.

There were 14 posters presented within the Gene Discovery and Engineering Resistance research area; four under the Pathogen Biology and Genetics area; 11 in FHB Management; 26 under Variety Development and Host Resistance; and three posters under Food Safety, Toxicology and Utilization.

Seventeen of the graduate students presenting posters also orally summarized their research projects in two “Flash & Dash” sessions before the general Forum audience.



— 2013 FHB Forum —

The importance of university-industry collaboration to help advance scab resistance research was the focus of **William (Bill) Berzonsky's** presentation at the December FHB Forum in Milwaukee. Berzonsky, formerly a spring wheat breeder at North Dakota State University as well as a winter wheat breeder at South Dakota State University, is now senior wheat breeder with Bayer CropScience, based at Lincoln, Neb.

“State and federal funding in the U.S. for research into host plant resistance to scab is often limited due to budget constraints, changing budget priorities and ever-increasing competition for state and federal funding,” Berzonsky noted. “An excellent way to address this problem is through the formation of university-industry collaborations that leverage existing funding as well as the shared resources that are expected to be available through such collaborations.” Berzonsky highlighted several



examples of areas where such collaboration can pay dividends:

- Educating and training the next generation of geneticists, breeders and pathologists to conduct scab research.
- Identifying new host plant resistance genes.

- Defining host genetic resistance mechanisms, host-pathogen interactions and disease epidemiology.

- Cloning host plant resistance genes and developing acceptable and safe transgenic approaches to host plant resistance.

- Optimizing genetic and fungicide management practices.

- Limiting the production of grain toxins to safeguard the U.S. food and feed supply.

“Fusarium Head Blight demands a concerted and combined private-public research effort,” Berzonsky stressed. Existing programs – such as the former NIFA Planting Breeding and Education Program, the National Science Foundation Industry-University Cooperative Research Center Program, and already-operational individual university-industry student fellowship and internship programs – can serve as models for furthering future scab research through collaboration, he added. ❖

H. Corby Kistler, research geneticist with the USDA-ARS Cereal Disease Laboratory in St. Paul, Minn., provided the Milwaukee National FHB Forum audience with an update on his lab’s research into “How the Fusarium Toxin DON is Made and Delivered to Plants.”

“Previous studies have shown that the [Fusarium] fungus is remarkably adapted for producing DON by precisely regulating the genes for its synthesis in order to promote toxin accumulation in the host plants,” Kistler noted.

“We have now found, by labeling proteins for toxin synthesis with fluorescent proteins, that these proteins are directed to subcellular ‘toxin factories’ – small vesicles called ‘toxosomes’ that appear to serve as the staging area for the toxin biosynthetic assembly line.”

When cell culture conditions are changed in order to promote toxin biosynthesis, “another pathway supplying precursor molecules for toxin



synthesis may be shifted within the cell to toxosomes,” thus streamlining the path to toxin synthesis, Kistler pointed out. “By making toxin in a confined vesicle within the cell, the fungus may protect itself from the inhibitory effects of its own toxin,” he continued, “and may allow for an efficient way to deliver it to the plant.”

This recent research establishes, concluded the ARS geneticist, that “toxin synthesis requires a complex developmental event in the fungus which ultimately determines the outcome of plant infection and plant health.” ❖



— 2013 FHB Forum —

Ian Nichols, founder and president of Weather INnovations Consulting (WIN), a Chatham, Ontario-based provider of turnkey online programs in climate and environmental monitoring and modeling. Nichols presented an overview of his company's efforts to provide agricultural producers with FHB advisories. WIN currently offers the DONcast® model in Ontario as well as DONcast® Europe.

WIN's website for Ontario grain growers (WeatherCentral.ca) offers site-specific weather forecasts, disease and insect risk advisories, growth stage models – and tools targeted at Fusarium-related issues. The DONcast model predicts deoxynivalenol toxin concentration in wheat at



harvest during the heading stage as a means of assisting growers with fungi-

cide application decisions. The model examines observed, forecasted and historical weather data, along with field-specific agronomic data, updating predictions on a daily basis through to harvest time.

