USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
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Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-8-071
USDA-ARS Agreement Title:	Management and Resistance Sources for Control of FHB in Barley.
FY08 USDA-ARS Award Amount:	$ 80,991

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
BAR-CP	Understanding the Mechanisms Involved in Poor Control of FHB by Fungicides in Barley.	$27,503
BAR-CP	Screening Advanced Breeding Lines for Scab Resistance Region Uniform Nurseries.	$ 14,520
BAR-CP	Transformation and Field Testing of Transgenic Barley Lines.	$ 2,906
BAR-CP	Development and Validation of FHB and DON Prediction Models for Barley.	$ 6,829
BAR-CP	Screening Hordeum Germplasm for Resistance to Fusarium Head Blight and DON Accumulation.	$ 29,233
	Total Award Amount	**$ 80,991**

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Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Understanding the Mechanisms Involved in Poor Control of FHB by Fungicides in Barley.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?** Improvement in FHB control in barley with fungicides is needed. Barley has a long window of susceptibility to FHB infection (head emergence until hard dough), and many barley head morphological characteristics may interfere with fungicide deposition, such as head angle and awns. Optimum deposition is needed for optimum control. Two factors were studies to determine if fungicide control could be enhanced: head angle and types of adjuvants. Head angle may interfere with fungicide deposition. Three head angles were studied: normal, slightly drooping head angle, a horizontal head, and a completely vertical head. Head angles were maintained using wire flags. Adjuvants studied included Induce, Preference, Interlock, Inplace, Syltac and Silken; adjuvants varying in compositions that may affect penetration, deposition, and retention of the fungicide. Prosaro fungicide was applied with varying adjuvants to varying head angles, at 75% head emergence – to two varieties, Robust (6-rowed) and Conlon (2-rowed). Plots were not misted and no inoculum was added. FHB incidence, severity and DON disease parameters were measured.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment: Fungicide treatments plus adjuvants significantly reduced disease parameters compared to the untreated, but no differences were observed among adjuvants. Head angle did impact control with fungicides, with FHB incidence and severity significantly higher with horizontal and vertical heads, than normal, slightly drooping barley heads. A greenhouse study with head angles also showed that fungicides were most effective on normal angled barley heads, with FHB severity highest on heads held at a horizontal angle, followed by vertical heads, and lowest with normal head angles.

   Differences in disease levels were observed between Robust and Conlon with all treatments, with Robust having significantly higher FHB incidence, severity and DON.

   Impact: Fungicide sprays should be applied at normal head angles, angles which occur during the early part of full head emergence. Once heads become heavy with grain and more horizontal in their angle profile, fungicide protection will be less effective, even though barley can accumulate DON up to almost maturity (most pre-harvest intervals associated with fungicides also preclude this later application). Adjuvants performed similarly with Prosaro, so type of adjuvant used is not as important as using a good fungicide in conjunction with a good adjuvant.

Project 2: *Screening Advanced Breeding Lines for Scab Resistance Region Uniform Nurseries.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   The objective of this project is to coordinate the disease screening of elite barley germplasm in uniform FHB nurseries in North America. Advanced barley lines with FHB resistance were tested in mist-irrigated sites, as well as under normal rainfall conditions. Mist-irrigated nurseries also were artificially inoculated with *Fusarium graminearum* spores. The series of FHB screening nurseries in this project has been done for more than 10 years, and currently is known as the N. American Scab Evaluation Nursery (NABSEN). In 2008, ND had four locations for this nursery – Fargo, Langdon, Osnabrock and Casselton. Other locations included St. Paul and Crookston, MN, Brandon, Manitoba, and Hangzhou, China. In ND, the Casselton and Osnabrock sites were unmisted, while the Fargo and Langdon sites were misted. The nurseries included breeding lines with putative FHB resistance from NDSU 2-rowed and 6-rowed lines, and lines from the Univ. of Minnesota, Busch Ag, and Agriculture and Agri-Food Canada. FHB parameters, DON, and agronomic factors are recorded.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment: The nursery contained 50 lines, including 6 resistant and susceptible controls. FHB severity was very low at the Casselton, ND site, but all other sites had adequate to good development of FHB to distinguish relative levels of FHB resistance in the breeding programs. The inoculated, misted sites had higher FHB levels than the dryland, Osnabrock site.

