USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
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Cover Page

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Fiscal Year:	FY11
USDA-ARS Agreement ID:	59-0206-9-071
USDA-ARS Agreement Title:	A First-Generation Model for DON Prediction and Integrated Management of FHB and DON.
FY11 USDA-ARS Award Amount:	$ 9,235

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Integrating Multiple Strategies to Minimize Losses due to FHB and DON in Wheat.	$ NCE
MGMT	Continued Development of Prediction Models for FHB and DON.	$ 9,235
	Total ARS Award Amount	**$ 9,235**

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
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Integrating Multiple Strategies to Minimize Losses due to FHB and DON in Wheat.*

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

The integration of fungicide application, host resistance, and cultural practices is the most effective approach for managing Fusarium head blight (FHB) and deoxynivalenol (DON) in wheat. However, under favorable weather conditions, even when the best pre-harvest management practices are used, FHB and DON contamination of grain cannot be avoided. Grain harvesting strategies have also been recommended as a way of reducing losses due to FHB and DON. In 2011, a field experiment was conducted to evaluate the influence of varying combine harvester configurations as part of an integrated management strategy on grain yield and quality. Plots of two moderately resistant and two susceptible cultivars were treated with the fungicide Prosaro (6.5 fl oz/A + NIS) at anthesis and then inoculated with a spore suspension of *Fusarium graminearum* approximately 36 hours after. Non-inoculated, non-treated plots were used as checks. FHB intensity was rated at soft dough, and Fusarium damaged kernels (FDK), DON, grain yield, and test weight were quantified at harvest. Two different combine harvester configurations (C1, the default, and C2, modified to increase air flow through the combine) were used to harvest different groups of the plots of each resistance x treatment combination.

High relative humidity and frequent rainfall during anthesis (Feekes 10.5.1) and early grain fill are the primary environmental risk factors for FHB development and DON accumulation in wheat. Therefore, fungicide applications are recommended, and are most effective against FHB and DON, at early anthesis (Feekes 10.5.1). However, producers often find it difficult to follow this management recommendation due to the physical limitations of spraying fungicides in the rain and driving equipment in soggy fields. Field studies in Wooster and South Charleston, OH were conducted to evaluate the effectiveness of fungicide applications made post-anthesis. At Wooster, a moderately resistant and a susceptible SRWW cultivar were planted as whole plots in a randomized complete block design, with three replicate blocks. The sub-plot was fungicide treatment: untreated check, Prosaro (6.5 fl oz/acre + NIS) at anthesis, 2, 4 and 6 days post-anthesis (dpa) and the sub-sub-plot consisted of four different inoculum concentrations, applied at anthesis. At South Charleston a susceptible cultivar was used, and seven fungicide treatments were assigned to plots in a randomized complete block design, with 4 blocks. The treatments were: untreated check, Prosaro (6.5 fl oz/acre + NIS) at anthesis, 2 and 5 dpa and Caramba (13.5 fl oz/acre + NIS) at anthesis, 2 and 5 dpa. Plots were naturally infected at South Charleston. FHB incidence and index were estimated approximately 3 weeks post-anthesis, while FDK and DON concentration were assessed post-harvest.

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 main and interaction effects of fungicide and cultivar were significant for all measures of FHB and DON. C2, the modified combine configuration, resulted in numerically lower FDK and DON than the default (C1), and significantly higher test weight than C1. Together, resistance, fungicide, and C2 resulted in the highest test weight.

At Wooster, variety had a marginal effect on index and a significant effect on FDK, DON and yield. Inoculum density did not have a significant effect on any of the measured responses. At both Wooster and South Charleston, fungicide treatment had significant effects on incidence, index, FDK, DON and yield. All treatments, regardless of timing, resulted in significantly higher yield and lower index, incidence, FDK and DON than the untreated check. At Wooster, mean differences in index, incidence, FDK and DON between the treatment applied as anthesis and those applied at 2, 4 and 6 days after anthesis were not significant. However, Prosaro at anthesis resulted in significantly higher grain yield than later applications. At South Charleston, where it rained during the anthesis treatment application, post-anthesis fungicide treatments provided better disease and DON control than treatments made at anthesis.

Impact:

Based on data from years of uniform fungicide and integrated management trials, best-management practices for FHB and DON are being developed. However, there are several practical issues that could potentially prevent widespread adoption of these practices. This project addressed a few of those issues, with results that could serve as the basis for improving management recommendations. Preliminary results suggest that changing combine harvester configuration in order to remove diseased, lightweight kernels is an excellent approach for improving grain quality, even after integrated management strategies are implemented in the field. In terms of fungicide timing, producers should continue to target anthesis as the ideal time for fungicide application for FHB/DON control; however, preliminary results from this project showed that foliar fungicides may still provide effective FHB and DON control when applications are made up 6 days after anthesis. In fact, if it rains during anthesis at the time of fungicide application, post-anthesis applications may even be more effective than application made at anthesis. This is invaluable research-based information that will help to minimize losses due to FHB and DON.

Project 2: *Continued Development of Prediction Models for FHB and DON.*

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

The risk of severe FHB epidemics is often associated with several environmental factors and cultural practices. In particular, most major FHB outbreaks have been associated with above-normal rainfall before, during, and after anthesis. In addition, planting wheat into fields with corn or other host-crop residues also increases the risk of FHB and DON. Current US FHB forecasting models, initially developed using a very small dataset with the main goal of serving as a tool to guide fungicide application, do not account for the effects of post-anthesis weather, crop residue, or winter wheat variety resistance. Accounting for these factors may contribute to increasing the overall accuracy of current models and potentially to the development of new, more accurate models. Data were collected from USWBSI-funded FHB integrated management trials in an effort to evaluate the influence of weather factors, cultivar resistance, and host-crop residue on the risk of FHB epidemics and to identify predictor variables for the development and refinement of forecasting models. Logistic regression and Boosted Regression Tree were used for model development.

