

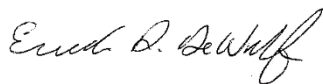
USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Report
Due date: July 24, 2020

Cover Page

Principle Investigator (PI):	Erick DeWolf
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Fiscal Year:	2019
USDA-ARS Agreement ID:	59-0206-6-015
USDA-ARS Agreement Title:	Prediction Models and Improved Pre-Harvest Estimates of Deoxynivalenol
FY19 USDA-ARS Award Amount:	\$ 126,118
Recipient Organization:	Kansas State University 10 Anderson Hall Manhattan, KS 66506
DUNS Number:	929773554
EIN:	48-0771751
Recipient Identifying Number or Account Number:	AR9851 / GAPP603919
Project/Grant Reporting Period:	6/7/19 - 6/6/20
Reporting Period End Date:	6/6/2020

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HW-CP	Development of Scab Resistant Wheat Cultivars for Kansas	\$ 59,009
MGMT	Continued Deployment of Prediction Models for Fusarium Head Blight	\$ 14,709
MGMT	Improving the Accuracy of Fusarium Head Blight Predictive Models within Changing Production Environments	\$ 37,460
MGMT	Integrated Management of Fusarium Head Blight in Kansas	\$ 14,940
FY19 Total ARS Award Amount		\$ 126,118



Principal Investigator

7/23/20

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
HW-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: *Development of Scab Resistant Wheat Cultivars for Kansas*

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

1) test existing local cultivars for resistance, 2) test advanced breeding lines for resistance, 3) test exotic germplasm lines for resistance, 4) test the Hard Winter Wheat (Kansas, Nebraska, South Dakota, Montana, North Dakota) Scab Nursery for reaction to scab, and 5) incorporate new sources of scab resistance into the Kansas wheat breeding program.

2. What was accomplished under these goals or objectives? (For each major goal/objective, address items a-b) below.)

a) What were the major activities?

Until involvement in the USDA Scab Initiative, there was little effort to identify sources of scab resistance in Kansas breeding programs. The Initiative has resulted in the development of accurate and efficient field evaluation nurseries that are providing useful ratings for current cultivars in Kansas and advanced breeding lines. This screening effort now includes entries from winter wheat breeding programs throughout the Great Plains region. The long-term goal of the research is to develop, deploy, and advertise winter wheat cultivars adapted for Kansas with improved levels of resistance to scab.

b) What were the significant results?

In 2009, Kansas State University released the first hard red winter wheat cultivar adapted to Kansas selected for improved levels of resistance to scab. This variety “Everest” is still a top variety in KS representing more than 60% of the acres planted in regions of the state most prone to FHB. KSU released a new variety, Zenda, with moderate levels of resistance to FHB in 2016, several private breeding programs have also released varieties with improved resistance to FHB including Bob Dole, WB4269, WB4699 and SY Benefit. The screening nurseries supported by the USWBSI were essential in the development of these varieties

c) List key outcomes or other achievements.

Because of the scab testing efforts, wheat farmers in Kansas have access to quality information about wheat varieties reaction to FHB. This information is released in the popular KSU extension publications “*Wheat Variety Disease and Insect Ratings, 2020*” and “*Kansas Performance Tests with Winter Wheat Varieties*”. Both publications are available as “hard copy” or online.

Wheat varieties like Everest and Zenda are among the most popular varieties in Kansas representing more than 60% of the acres planted in areas of the state most prone to FHB. The adoption of this cultivar has significantly lowered the susceptibility of the state’s wheat crop to scab; 22% lower statewide and 40% lower in the eastern part of the state where scab is prevalent. The release of 5 new varieties with moderate or intermediate

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levels of resistance by KSU and private breeding programs means that wheat growers in Kansas have more tools than ever before to manage this troublesome disease.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

COVID-19 pandemic did disrupt the flow of research. Despite these challenges, all objectives were accomplished for FY19

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

The FHB screening nursery provides training opportunities for 2 graduate students and an undergraduate student within the Applied Wheat Pathology Lab to gain hands-on experience in the operation and rating of these multi-disciplinary projects. Students are involved in every aspect of the project from planting, harvest and processing the diseased grain.

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

Reports of the phenotyping nurseries are sent to all cooperating breeding programs. These include the public wheat breeding efforts in Kansas, Nebraska, South Dakota, Montana, and North Dakota. Similar reports are sent to the breeding efforts in participating private companies.

Information about current wheat varieties is released via KSU extension publications "*Wheat Variety Disease and Insect Ratings, 2020*" and "*Kansas Performance Tests with Winter Wheat Varieties*". Both publications are available as "hard copy" or online.