   When averaged over all sites, including those outside of ND, two lines from the Univ. of Minnesota displayed the best resistance, although not as high as seen in Chevron, the resistant 6-rowed check. Two lines from the 2-rowed material from Canada has the lowest FHB levels among two row lines tested, but still slightly higher than the resistant 2-rwoed check, CI4196. NDSU had two lines with the lowest DON accumulation, lower than the resistant checks.

   Impact: Significant progress is being made toward developing FHB resistant barley cultivars. All North American barley breeders have access to the data collected in this project. The breeders are able to use the relative performance data to make decisions about continuing or dropping particular breeding lines. Breeders now have: 1) tests of the resistance stability of their breeding lines across a range of environments and disease pressures; 2) a measure of the resistance in their advanced lines compared to those of the other barley breeders in North America and CIMMYT/ICARDA; and 3) access to unique germplasm with resistance to FHB and DON accumulation.

Project 3: *Transformation and Field Testing of Transgenic Barley Lines.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Existing, commercially accepted barley lines are very susceptible to FHB and DON accumulation. Progress has recently been made in breeding programs, but these lines must be approved for malting quality. Also, DON accumulation may still be above acceptable industry standards in these new lines, if an epidemic should occur. Transgenic barley lines are being examined to determine if they may offer new avenues for incorporating resistance and also better levels of resistance and better reduction in DON than can be achieved with conventional breeding programs.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment: The NDSU barley pathology program is cooperating with Dr. Lynn Dahleen from the USDA-ARS facility in Fargo, to field screen transgenic materials she has developed. The NDSU barley pathology project planted the material, applied corn based inoculum, set up the misting system and maintained the nursery, all in Langdon, ND. Dr. Dahleen does the disease scoring and grain harvesting. See Dr. Dahleen's project report for the accomplishments she has achieved with this project.

   Impact: Please see Dr. Dahleen's report on this project.

Project 4: *Development and Validation of FHB and DON Prediction Models for Barley.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   A prediction model for forecasting the risk of FHB in barley is needed. The wheat FHB prediction model was based on disease occurrence in wheat in correlation with environmental factors associated with disease levels in wheat. Barley risk factors and duration of risk may be different than wheat. Jeff Stein at South Dakota State University is coordinating a multi-state effort to look at weather and cropping system parameters that affect FHB development in barley. NDSU recorded disease and environmental parameters for 4 barley lines (Tradition, Robust, M122, and Conlon 2 row) across 5 locations. Disease and environmental data was collected for these lines across all sites; environmental conditions were natural - not misted or inoculated. Weather data was collected from nearby NDAWN weather stations.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment: Disease and weather data were collected from Langdon, Minot, Carrington, Dazey, and Fargo, ND – locations representing different environments, soil types and cropping systems. Information collected were: heading date, FHB incidence and severity, and DON accumulation in harvested samples. Weather conditions were generally dry at the five locations in 2008, and disease severity averaged less than 1% and DON levels ranged from 001 to 0.4 ppm. Data on disease severities, DON, and environment were sent to South Dakota State to be included in their data set.

   Impact: This information will help researchers develop a prediction model for barley, similar to that developed for wheat. Producers and crop advisors will then be able to use this information to make informed decisions on fungicide use for a range of susceptibility of barley varieties.

Project 5: *Screening Hordeum Germplasm for Resistance to Fusarium Head Blight and DON Accumulation.*

1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?

Resistance to FHB in barley currently relies on a few original sources of resistance, and comprehensive screening of the US barley germplasm collection and collections from the Dutch center for genetic resources have found only a few potentially new resistance sources. Additional sources of resistance need to be identified and exploited as soon as possible. This project uses an accelerated screening of diverse *Hordeum* germplasm from yet unscreened gene bank collections, screening in replicated experiments at several location in North America.