WIN develops tools like DONcast through research and development collaborations with industry, universities and other stakeholders. One variation of the DONcast model, for instance, has been calibrated for European conditions with support from Bayer CropScience. "WIN's European modeling activity includes forecasts of several major Fusarium species," Nichols remarked, "which helps refine the prediction of mycotoxin contamination in wheat." ❖



Above Left: John Leslie, Kansas State University, addresses "Saying Good-Bye to Gibberella zea."

Left: USWBSI co-chair Art Brandli delivers closing remarks as the 2013 Forum concludes.

Above Right: Several Focused Group Discussions provided excellent venues for discussion on current research and future FHB and DON needs and priorities.

Right: Jyoti Shah, University of North Texas, speaks on "Targeting Host Defense and Susceptibility Mechanisms for Engineering FHB Resistance."



Hard Winter Wheat Scab Nurseries — 2006 to the Present —

By W. W. Bockus, P. S. Baenziger, W. Berzonsky, M. Caffè, M. A. Davis,
A. K. Fritz, G. Marais, J. Ransom, S. N. Wegulo, G. Zhang

The Hard Winter Wheat Fusarium Head Blight (FHB) field nurseries are currently in their ninth year, having begun in the 2005-06 winter wheat season. The public wheat breeding



programs from four states (Kansas, Nebraska, South Dakota and North Dakota) are involved.

Each state is allowed 15 entries, and three common “check” cultivars are included. These entries are planted in replicated nurseries at one location per state using the disease phenotyping protocols adopted by that state.

In addition to disease ratings, grain from entries is evaluated for percentage Fusarium damaged kernels and amount of deoxynivalenol (DON). The Veterinary Diagnostic Lab at North Dakota State University performs the DON analyses.

Data are published (e.g., Bockus et al., 2013) and shared electronically with all participants, and the breeders

Left: Typical field nursery for testing wheat breeding lines for reaction to Fusarium Head Blight. Each short row is a different wheat entry.

Below: Winter wheat cultivar showing resistance to Fusarium Head Blight (left), compared to a susceptible variety (right).



Photos: W. Bockus

can use them to make selections.

These nurseries have had a profound impact on the region. As one example, the cultivar Everest was released by the Kansas Agricultural Experiment Station in 2009 and is now the number-one cultivar in Kansas. One of the main reasons it was advanced and recommended for release was its improved resistance to FHB. Without the nurseries, that desirable trait would not have been known. The adoption of Everest has significantly reduced the vulnerability of the Kansas wheat crop to FHB. Similar success stories (e.g., cultivars Overland and Lyman) could be highlighted for the other states.

Due to the importance of FHB resistance to the region and the desire to involve all regional breeding programs, a sister nursery was begun in the 2009-10 season to include entries from private breeding companies. Each company is allowed 15 entries, and similar data as described above are collected. Because at least one important wheat-breeding company in the region could not participate without a Material Transfer Agreement (MTA), such an agreement was recently developed and is being implemented. This is a “test only” MTA modelled after those that are already in use for other regional wheat testing nurseries.

In summary, the Hard Winter Wheat FHB nurseries, funded by the U.S. Wheat and Barley Scab Initiative, have provided valuable data for public and private wheat breeders in the region and are showing important benefits in reducing the susceptibility of hard winter wheat cultivars to FHB and DON. Without the Initiative, that progress would not have happened. ❖

Bockus, W. W., Zhang, G., Fritz, A., Davis, M., Baenziger, P., and Berzonsky, W. 2013. Reaction of Kansas, Nebraska, and South Dakota winter wheat accessions to Fusarium head blight (FHB), 2012. (online) Plant Disease Management Reports 7:CF019. DOI:10.1094/PDMR07. The American Phytopathological Society, St. Paul, MN.