Project 2: *Continued Deployment of Prediction Models for Fusarium Head Blight*

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

- 1) Continued deployment of the disease prediction models in 30 states including the support of the state commentary tools, FHB Alerts and the web-page information explaining the models.
- 2) Refine and maintain a version of the FHB Prediction Center for use with mobile devices (cellular-based mobile/"smart" phones and tablets).
- 3) Redesign the expert tools used to test experimental models before public deployment.
- 4) Modification of the web-based tools to improve functionality and compatibility of the Prediction Center.
- 5) Implement a user survey to document value of the prediction system and its impact for stakeholders.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address items a-b) below.)*

a) What were the major activities?

- 1) Disease prediction models were delivered to stakeholders in 33 states via web-based tools. This includes the addition of 3 new states in central and western US. This effort included support for state commentary feature that enables local disease experts to post the assessment of disease risk and recommendations for control. This commentary is also sent to stakeholders via the FHB Alert system with text saved to the USWBSI blog site.
- 2) Continued support and development "behind the scenes" data bases and weather resources that enhance the stability of the web-based tools and reliability of the forecasts. Extra work was required and is on-going this year because of the redesign of the web-based tools.
- 3) Redesign of the expert tools "Dashboard" that allow us to test new predictive models for FHB.
- 4) Redesign of the web-based user interface for the Prediction Center. This includes upgrades in web browser compatibility and access via mobile devices.
- 5) Conducted user survey for the 2019 growing season and plans are in place to survey the audience again in 2020.

b) What were the significant results?

- 1) Disease prediction models were delivered to stakeholders in 33 states via web-based tools for 2020 season.
- 2) FHB Alerts distributed timely information regarding disease risk and management recommendations in key areas affected by FHB.

- 3) Testing of the FHB prediction models for state in the Pacific Northwest region where the disease has emerged as a problem in recent years. Models deployment was expanded to include parts of CO, WY and MT.
- 4) Much of the foundation of the new user interface was completed in FY19. The new tools were launched for the 2020 growing season with core functionality in place, This upgrade addressed browser and mobile device compatibility concerns expressed by users in recent years. We are now working to include additional functionality including the display of site-specific forecasts for disease, graphical representations of local weather information, and smoother distribution of the FHB Alert Commentaries.
- 5) Updated the overall survey of users to provide impact information for the USWBSI for 2019.
- 6) Developed case studies on new predictive models as training modules for disease experts in the US. These were presented to wheat disease specialists NCERA-184 meeting (2019), which reaches most key scientists in most FHB prone regions of the US.

c) List key outcomes or other achievements.

- 1) During the 2019-growing season (1 March – 15 August), the prediction tools provided over 6,672 sessions (11,247 page views) for 3,415 users in the US.
- 2) Greater than 95% of the users considered the information to be of high or moderate value for their farm operations and businesses.
- 3) User surveys indicate that the median monetary value of the information provided by the prediction system was \$12,158 per user during these time periods.
- 4) Survey results between 2010-2019 indicates that impact of the FHB prediction model exceeds \$56 million annually.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

Yes, delays in launch of forecasting tools and commentary features in 2020. Some states in the deep-south had reached critical growth stages before the website was active.

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

Disease specialists in the US received training on the FHB forecasting models and progress development of new models. NCERA-184 meeting (2019).

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

Disease prediction models were delivered to thousands of stakeholders in 33 states via web-based tools with more than 3,400 users. This effort included support for state commentary feature that enables local disease experts to post the assessment of disease risk and recommendations for control. This commentary is also sent to stakeholders via the FHB Alert system and archived on the USWBSI blog site.

Project 3: *Improving the Accuracy of Fusarium Head Blight Predictive Models within Changing Production Environments*

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

The overall project goal is to create better models for predicting Fusarium head blight (FHB). The objectives are to (i) identify periods within weather time series that are significantly different between FHB epidemics and non-epidemics, (ii) create variables summarizing those identified periods, (iii) use the summary variables in new logistic regression models for predicting FHB epidemics, (iv) compare the predictive performances of new models with the performances of the currently deployed models, and (v) replace the current models with the newer versions after they have been field-tested.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address items a-b) below.)*

a) What were the major activities?

- Completed and published the Functional Data Analysis examining weather time series that are important for predicting epidemics of FHB.
- Functional data analysis identified new variables representing weather patterns that favor disease development and the outbreaks of disease.
- Developed new logistic regression models based on the new variables and time periods recommended by the functional data analysis. Compared the predictive capabilities of these new models with the best available models currently available.
- Currently field testing an ensemble of predictive models with historical data set of FHB epidemics in the US.

b) What were the significant results?