To achieve this goal, 550 lines in 2007, and 405 lines in 2008 were screened in irrigated and inoculated nurseries at Fargo and Langdon, ND, two areas that are climatically and geographically different. Experimental units in these nurseries consisted of single, short rows, and arranged in an augmented block design. Checks were Stander (FHB susceptible 6-rowed cultivar), Chevron (FHB resistant 6-rowed cultivar), Conlon (FHB susceptible 2-rowed cultivar), and CIho 4196 (FHB resistant 2-rowed accession), as well as IBC11809 and PI38393. Checks were sown every 50 entries. Entries were inoculated using two applications of grain spawn, once before head emergence and once prior to early dough. FHB severity was determined at the mid-dough stage on 20 spikes per row. Entries were scored for flowering date, height, and other important agronomic characteristics. DON analysis was done on harvested grain.

2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):

Accomplishment: Disease pressure at Langdon was very high in 2008, and only one line of the 405 lines tested had a rating comparable to the resistant checks of CI4196 and Chevron. At Fargo, severity levels were more moderate, and 82 of the 405 lines had a rating comparable to the resistant checks. Thirteen lines were selected as having the lowest FHB symptoms and they were harvested from Fargo and tested for DON accumulation. The 13 best lines had a mean DON level of 5.5 ppm, with a range of 0.3 to 13.2 ppm. The resistant check Chevron had a mean DON of 3.0 ppm, while CI4196 had a mean DON of 6.0 ppm. The susceptible check Stander had a mean of 13.0 ppm, while IBC11809 had a mean of 10 ppm.

Impact: Experimental material has been identified that have FHB and DON levels similar to that found in the current resistant checks. Those lines will now be tested in multiple filed sites to ensure their resistance over different environmental conditions, and under a range of disease pressures. Once these lines are proven to be stable across environments, they will be

moved into the next stage of genotyping, to ensure that they are unique and crossed to breeding lines adapted to the upper Midwest.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Bondalapati, K.K., Stein, J.M., Osborne, L.E., and Neate, S.M. 2008. "Modeling Fusarium Head Blight and DON in Barley." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. p. 10.

Bregitzer, P., Dahleen, L.S., Neate, S., Schwarz, P., and Manoharan, M. 2008. "A Single Backcross Effectively Eliminates Agronomic and Quality Alterations Caused by Somaclonal Variation in Transgenci Barley. Crop Science 48: 471-476.

Dahleen, L.S., Dill-Macky, R., and Neate, S.M. 2008. "2008 FHB Analysis of Transgenic Barley Lines." In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. p. 106.

Gross, P.L. and Neate, S.M. 2008. "Evaluation of Split Applications of Folicur and JAU6476 for control of Scab and DON on Barley. Proc. of American Soc. of Agronomy Meeting, Houston, TX, Oct. 5-9, 2008. p. 266.

Gross, P.L. and Neate, S.M. 2009. "Evaluation of Swathing vs Combined Plots for Scab Control in Barley at Fargo, ND 2007." Poster to be presented at National American Phytopathological Society meeting in Portland, OR, Aug. 1-4, 2009.

McMullen, M., Zhong, S., and Neate, S. 2008. Fusarium Head Blight (scab) of Small Grains. NDSU Extension Circular PP-804 (revised). 4 p.

Neate, S.M., Gross, P.L., Horsley, R.D., Smith, K.P., Cooper, D.B., Skoglund, L.G., and Zhang, B. "Seven Years of Progress in the North American Barley Scab Evaluation Nursery (NABSEN). In: Canty, S.M., E. Walton, A. Clark, D. Ellis, J. Mundell, and D. Van Sanford. Proc. of 2008 National Fusarium Head Blight Forum. Dec. 2-4, 2008. Indianapolis, IN. Lexington, KY: University of Kentucky. p. 190.

If your FY08 USDA-ARS Grant contained a VDHR-related project, include below a list all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert 'Not Applicable' below.

Not applicable.