Upcoming Meetings

2014 Master Brewers Association of the Americas Annual Conference

June 5-7
Palmer House / Chicago, Ill.
www.mbaa.com/meetings

21st Triennial North American Barley Researchers Workshop

June 29 - July 2
University of Minnesota / St. Paul
<http://www.nabrw.umn.edu>

American Phytopathological Society / Canadian Phytopathological Society Joint Meeting

August 9-13
Minneapolis Convention Center
www.apsnet.org/meetings

2014 National Fusarium Head Blight Forum

December 7-9
Hyatt Regency St. Louis at the Arch
St. Louis, Mo.
www.scabusa.org



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 producers, processors and consumers of wheat and barley. Contact information is as follows:

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Impact of FHB Prediction Tools, 2009-13

The following summary was presented as a poster at the 2013 National FHB Forum. Lead author is Erick De Wolf, plant pathologist with Kansas State University, Manhattan.

A multi-state effort to predict epidemics of Fusarium Head Blight (FHB) continued during the 2009-13 growing seasons. This prediction effort includes web-based tools that display daily estimates of disease risk for 30 states. Commentary developed by a disease specialist in each state covered by the tool is displayed along with the risk maps. Commentary is also distributed via an FHB Alert System that sends email and text messages to mobile devices.

The prediction tools received 20,883 visits (122,000 hits) during the 2013 growing season in the U.S. (April-August). Nearly all of the wheat disease specialists in the 30 states covered by the disease prediction system contributed commentary to the disease prediction effort. A total of 126 commentaries were submitted in 2013. The FHB Alert System sent commentary to just under 1,000 subscribers in 2013.

Users of the FHB prediction models and the FHB Alert System were sur-

veyed annually in 2009-12. The survey results included input from 1,828 respondents and indicated that 64% of these users were either farmers or farm advisors. More than 70% of the users applied the information directly on their farm, or used it to make recommendations to others about disease management. In 2009-12, 95% of the users considered the information to be of high or moderate value for their farm operations and businesses.

A subset of questions targeting the influence of the information suggests that more than 90% of the users experienced moderate or great improvement in their awareness of the disease risk in their area. The results also showed that the information influenced disease management decisions directly for 35% of the respondents, and motivated another 28% to seek advice from others.

The 2012 survey asked growers to estimate the monetary value of the information provided to their farm or business. This survey indicates that the average monetary value of the information provided by the prediction system was \$17,000 per user. Combining this figure with use statistics suggests that annual impact of the FHB prediction model exceeds \$170 million. ❖

Recent Scab-Related Peer-Reviewed Publications

- Berger, G., Green, A., Khatibi, P.A., Brooks, W.S., Rosso, L., Liu, S., Chao, S., Griffey, C.A., and Schmale, D.G. 2014. Characterization of Fusarium head blight resistance and deoxynivalenol accumulation in hulled and hullless winter barley. *Plant Disease*. Accepted, October 2013. First Look. <http://apsjournals.apsnet.org/doi/abs/10.1094/PDI-S-05-13-0479-RE>
- Clark, A.J., Costa, J.M., Griffey, C.A., Brown-Guedira, G.L., Dong, Y., Souza, E.J., Murphy, J.P., and Van Sanford, D.A. Registration of Scab-Resistant KY06C-11-3-10 in Soft Red Winter Wheat Germplasm. *Journal of Plant Registrations*, In Press.
- Hernandez Nopsa, J. F., Wegulo, S. N., Panthi, A., Hallen-Adams, H. E., Harris, S. D., and Baenziger, P. S. 2014. Characterization of Nebraska isolates of Fusarium graminearum causing head blight of wheat. *Crop Sci.* 54:310-317.
- Navara, S., and Smith, K.P., 2014. Using near-isogenic barley lines to validate deoxynivalenol (DON) QTL previously identified through association analysis. *Theor Appl Genet*, DOI 10.1007/s00122-013-2247-x.
- Prussin, A.J., Ross, S.D., and Schmale, D.G. 2014. Monitoring the long distance transport of Fusarium graminearum from field-scale sources of inoculum. *Plant Disease*. Accepted, October 2013. First Look. <http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-06-13-0664-RE>
- Prussin, A.J., Szanyi, N.A., Welling, P.I., Ross, S.D., and Schmale, D.G. 2014. Estimating the Production and Release of Ascospores from a Field-scale Source of Fusarium graminearum Inoculum. *Plant Disease*. Accepted, October 2013. First Look. <http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-04-13-0404-RE>

