USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017

Cover Page

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Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-018
USDA-ARS Agreement Title:	Modeling The Effects of Weather on FHB And DON and Developing Robust Strategies to Minimize Losses.
FY16 USDA-ARS Award Amount:	$ 53,952
Recipient Organization:	The Ohio State University Research Foundation Accounting Dept. 1960 Kenny Road, 4th Floor Columbus, OH 43210
DUNS Number:	07-165-0709
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Project/Grant Reporting Period:	5/13/16 - 5/12/17
Reporting Period End Date:	05/12/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Efficacy and Curative Effects of Fungicides for FHB and DON Management in Ohio.	$ 28,977
MGMT	Functional Analysis for Getting Better Weather-based Predictors of Fusarium Head Blight.	$ 10,602
MGMT	Risk-based Fungicide Decision-making for FHB and DON Management in Wheat.	$ 14,373
	FY16 Total ARS Award Amount	**$ 53,952**

07/28/2017

Principal Investigator Date

* MGMT – FHB Management
FST – Food Safety & Toxicology
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
EC-HQ – Executive Committee-Headquarters
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: *Efficacy and Curative Effects of Fungicides for FHB and DON Management in Ohio.*

1. **What are the major goals and objectives of the project?**
   The overall goal of this project (as part of the FHB Integrated Management Coordinated Project [IM-CP]) was to develop more robust guidelines to provide producers with additional and more effective options for managing FHB and DON. The specific objectives were to:
   1. Determine the efficacy and economics of integrating anthesis and post-anthesis fungicide applications and cultivar resistance to minimize losses due to FHB and DON**.**
   2. Investigate the curative effect of Prosaro and Caramba on FHB and DON.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*
   1) Major activities
   Field and growth chamber/greenhouse experiments were conducted during the 2015-2016 growing seasons. *Objective 1*: Fungicide treatments, consisting of **1)** an untreated check, **2)** Prosaro at anthesis; **3)** Prosaro at anthesis followed by Caramba 4 days later; **4)** Caramba at anthesis followed by tebuconazole 4 days later; **5)** Proline at anthesis followed by tebuconazole 4 days later; and **6)** an untreated, non-inoculated check, were applied to plots of susceptible, moderately susceptible, and moderately resistant cultivars. *Objective 2*: Prosaro and Caramba were applied at regular intervals between anthesis and soft dough to a moderately resistant and a susceptible cultivar in the field, and a susceptible cultivar in the greenhouse. FHB and DON were quantified in all experiments, including systematic assessments and sampling to quantify these responses in primary and secondary tillers.

   2) Specific objectives
      a. Determine the efficacy and economics of integrating sequential fungicide applications (one at anthesis and a second four days later) and cultivar resistance to manage FHB and DON**.**
      b. Quantify the curative effect of Prosaro and Caramba on FHB and DON.

   3) Significant results
   Objective 1: All fungicide programs resulted in lower mean FHB and DON than the untreated check, and two-treatment (sequential application) programs, particularly treatment 3 (Prosaro at anthesis followed by Caramba 4 days later), resulted in lower mean levels of disease and toxin than a single application of Prosaro at anthesis or at four days after anthesis. However, the magnitude of these effects (relative difference in percent control between two- and single-treatment programs) varied among cultivars.
   Objective 2: Anthesis and post-anthesis treatments, particularly those applied between 2 and 4 days after anthesis consistently reduced FHB and DON relative to the check. For later post-anthesis treatments (applied between 6 and 20 days after anthesis), effects varied between fungicides and cultivars; Prosaro was consistently more effective than Caramba in the field; effects were greater on the susceptible than the moderately resistant cultivar; and provided greater reduction in DON than FHB relative to the check.

4) Key outcomes or other achievements
We accomplished our objectives, demonstrating the efficacy of two-treatment fungicide programs and the curative effects of Prosaro and Caramba. We will await the completion of the second set of experiments and analysis of the data before making major conclusions. However, these preliminary results suggest that two-treatment programs may be more warranted when susceptible cultivars are planted and disease/toxin levels are moderate; treatments applied at 2 or even 4 days after anthesis are just as or more effective than anthesis treatments; and both Prosaro and Caramba show evidence of curative effects when applied up to six days after infection but not later.

