USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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USDA-ARS Agreement ID:	59-0790-4-107
USDA-ARS Agreement Title:	FHB Epidemiology on Spring Wheat in South Dakota.
FY06 ARS Award Amount:	$ 70,758

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
EEDF	Environmental Factors Influencing Scab of Barley in the Great Plains and Midwest.	$ 32,988
EEDF	FHB Forecasting and Model Validation for Spring and Winter Wheat in South Dakota.	$ 37,770
	Total Award Amount	**$ 70,758**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Environmental Factors Influencing Scab of Barley in the Great Plains and Midwest.*

1. What major problem or issue is being resolved 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 mid 1980'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. Significant progress has been made in recent years in the development of disease forecast models for wheat; however, the effectiveness of these models in predicting disease, and more importantly DON accumulation, for barley is questionable. We are addressing this issue by attempting to develop models, and eventually a forecasting system, that can predict disease and 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) continue developing a database of information on environment, crop residue, field disease, and mycotoxin levels for spring barley in the region and 2) begin identifying variables that are predictive of disease and DON accumulation in barley in order to develop models and risk advisory systems. Objective 1 was conducted in collaboration with researchers at North Dakota State University and Montana State University, Eastern Ag Research Center in Sidney, MT. Plots were planted at 11 locations throughout the region and the environment was 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, vapor point depression, etc). Correlation analysis was then conducted on the combined 2005 and 2006 data sets to determine which, if any, of these factors were strongly associated with field disease or DON content in the grain.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment #1:

The most significant accomplishment of this project was the continued development of a database of information on weather, crop residue, field disease, and mycotoxin levels for spring barley. We now have 20 location-years in this dataset with information on both 2- and 6-row barley cultivars commonly grown in the region. The disease severity and DON concentrations range from 0 - 13% and 0 - 3.4 ppm, respectively. It should be noted that all of the locations had very little disease and mycotoxin in 2006 due to a widespread drought in the region. Therefore, the total dataset is still insufficient for full model development.

Impact:

To date, this effort has not directly impacted barley producers in the region. However, a future impact is expected following future modeling efforts.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:
Currently, we lack the number of location-years required for the development of accurate models for disease and DON prediction. However, as the dataset being generated by this project increases in size we will be able to better understand which environmental factors are best able to predict disease and DON in barley. This will lead to the development of models that are more robust and effective at prediction.

Accomplishment #2:
Using a very limited dataset, we have identified candidate environmental variables that are putatively associated with disease severity and mycotoxin concentration (DON) for barley.

Impact:
It is widely acknowledge that the amount of FHB disease in barley is highly influenced by weather prior to, and during, heading. This is the first attempt at identifying those environmental variables that impact both disease and DON accumulation in grain for malting barley. By better understanding these relationships, we will be able to develop disease and DON forecasting models that can be used to make integrated crop management decisions.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?:
Through the preliminary exploration of environmental factors that are associated with FHB of barley and DON accumulation in the grain, we have identified several candidate variables that could be useful in future modeling efforts. Specifically, we have found that the average hourly temperature and relative humidity in the 10 days prior to full head emergence were both significantly correlated with final disease severity. Interestingly, these same factors appeared to have no significant impact on mycotoxin concentration in the grain. In the current dataset, measurements of humidity after heading (e.g. vapor point depression) were the only factors associated with final DON concentration. From these results, we hypothesize that different environmental factors may be impacting this pathosystem in various ways and the development of a single model for both disease and DON prediction is unlikely.

Project 2: *FHB Forecasting and Model Validation for Spring and Winter Wheat in South Dakota.*

1. What major problem or issue is being resolved and how are you resolving it?

We are addressing the issues related to the epidemiology of scab on wheat in South Dakota. The specific objectives addressed were to: 1) examine the effects of inoculum abundance, host resistance, fungicide, and weather on Fusarium head blight of both spring and winter wheat in order to provide a knowledge base for the development of accurate disease forecasting systems and comprehensive disease management strategies; and 2) continue with the validation and ground-truthing of previously developed spring wheat FHB risk assessment/forecast models. Objective 1 was studied in collaboration with researchers at Pennsylvania State University, North Dakota State University, Ohio State University, and Purdue University. Coordinated field plots with varying amounts of corn stubble residue were established to monitor disease development over time, in conjunction with environmental (weather) conditions and inoculum monitoring. Objective 2 was also performed in collaboration (ala Objective 1) and continued the development of a spring wheat scab data set for model development and validation through the repeated assessment of numerous wheat crops.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

Accomplishment #1:

The most significant accomplishment of this project continues to be enhancements and further development of the Wheat Scab Risk Advisory Tool, delivered through Penn. State University as well as the South Dakota Scab Risk Advisory delivered through South Dakota State University.