Improved the prediction accuracy of forecasting models over currently deployed models for FHB with models developed and tested with over 900 location years of information collected by the integrated management CP.

Identified weather patterns that begin to 3 to 4 weeks prior to the critical growth stages for FHB development. This information will help us provide earlier warnings of disease risk and help wheat growers respond with fungicides when needed to suppress disease epidemics. This is significantly earlier than the current prediction models that make predictions just days prior to the critical growth stages. We have integrated these new variables into predictive models and ensembles of models with the historical data sets and recent observations from 2019-2020 growing seasons.

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c) List key outcomes or other achievements.

These results provide a foundation for improvements in disease prediction models deployed by the USWBSI. Improvements in this system provide more timely estimates of disease risk for stakeholders. These models and supporting commentary from wheat disease enable growers to better determine when fungicide applications are needed to suppress the risk of FHB and DON. They also help growers avoid unnecessary pesticide applications, reduce the cost of crop production and help preserve the environments in rural communities.

3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

This project was not affected directly during the 2019-2020 pandemic of COVID19. However, there may be future effects on the modeling effort. We anticipate that some cooperators may have difficulty providing data to the integrated management CP that is used in model future model development.

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

Disease specialists in the US received training on the FHB forecasting models and progress development of new models. NCERA-184 meeting (2019).

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

Presentations and posters and scientific meetings and stakeholders. The prediction models developed by this project are deployed as part of the Fusarium Prediction Center supported by the USWBSI. This forecasting system provides timely estimates of disease risk for more than 3,400 US wheat and barley producers and their advisors.

Project 4: *Integrated Management of Fusarium Head Blight in Kansas*

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

This project will establish integrated management studies for Fusarium head blight (FHB) in Kansas. The project has the following objectives: 1) Demonstration of Integrated Management for FHB in Kansas environments and locally adapted varieties that can be shared; 2) Contribution of Kansas observations to overall integrated management and disease forecasting projects in the US.

2. What was accomplished under these goals or objectives? (For each major goal/objective, address items a-b) below.)

a) What were the major activities?

Field trials were conducted at two locations in Kansas with a history of problems with FHB. At each location, the experiments included three varieties planted in a replicated complete block design with a split-plot arrangement. Wheat variety will be the whole plot and 6 combinations of fungicide and inoculum as the sub-plots. Treatments included control plots and the fungicides Prosaro®, Marius Ace® applied at rates recommended and timings recommended by the MGMT-CP. The trial were replicated 4 times at each location and weather data collected on site. The plots will be rated for disease incidence and severity during the soft dough stage of development. Grain was harvested to calculate yield and test weight. Sub samples of the grain were collected to assess the percentage of *Fusarium* damaged kernels and DON.

b) What were the significant results?

These results verify the integrated management approach with wheat varieties locally adapted for growing conditions in Kansas. In 2020, growing season was characterized by above normal levels of rainfall, but hot dry weather during grain fill appeared to limit disease development. Incidence of FHB on susceptible varieties in the trials were generally >2%. Plots were harvested and plans are in place to complete observations of FDK and DON as directed by the protocols.

c) List key outcomes or other achievements.

Collection of observation of integrated management for FHB for multiple years provides helpful data for local programing in Kansas. The data also represents unique environments for the national level projects on FHB management and disease forecasting.

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3. Was this research impacted by the COVID-19 pandemic (i.e. university shutdowns, reduced or lack of support personnel, etc.)? If yes, please explain how this research was impacted or is continuing to be impacted.

The COVID-19 pandemic did disrupt the flow of research. Inoculum production in the laboratory was complicated by the University shutdowns. Despite these challenges, all objectives were accomplished for FY19, just with lower than expected inoculum levels.

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

Mentoring graduate student on application of FHB treatments, inoculation methods and rating for disease (1 master's student).

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

Kansas specific observations will help us customize local programs addressing FHB management for wheat growers in Kansas. Now that we have several years of observations, will help us expand programming over historical educational efforts in the state.

Results are also share with IM-CP coordinator P. Paul and The Ohio State University. Dr Paul compiles information from around the country to develop robust recommendations for FHB management applicable throughout the US.

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Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY19 award period (6/7/19 - 6/6/20). 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 FY19 award period?**

None

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 FY19 award period?**

None

If yes, how many?

- 3. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?**

None

If yes, how many?

- 4. Have any post docs who worked for you during the FY19 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?**

None

If yes, how many?

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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 FY19 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations.

NOTE: 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
Western Star	HRW	MR	5	2019
Silverado	HWW	MS	7	2019

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

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Publications, Conference Papers, and Presentations

Instructions: Refer to the FY19-FPR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY19 grant award. Only citations for publications published (submitted or accepted) or presentations presented during the **award period (6/7/19 - 6/6/20)** should be included. If you did not publish/submit or present anything, state ‘Nothing to Report’ directly above the Journal publications section.

