USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
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Cover Page

PI:	Jeffrey Stein
Institution:	South Dakota State University
Address:	Plant Science Department Box 2108 Brookings, SD 57007
E-mail:	Jeff.Stein@sdstate.edu
Phone:	605-688-5540
Fax:	605-688-4024
Fiscal Year:	2007
USDA-ARS Agreement ID:	59-0790-4-107
USDA-ARS Agreement Title:	FHB Epidemiology on Spring Wheat in South Dakota.
FY07 ARS Award Amount:	$ 96,585

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
CBCC	Influence of Residue Management on Inoculum Production, Disease, and DON.	$19,512
EEDF	Environmental Factors Influencing FHB and DON Accumulation in Hard Red Wheat.	$ 38,537
EEDF	Environmental Factors Influencing FHB and DON Accumulation in Malting Barley.	$ 38,536
	Total Award Amount	**$ 96,585**

____7/14/08________
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
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

(Form FPR07)

Project 1: *Influence of Residue Management on Inoculum Production, Disease, and DON.*

1. What major problem or issue is being resolved 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 we now have partially resistant varieties and moderately effective fungicide programs. In contrast, residue management has essentially been limited to rotational or tillage practices. Unfortunately, growers are often limited in what schemes they can do for a variety of reasons. If additional practices were available for residue management, the frequency and severity of FHB epidemics and/or deoxynivalenol (DON) contamination in grain might be effectively reduced. The objectives of the proposed research were to utilize A) physical residue management and B) biological control agents in an attempt to inhibit the growth, sporulation, and infection of wheat by *Gibberella zeae*.

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 or fungicide was applied to each plot in the fall or spring. The wheat was un-inoculated and we recorded the disease severity 18 days after heading and determined the final DON accumulation in the grain 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 (how is it being used?). Complete all three 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 2007 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 residue samples were processed in the lab using FDA hydrolysis, most of the samples were found to have a fairly similar level of saprophytic activity. The only treatment that had an elevated level of activity was the fall-applied *Trichoderma*. This organism is both mycoparasitic and saprophytic and could be impacting the ability of *G. zeae* to survive in the residue. It was also noted that the physical processing of maize residues in the fall significantly reduced the amount of material that was present in the spring. In fact, it was difficult to visual discern the tillage and fall-residue shredding treatments.

Impact:

None to date.

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 aggressive chopping of maize residues following harvest in the fall results in the accelerated decomposition of this material with most of it degrading by the next growing season. Although we have yet to specifically document any impacts from this treatment on FHB, we have found a strong relationship in other studies between the level of maize residue present, the number of spores reaching wheat heads in that field, and the resulting disease severity and mycotoxin accumulation. Therefore, it stands to reason that the processing of cereal residues following harvest will reduce both the level of in-field inoculum and the risk of economic losses from FHB.

Project 2: *Environmental Factors Influencing FHB and DON Accumulation in Hard Red Wheat.*

1. What major problem or issue is being resolved 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 primary objective of this project was to conduct research that would facilitate the development of mechanistic models that attempt to predict both disease and DON accumulation using weather, varietal resistance, and timing of infection.

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

<u>Accomplishment:</u>

Unfortunately for this project, the environmental conditions leading up to, and during, the period of heading in 2007 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. In comparison, there were no significant differences between the treatments with respect to DON concentration.

<u>Impact:</u>

None to date.

<u>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?:</u>

Nothing to date.

Project 3: *Environmental Factors Influencing FHB and DON Accumulation in Malting Barley.*

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 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. 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 for eventual incorporation into forecasting systems which 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 the University of Minnesota. Plots were planted at 12 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, etc). Correlation analysis was then conducted on the combined 2005-7 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):**

<u>**Accomplishment:**</u>

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 30 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 - 59% and 0 - 3.4 ppm, respectively. It should be noted that many of the locations had very little disease and mycotoxin in 2007 due to dry conditions during the period of heading. 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 the model development effort.

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 robust and effective at predicting FHB and DON accumulation in barley.

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:

Paul, P., P. Lipps, G. Shaner, G. Buechley, T. Adhikari, S. Ali, J. Stein, L. Osborne, and L. Madden. 2007. A distributed-lag analysis of the relationship between *Gibberella zeae* inoculum density on wheat spikes and weather. Phytopath. 97:1608-1624.

Osborne, L.E., and J.M. Stein. 2007. Epidemiology of Fusarium Head Blight on Small Grain Cereals. Intl. J. Food. Microbiol. 119:103-108.

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

Nita, M., E. DeWolf, L. Madden, P. Paul, G. Shaner, T. Adhikari, S. Ali, J. Stein, and L. Osborne. 2007. Integrated management of Fusarium Head Blight (FHB) and deoxynivalenol concentration. Presented at the Joint Meeting of the APS/SON. San Diego, CA. Phytopathology 97:S85.

Stein, J.M., L.E. Osborne, S. Neate, and C. Hollingsworth. 2007. Environmental Factors Influencing FHB Severity 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. 140.

Osborne, L.E., J.M. Stein, K.D. Glover, and C.A. Nelson. 2007. Spore Load, Disease, and DON: An Inoculum Gradient Study Using Sister Wheat Lines. Poster: Proceedings of the 2007 National Fusarium Head Blight Forum, as before. pp. 114.

Osborne, L.E., J.M. Stein, and C.A. Nelson. 2007. Spore Load, Disease, and DON: A Four Year Variety by Residue Study for FHB Management. Poster and Report: Proceedings of the 2007 National Fusarium Head Blight Forum, as before. pp. 109-113.

Nita, M., E. DeWolf, L. Madden, P. Paul, G. Shaner, T. Adhikari, S. Ali, J. Stein, L. Osborne, and S. Wegolu. 2007. Mechanistic Simulation Models for Fusarium Head Blight and Deoxynivalenol. Poster: Proceedings of the 2007 National Fusarium Head Blight Forum, as before. pp. 108.