Impact:

Producers, crop managers and scab researchers are able to utilize these systems for a variety of purposes. Producers and crop managers utilize them to make fungicide spray decisions, as well as to make marketing plans as harvest approaches. Agribusiness personnel utilize the Penn. State system to understand the condition of the crop in the U.S., and to make sourcing decisions as the season progresses. Finally, these systems are used in conjunction with other management tools including resistant varieties and fungicides as a component of an integrated pest management plan for small grains.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

The agricultural community now has tools to incorporate into an integrated management plan for scab management. The use of the Penn. State risk assessment systems provides advance warning of the disease for many regions of the U.S. Furthermore, the system is able to utilize a very complex database of weather information and turns that information into an applied solution for producers and crop managers.

Accomplishment #2:

We have collected enough data just in South Dakota to assess the impact of varietal resistance and crop residue type and amount on scab. Based on the four years of data collection and analysis from this set of studies, it is clear that for South Dakota, visual disease symptoms are impacted more by the broad environment and varietal resistance than by a cultural practice such as corn residue management. There were no significant differences across residue treatments in any year. Significant differences in disease were observed across years in this study and between varieties in each year. Although visual symptoms were not impacted by residue level, spore load on heads and toxin concentration in grain were significantly higher for the high corn residue treatment in 2004, the year of highest disease pressure of the four-year study. Coupled with data from temporal inoculum studies we have conducted, it is evident that inoculum in South Dakota is probably transported and mixed in the atmosphere to such a degree that spore-producing residues beneath a crop canopy are less important to the overall disease epidemiology than the favorability of the weather at the field.

Impact:

The impact of this accomplishment is in educating the producers and crop managers about the importance of varietal resistance in scab management, as well as about the importance of local environment on disease development. It counters the idea that residue management and crop rotation are key factors in disease etiology in South Dakota. While these factors may be important and indeed are shown to influence disease levels in some studies, they are not the critical factors in influencing epidemic levels of disease in this state. Where residues may have more impact is on the total fungal load on spikes. Initial findings have led to investigation of spore load on spikes and resultant toxin in grain.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?

The scientific community should now understand the factors of greatest importance in this region, and that they may differ from key components of the disease prediction elsewhere in the U.S. and Canada.

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:

Osborne, L.E., J.M. Stein, J.D. Smolik, and Y. Jin. 200x. Temporal dynamics for airborne propagules of Gibberella zeae. *Can. J. Plant Pathol.* Submitted for Review.

Paul, P., P. Lipps, G. Shaner, G. Buechley, T. Adhikari, S. Ali, J. Stein, L. Osborne, and L. Madden. 200X. A distributed-lag analysis of the relationship between Gibberella zeae inoculum density on wheat spikes and weather. *In revision* for Phytopathology.

Osborne, L.E., and Stein, J.M. 2007. Epidemiology of Fusarium Head Blight on Small Grain Cereals. Intl. J. Food. Microbiol. *In press*.

M. Kadariya, L.E. Osborne, M. Mergoum, R.W. Stack, and K.D. Glover. 2007. Biplot analysis of agronomic and Fusarium head blight resistance traits in spring wheat. J. of Crop Improvement. *In Press*.

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

Osborne, L. 2007. Wheat and Barley Scab Risk Advisory. (17 updates). Disease forecast and commentary. URL: http://plantsci.sdstate.edu/smallgrainspath/scab_advisory.html

Osborne, L. 2007. The Fusarium Head Blight Prediction Center. (17 commentaries). Site-specific weather and disease forecast information. URL: http://wheatscab.psu.edu

Osborne, L, and J. Stein. 2006. Wheat and Barley Scab Risk Advisory. (14 updates). Forecast and commentary. URL: plantsci.sdstate.edu/smallgrainspath/scab_advisory.html

“Scab Epidemiology” - Dec. 2006. Presention to an international audience at the workshop: Mycotoxins from the Field to the Table. Organisation for Economic Cooperation and Development (OECD), 28 Nov.- 1 Dec. Omaha, NE

“Small Grains Disease Biology and Control” – July, 2007. SDSU Northeast Research Farm Field Tour, South Shore, SD. Info on scab, other cereal diseases, and disease management considerations to producers and crop management professionals.