3. What opportunities for training and professional development has the project provided?

A Research Associate and a Research Assistant were trained as part of this project. In addition to learning how to establish experiments and collect data to evaluate integrated management programs for FHB, they both learned how to use linear mixed models to analysis data from multiple locations. They also contributed to the preparation of abstracts and posters presented at the scab forum and the APS meeting.

4. How have the results been disseminated to communities of interest?

Results were disseminated by way of posters and abstracts at scientific meetings, electronic newsletter articles, and several extension presentations.

Project 2: *Functional Analysis for Getting Better Weather-based Predictors of Fusarium Head Blight.*

1. What are the major goals and objectives of the project?

The overall goal of this project was to create better models for predicting Fusarium head blight (FHB). The specific objectives were to:

1) Identify periods within weather time series that are significantly different between FHB epidemics and non-epidemics,
2) Create variables summarizing the identified periods,
3) Use the summary variables in new logistic regression models for predicting FHB epidemics,
4) Compare the predictive performances of new models with the performances of the currently deployed models, and
5) Replace the current models with the newer versions after they have been field-tested.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

1) Major activities

During the first year of this project, additional data were collected for the forecasting effort from field experiments conducted in 17 US wheat-growing states (AL, DE, ID, IN, KY, MD, MI, MN, ND, NE, NY, OH, PA, SD, TN, VA, and WI) as part of the FHB IM-CP. At least three commercial wheat cultivars, classified as susceptible (S), moderately susceptible (MS), or moderately resistant (MR), were planted in each trial. FHB index, incidence and DON data were collected from non-treated, non-inoculated plots of each cultivar in several of the trials and edited for addition to the master data file for FHB risk model development and validation.

Working closely with Dr. De Wolf and his team at Kansas State, we conducted functional data analysis to quantify associations between weather time series relative to anthesis and FHB epidemics (index > 10%). For each field plot location, daily time series were generated for dewpoint (d), pressure (p), relative humidity (rh), temperature (t), vapor pressure deficit (vpd), and temperature-dewpoint depression (tdd) for periods between 60 days post-anthesis and 01 September of the previous year. Functional mean curves, standard deviations, and derivatives (1st and 2^{nd}) were generated and compared for FHB epidemics relative to non-epidemics.

2) Specific objectives

The objective was to explore functional representations of weather time series linked to observations of FHB epidemics and non-epidemics.

3) Significant results

The daily mean temperature curves for epidemics and non-epidemics were very similar over the time series. However, the amplitude of the difference between the curves was higher from 40 days pre-anthesis up to the period post-anthesis. The overall mean relative humidity curves for epidemics was higher than the corresponding curve for non-epidemics from 35 days pre-anthesis up to the post-anthesis period.

4) Key outcomes or other achievements
Results from the functional data analyses suggest that FHB predictor variables could be summarized for periods extending to as many as 40 days pre-anthesis, much earlier than the 7-15-days pre-anthesis window used in current models. Functional data analysis has improved our knowledge of relationships between weather and FHB epidemics.

3. What opportunities for training and professional development has the project provided?

The Research Associate who contributed to this project learned certain aspects of basic datamining.

4. How have the results been disseminated to communities of interest?

Preliminary results were presented as an abstract with a poster at the scab forum. A manuscript was prepared for publication and is currently under internal review.

Project 3: *Risk-based Fungicide Decision-making for FHB and DON Management in Wheat.*

1. **What are the major goals and objectives of the project?**
   The overall goal of this project was to facilitate the practical utilization of the web-based FHB risk assessment system for fungicide application decision-making. The specific objectives were to:
   1) Evaluate criteria for using the web-based risk assessment tool to make fungicide application decisions for FHB management.
   2) Develop risk-based fungicide application guidelines for FHB management.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*
   1) Major activities
      FHB and DON data were collected from fungicide-treated and non-treated, naturally-infected plots of susceptible, moderately susceptible, and moderately resistant wheat cultivars planted at five locations in Ohio. Prosaro was applied at anthesis, and FHB index and DON data were collected. Weather data were also collected at each location. A similar protocol was used to collect data in Michigan, North Carolina, Wisconsin, Kentucky, Nebraska, Tennessee, North Dakota, Virginia, South Dakota, Indiana, Minnesota, Delaware, and Vermont.

