USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
July 15, 2009

Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-4-107
USDA-ARS Agreement Title:	FHB Epidemiology on Spring Wheat in South Dakota.
FY08 USDA-ARS Award Amount:	$ 71,276

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
MGMT	The Targeting of Residues as a Management Strategy for FHB of Wheat and Barley.	$12,013
BAR-CP	Development and Validation of FHB and DON Prediction Models for Barley.	$ 36,365
MGMT	Incorporating Infection Cycle Components into FHB and DON Prediction Models.	$ 22,898
	Total Award Amount	**$ 71,276**

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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: *The Targeting of Residues as a Management Strategy for FHB of Wheat and Barley.*

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

Fusarium head blight (FHB) continues to be a serious problem in the U.S. and Canada. The most effective management of this disease occurs when an integrated approach is taken that combines a resistant variety, appropriately timed fungicide application, and residue management practices that limit fungal survival and/or inoculum production. The first two strategies have been investigated thoroughly and many producers now have partially resistant varieties and moderately effective fungicides available as management tools. In contrast, residue management has essentially been limited to rotational and/or tillage practices and if additional practices were available, the frequency and severity of FHB epidemics and/or deoxynivalenol (DON) contamination in grain might be effectively reduced. The objectives of this project were to evaluate the effects of physical, biological, and chemical treatments on colonization of cereal residues by microorganisms (including *Gibberella zeae*), FHB severity, and DON.

To address these objectives we planted spring wheat into plots containing maize residue that had been left to over-winter after a standard harvest, shredded further, or incorporated into the soil. A biocontrol agent, fungicide, or microbe-facilitating substance was applied to the each residue treatment, with most applications occurring in the fall. The wheat was un-inoculated, disease severity rated 18 days after flowering, and DON concentration in the grain measured for individual plots. We also conducted assays designed to determine the activity of saprophytic microbes in the residue. These organisms are potential antagonists to *G. zeae* and could impact sporulation and infection.

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:

Unfortunately for this project, the environmental conditions leading up to, and during, the period of heading in 2008 were highly unfavorable for spore production and infection by *G. zeae*. We had essentially no precipitation between early June and late July in Brookings and this negatively impacted our ability to compare both the residue processing and biological treatments. Similarly, the soil and surface residues in field plots were very dry and CO_2 emissions were detected but quite low, making it impossible to compare treatments. When whole residue samples were processed in the lab using FDA hydrolysis, no significant differences were found between treatments, indicating that they all had the same level of saprophytic activity.

Impact:

To date, this project has not identified any additional strategies for impacting the survival of *G. zeae* in residue.

Project 2: *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?

Fusarium head blight (FHB) of barley continues to be a serious problem for producers in the Northern Great Plains. Barley production in the Dakotas and Minnesota has declined steadily since the early 1990's and this can be attributed to, at least in part, the re-emergence of *Fusarium* head blight. Of particular importance to barley production is the accumulation of deoxynivalenol (DON) in the grain. Models exist for predicting disease development in wheat, however they are not effective for barley. We are addressing this issue by attempting to develop models for eventual incorporation into forecasting systems that can predict disease and/or DON accumulation for barley. Such a system would offer producers the information required to make effective management decisions.

The objectives of the proposed research were to 1) contribute to the development of an experimental database containing information on cultural practices, weather, and resulting field disease and mycotoxin levels for barley and 2) conduct variable exploration and model development for FHB and DON accumulation in barley. Objective 1 was conducted in collaboration with researchers at North Dakota State University and the University of Minnesota. Plots were planted at 12 locations throughout the region and the environment monitored at each location during the growing season. Field ratings of disease were taken and DON concentration in the grain was quantified. For Objective 2, approximately 100 variables, both simple and complex, were generated using environmental parameters that are known to impact the biology of this pathosystem (temperature, relative humidity, etc). Correlation analysis and univariate logistic regressions were then conducted on the combined 2005-8 data sets to determine which, if any, of these factors were potentially predictive with field disease or DON content in the grain. Three models were developed from the best variables and are being tested in the 2009-growing season.

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 most significant accomplishment of this project was the identification of ~30 variables that were predictive of economically important DON accumulation in barley grain. From these, three models were identified that were highly predictive and worthy of being validated using 2009 field data.

Impact:
To date, this effort has not directly impacted barley producers in the region. However, a future impact is expected following model development in 2010.