NOTE: Directly below each citation, you **must** indicate the Status (i.e. published, submitted, etc.) and whether acknowledgement of Federal support was indicated in the publication/presentation.

Journal publications.

Shah, D.A., Paul, P.A., De Wolf, E.D., and Madden, L.V. 2019. Predicting plant disease epidemics from functionally-represented weather series. *Phil. Trans. R. Soc. B.* 374:20180273.

Status: Journal Article Accepted and Published

Acknowledgement of Federal Support: YES (Journal)

Shah, D.A., De Wolf, E.D., Paul, P.A. and Madden, L.V. 2019. Functional data analysis of weather variables linked to Fusarium head blight epidemics in the United States. *Phytopathology* 109:96-110.

Status: Journal Article Accepted and Published

Acknowledgement of Federal Support: YES (Journal)

Books or other non-periodical, one-time publications.

Other publications, conference papers and presentations.

De Wolf, E., D. Shah, P. Paul, L. Madden, S. Crawford, D. Hane, S. Canty, R. Dill-Macky, D. Van Sanford, K. Imhoff and D. Miller. 2019. “Impact of Prediction Tools for Fusarium Head Blight in the US, 2009-2019.” In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (p. 12), Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

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Paul, P., Ng, S., Bergstrom, G., Bissonette, K., Bowen, K., Bradley, C., Byamukama, E., Chilvers, M., Collins, A., Cowger, C., Darby, H., DeWolf, E., Dill-Macky, R., Esker, P., Friskop, A., Kleczewski, N., Koehler, A., Madden, L., Marshall, J., Mehl, H., Moraes, W., Nagelkirk, M., Rawat, N., Smith, D., Telenko, D., Wegulo, S., and Young-Kelly, H. 2019. "Fusarium head blight management coordinated project: uniform fungicide trials 2018-2019." In: S. Canty, A. Hoffstetter, H. Campbell, and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum* (pp.25-27). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)

Lingenfelter, J., Auld, A., Davis, H., De Wolf, E., Fritz, A., Knapp, M., Lollato, R., Whitworth, J., Winne, S., Adee, E., Esser, A., Kimball, J., Larson, M., Haag, L., Mengarelli, L., Sassenrath, G., Schlegel, A., Seaman, C., Zhang, G., Knopf, J. and Bohnert, C. 2019. Wheat Performance Tests with Winter Wheat Varieties: Report of Progress. Kansas Agricultural Experiment Station; No.1151.

Status: Extension Publication

Acknowledgement of Federal Support: No, (not generally done for this type of publication)

De Wolf, E.D., Lollato, R. and Whitworth, J.R. 2019. Wheat variety disease and insect ratings, 2019. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pub. No. MF991.

Status: Extension Publication

Acknowledgement of Federal Support: No (not generally done for this type of publication)

De Wolf, E.D. 2019. Foliar fungicide efficacy ratings for wheat disease management, 2019. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pub. No. EP130.

Status: Extension Publication

Acknowledgement of Federal Support: No (not generally done for this type of publication)

De Wolf, E.D. 2019. Fusarium head blight. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pub. No. MF3458.

Status: Extension Publication

Acknowledgement of Federal Support: No (not generally done for this type of publication)

Mangel, D., Bruce, M., Davis, M., and **Rupp, J.L.**, (2020) Reaction of Kansas Intrastate Nursery winter wheat accessions to Fusarium head blight (FHB), 2019. Plant Disease Management Report (PDMR), Vol. 14, Report No. 14:CF090.

Status: Technical Report

Acknowledgement of Federal Support: No (not generally done for this type of publication)

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Ranabhat, N., Bruce, M., Davis, M., Wegulo, S., Baenziger, P.S., and **Rupp, J.L.**, (2020)
Reaction of Kansas and Nebraska winter wheat accessions to Fusarium head blight (FHB),
2019. Plant Disease Management Report (PDMR), Vol. 14, Report No. 14:CF091.

Status: Technical Report

Acknowledgement of Federal Support: No (not generally done for this type of publication)

Mangel, D., Bruce, M., Davis, M., and Rupp, J.L. (2020) “Impact of Environmental Conditions
on fungicide ability to control Fusarium head blight under field nursery conditions.” In: S.
Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019
National Fusarium Head Blight Forum* (p. 16), Milwaukee, WI; December 8-10.
University of Kentucky, Lexington, KY.

Status: Abstract Published and Poster Presented

Acknowledgement of Federal Support: YES (Abstract and Poster)