“Small Grain Diseases in the Northeast Counties of SD” – July, 2007. SDSU Northeast Research Farm, South Shore, SD. An update of the diseases expected and observed in the region presented to University Extension Educators.

"Small Grains Disease Update" – June, 2007. SDSU Central Research Farm Field Tour, Highmore, SD. Info on scab, other cereal diseases, and disease management considerations to more than 20 producers and crop management professionals.

"Small Grains Disease Update" – June, 2007. SDSU Plant Science Research Farm Field Tour, Brookings, SD. Info on scab, other cereal diseases, and disease management considerations to more than 50 producers and crop management professionals.

"Current small grain disease situation in South Dakota". Radio Interview with Watertown, SD area network KWAT. July 2, 2007.

Osborne, L. and J.M. Stein. 2006. Small Grains Disease Research Report. In: 2005 Annual Progress Report – Northeast Research Station, Watertown, South Dakota. Plant Science Pamphlet No. 23. South Dakota State University, Brookings, SD. pp. 45-47.

Osborne, L.E. and J.M Stein. 2006. Effect of maize residues on Fusarium head blight disease and head-borne inoculum on two differentially susceptible wheat cultivars. Presentation at the American Phytopathological Society – North Central Regional Meeting, June 14-15, 2006. Fargo ND.

Osborne, L.E. and J.M. Stein. 2006. Temporal inoculum dynamics for Fusarium head blight of wheat and barley in South Dakota. Presentation at the Joint Meeting of the American Phytopathological Society / Canadian Phytopathological Society / Mycological Society of America, July 29-Aug. 2, 2006. Quebec City, Quebec. Phytopathol. 96:S88

Stein, J.M., L.E. Osborne, S. Neate, and C. Hollingsworth. 2006. Environmental Factors Influencing Fusarium Head Blight of Barley in the Northern Great Plains. p. 51 in Proc. 2006 National Fusarium Head Blight Forum (Poster), Dec 10-12, 2006. Raleigh, NC.

Basnet, B.R., L.E. Osborne, J.M. Stein, and K.D. Glover. 2006. Evaluation of resistance among adapted spring wheat germplasm to FHB incited by several Fusarium species. p. 83 in Proc. 2006 National Fusarium Head Blight Forum (Poster), Dec 10-12, 2006. Raleigh, NC.

Stein, J.M. and L.E. Osborne. 2006. A relationship between the number of *Gibberella zeae* propagules present during heading and deoxynivalenol (DON) content in wheat grain. 2006 Presentation at the Joint Meeting of the American Phytopathological Society / Canadian Phytopathological Society / Mycological Society of America, July 29-Aug. 2, 2006. Quebec City, Quebec. Phytopathol. 96:S110

Nita, M., E. DeWolf, L. Madden, P. Paul, G. Shaner, T. Adhikari, S. Ali, J. Stein, and L. Osborne. 2006. Effect of Corn Residue Level, Fungicide Application, and Cultivar Resistance on Disease Incidence and Severity of Fusarium Head Blight and DON Concentration. p. 49 in Proc. National Fusarium Head Blight Forum (Poster), Dec 10-12, 2006. Raleigh, NC.

Paul, P.A., L.V. Madden, P.E. Lipps, E. DeWolf, G. Shaner, G. Beuchley, T. Adhikari, S. Ali, J. Stein, and L. Osborne. 2006. Influence of Weather on the Abundance of Gibberella zeae Propagules within Wheat Canopies: A Lag Regression Analysis. p. 50 in Proc. 2006 National Fusarium Head Blight Forum (Poster), Dec 10-12, Raleigh, NC.

Nita, M., E. De Wolf, L. Madden, P. Paul, G. Shaner, T. Adhikari, S. Ali, J. Stein, and L. Osborne. 2006. Effect of corn residue level on disease intensity of Fusarium head blight (FHB) and on deoxynivalenol (DON) concentration: A multi-state field study. Joint Meeting of the American Phytopathological Society / Canadian Phytopathological Society / Mycological Society of America (Poster), July 29-Aug. 2, 2006. Quebec City, Quebec. Phytopathol. 96:S85

Paul, P.A., L.V. Madden , P.E. Lipps, E. De Wolf, G. Shaner, G. Buechley, T. Adhikari, S. Ali, J. Stein, and L. Osborne. 2006. Modeling the abundance of propagules of Gibberella zeae within wheat canopies. Joint Meeting of the American Phytopathological Society / Canadian Phytopathological Society / Mycological Society of America, July 29-Aug. 2, 2006. Quebec City, Quebec. Phytopathol. 96:S91