   2) Specific objectives
      Our specific objective was to determine whether fungicide efficacy against FHB and DON was influences by risk scenarios based on whether the application was made under low, moderate, high, or consistently moderate-high risk predictions. Finding will then be used to develop risk-based fungicide application guidelines for FHB management.

   3) Significant results
      The success of this project is totally dependent on the availability of a wide range of FHB index data collected under a range of risk scenarios (based on predictions made by the risk tool). Unfortunately, in 2016 the risk of FHB was low across most of the locations and states from which data were gathered.

      However, we were able to mine data from previous non-inoculated integrated management trials. A total of 585 observations (unique combinations of cultivar, resistance, year, locations, and wheat market class) were collected from non-treated plots, 20% with index > 10% and DON > 2 ppm; 21% with index < 10% and DON > 2 ppm; 7% with index > 10% and DON < 2 ppm, and 52% with index < 10% and DON < 2 ppm.

   4) Key outcomes or other achievements
      Although the risk of FHB and corresponding levels of index were low across most of the participating locations, we were able to gather data from other sources in order to accomplish our objectives. We are now in the process of collecting data from Prosaro-treated plots, summarizing pre-anthesis relative humidity, and obtaining estimates of FHB risk corresponding to the time when treatments were applied. Percent control of

FHB index and DON will be estimated for each observation to determine which risk scenario results in the highest overall mean efficacy.

3. What opportunities for training and professional development has the project provided?

A Ph.D. graduate student is being trained as part of this project. He is learning how to use decision theory to evaluate fungicide efficacy against FHB and DON when application decisions are made under low, moderate, and high FHB risk.

4. How have the results been disseminated to communities of interest?

Results have not yet been disseminated.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 award period. The term "support" below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student's stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY16 award period?** No

   If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY16 award period?** No

   If yes, how many?

3. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?** No

   If yes, how many?

4. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?** No

   If yes, how many?

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY16 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.*

Name of Germplasm/Cultivar	**Grain Class**	**FHB Resistance** (S, MS, MR, R, where R represents your most resistant check)	**FHB Rating** (0-9)	**Year Released**

Add rows if needed.

NOTE: List the associated release notice or publication under the appropriate sub-section in the 'Publications' section of the FPR.

Abbreviations for Grain Classes

Barley - BAR
Durum - DUR
Hard Red Winter - HRW
Hard White Winter - HWW
Hard Red Spring - HRS
Soft Red Winter - SRW
Soft White Winter - SWW

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (5/13/16 - 5/12/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.
None

Books or other non-periodical, one-time publications.
None

Other publications, conference papers and presentations.

Moraes, W. B., Andersen, K. F., Cowger, C., Dill-Macky, R., Madden, L. V., and **Paul, P. A.** 2016. Effect of pre-anthesis rainfall patterns on fusarium head blight and deoxynivalenol in wheat: a multi-state study. Phytopathology 106:S4.131.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES

Ling, W., Paul, P. A., and Madden, L. V. 2016. Developing a Smart Phone App to Estimate *Fusarium* Damaged Kernels of Wheat Based on Computer Vision. In: S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), Proceedings of the 2016 National Fusarium Head Blight Forum (pp. 30). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES

Moraes, W. B., Lana, F. D., Schwarz, P. B., Madden, L. V. and Paul, P. A. 2016. Influence of Rainfall Patterns on Deoxynivalenol Accumulation in Wheat after Fusarium Head Blight Symptom Development. In: S. Canty, A. Clark, K. Wolfe and D. Van Sanford (Eds.), Proceedings of the 2016 National Fusarium Head Blight Forum (pp. 30). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.
Status: Abstract Published and Poster Presented
Acknowledgement of Federal Support: YES