Project 3: *Incorporating Infection Cycle Components into FHB and DON Prediction Models.*

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

   Fusarium head blight (FHB) continues to be a serious problem in the U.S. and Canada. The most effective management of this disease occurs when an integrated approach is taken that combines a resistant variety, appropriately timed fungicide application, and the management of in-field inoculum. Previous research funded by the U.S. Wheat and Barley Scab Initiative has resulted in the development of predictive models for wheat that target infection at a specific time point in the crop developmental stage (i.e. early flowering) using weather data collected over the previous 7 days. Unfortunately, this system has several limitations and does not model deoxynivalenol (DON) accumulation in the grain. Thus, the objectives of this project were to: 1) improve the accuracy of empirical models for FHB by adding variables describing the impact of variety resistance and local sources of inoculum on the risk of disease epidemics in winter wheat and (2) continue the development of mechanistic models of FHB epidemics and DON accumulation by incorporating model components. Specifically, we examined the interaction of variety and inoculum level on disease development and DON accumulation under varying environmental conditions.

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:
   Unfortunately for this project, the environmental conditions leading up to, and during, the period of heading in 2008 were highly unfavorable for infection by *G. zeae*. We had essentially no precipitation between early June and late July in Brookings and this negatively impacted our ability to compare the interaction between varietal resistance, timing of infection, and environment. That stated, the early (or optimal) inoculation timing had significantly higher disease incidence and severity, and lower yield, than the non-inoculated and late-inoculate treatments. Varietal resistance was also found to be significant with the most susceptible variety (Norm) having higher disease severity and DON accumulation, regardless of the inoculation timing.

   Impact:
   None to date. However, an experimental DON model for wheat is being tested that was developed, in part, from the data generated in this study. The deployment of this DON model will eventually provide producers with information that can be more directly used in the management of DON contamination in their crops, as apposed to using disease severity as a surrogate as in the previous model.

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.

Peer-reviewed articles:

Stein, J.M., L.E. Osborne, K.D. Bondalapati, K.D. Glover, and C.A. Nelson. 2009. Fusarium Head Blight Severity and Deoxynivalenol Concentration in Wheat in Response to *Gibberella zeae* Inoculum Concentration. Phytopathology. 99:759-764. DOI: 10.1094/PHYTO-99-6-0759

Non-peer reviewed (reports, posters, presentations, and related):

Stein, J. 2009. Progress Towards Predictive Models for Fusarium Head Blight and DON in Barley. Presented at the 2009 Barley Improvement Conference.

De Wolf, E., M. Nita, P. Paul, L. Madden, **J. Stein**, S. Ali and S. Wegulo. 2008. Advances in the Epidemiology of Fusarium Head Blight and Applications in Prediction Models. Invited Talk: Proceedings of the 2007 National Fusarium Head Blight Forum, Kansas City, MO. Canty, S.M., Clark, A., Ellis, D., and Van Sanford, D. (Eds.), University of Kentucky, Erlanger, KY. pp. 18.

Stein, J. 2008. Modeling Fusarium head blight in barley. Presented to the Montana State University Plant Science and Plant Pathology Department (invited departmental seminar).

Bondalapati, K.D., **J.M. Stein,** L.E. Osborne, S.M. Neate and C.R. Hollingsworth. 2008. Modeling Fusarium Head Blight and DON in barley. Poster: Proceedings of the 2007 National Fusarium Head Blight Forum, Kansas City, MO. Canty, S.M., Clark, A., Ellis, D., and Van Sanford, D. (Eds.), University of Kentucky, Erlanger, KY. pp. 10.

Nita, M., E. De Wolf, P. Paul, L. Madden, **J. Stein**, S. Ali, and S. Wegulo. 2008. Prediction Models for Deoxynivanenol Accumulation Risk using Empirical and Mechanistic Modeling Approaches. Poster: Proceedings of the 2007 National Fusarium Head Blight Forum, Kansas City, MO. Canty, S.M., Clark, A., Ellis, D., and Van Sanford, D. (Eds.), University of Kentucky, Erlanger, KY. pp. 49.

Stein, J., K. Bondalapati, L. Osborne, S. Neate and C. Hollingsworth. 2008. Progress towards predictive models for Fusarium Head Blight and DON in barley. Poster: Proceedings of the 2008 North American Barley Researchers Workshop. Madison, WI. pp. 34.

Stein, J.M., L. Osborne, and K. Glover. 2008. Fusarium head blight severity and deoxynivalenol accumulation in wheat spike tissues as a function of *Gibberella zeae* inoculum density. Poster: American Phytopathological Society Annual Meeting, Minneapolis, MN. Phytopathology 98:S150.

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.