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:

From the 2010 and 2011 FHB integrated management coordinated project, several new observations were collected from both spring and winter wheat regions. Approximately 20-30% of the integrated management observations were suitable for modeling purposes, because they were obtained from uninoculated, untreated, non-irrigated plots with known anthesis date, cultivar resistance level and supporting weather information. After combining replicates and accounting for duplication of variety resistance classes, the 2010 and 2011 integrated management trials resulted in approximately 72 and 102 cases, respectively, that are useful for model development. Of these 72 and 102 cases, about 33 and 44%, respectively, were considered epidemics (FHB index >10%). Data from 2011 are currently being reserved for model testing. More than 500 predictor variables were generated and evaluated. After a series of model fitting and evaluation steps, 15 candidate logistic regression models were selected.

Impact:

Preliminary evaluations of the logistic models based on prediction accuracy indicated that the new models performed better than currently models, but the overall accuracy was similar to the old benchmarks of 70-80%. These 15 models will now serve as the basis for model development using Booster Regression Tree with the hope of further improving prediction accuracy with the more sophisticated modeling technique. The web-based forecasting system

continues to be an extremely useful to tool for FHB management. It is now available for use in 30 US states. During the 2011 growing season alone, the system received more than 13,000 visits. A total of 132 commentaries were submitted to the system by specialists from 12 states. Based on results from surveys of the forecasting system and scab Alert, more than 65% of the users were farmer or crop advisors, and more that 94% of the users between 2009 and 2011 considered the information to be of high or moderate value.

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:

1. Willyerd, K. T., Li, C., Madden, L. V., Bradley, C. A., Bergstrom G. C., Sweets, L. E., McMullen, M., Ransom, J. K., Grybauskas, A., Osborne, L., Wegulo, S. N., Hershman, D. E., Wise, K., Bockus, W. W., Groth, D., Dill-Macky, R., Milus, E., Esker, Waxman, K. D., P. D., Adee, E. A., Ebelhar, S. E., Young, B. G., and **Paul, P. A.** 2012. Efficacy and stability of integrating fungicide and cultivar resistance to manage Fusarium head blight and deoxynivalenol in wheat. **Plant Dis.** 96:957-967.

2. Salgado, J. D., Wallhead, M. W., Madden, L. V., and Paul, P. A. 2011. Grain harvesting strategies to minimize grain quality losses due to Fusarium head blight in wheat. Plant Dis. 1448-1457.

Forum Proceedings:

1. D'Angelo, D., Willyerd, K., Salgado, J. D., Madden, L. and Paul, P. 2011. Effect of post-anthesis fungicide application on Fusarium head blight and DON in soft red wheat. In: S. M. Canty, A. Clark, A. Anderson-Scully, D. Ellis and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2011 Dec. 4-6; St. Louis, MO. East Lansing, MI/Lexington, KY: US Wheat and Barley Scab Initiative. pp. 132.

2. De Wolf, E., Paul, P., Hane, D., Canty, S., Van Sanford, D., Knight, P. and Miller, D. 2011. Evaluating the impact of the FHB prediction models and FHB Alerts, 2009-2011. In: S. M. Canty, A. Clark, A. Anderson-Scully, D. Ellis and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2011 Dec. 4-6; St. Louis, MO. East Lansing, MI/Lexington, KY: US Wheat and Barley Scab Initiative. pp. 134.

3. De Wolf, E., Shah, D., Paul, P., Madden, L., and Willyerd, K. 2011. The risk of FHB epidemics based on weather, host resistance and corn residues. In: S. M. Canty, A. Clark, A. Anderson-Scully, D. Ellis and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2011 Dec. 4-6; St. Louis, MO. East Lansing, MI/Lexington, KY: US Wheat and Barley Scab Initiative. pp. 135.

4. Willyerd, K., Bergstrom, Bradley, C., G., Dill-Macky, R., Gross, P., Grybauskas, A., Halley, S., Hershman, D., Madden, L., McMullen, M., Milus, G., Osborne, L., Ruden, K., Salgado, J. D., Sweets, L., Wegulo, S., Waxman, K., Wise, K., and **Paul, P.** 2011. Uniform Fusarium head blight integrated management trials: a 2011 update. In: S. M. Canty, A. Clark, A. Anderson-Scully, D. Ellis and D. Van Sanford (Eds.), Proceedings of the National Fusarium Head Blight Forum; 2011 Dec. 4-6; St. Louis, MO. East Lansing, MI/Lexington, KY: US Wheat and Barley Scab Initiative. pp. 161-166.

Unpublished Scholarly Presentations:
Pierce Paul. "The Concept of *Bliss Independence* Applied to Integrated Management of FHB" Department of Plant Pathology Seminar Series, The Ohio State University, Ohio Agricultural Research and Development Center, Wooster, OH, 10/18/2011.

Extension Presentations:
Event: 2012 Paulding County Agronomy Day
Title: "*Wheat Head Scab Update*"
Location: Paulding, OH
Date: 01/27/2012

Event: 2012 Putnam County Agronomy Night
Title: "*Wheat Scab Fungicides-Research Trail Results From 2011*"
Location: Kalida, OH
Date: 01/26/2012