USDA-ARS
U.S. Wheat and Barley Scab Initiative
FY19 Final Performance Progress Report
Due date: August 31, 2021

Cover Page

Agency PI:	Gina Brown-Guedira
Cooperating Principle Investigator (PI):	David Van Sanford
Institution:	University of Kentucky
E-mail:	dvs@uky.edu
Phone:	859-338-2409
Fiscal Year:	2019
USDA-ARS Agreement ID:	58-6070-8-020
USDA-ARS Agreement Title:	Collaborative Research to Accelerate the Development of FHB-Resistant Soft Red Winter Wheat Varieties
FY20 USDA-ARS Award Amount:	$ 74,424
Recipient Organization:	University of Kentucky Research Foundation University Station Lexington, KY 40506-0057
DUNS Number:	939017877
EIN:	61-6033693
Recipient Identifying Number or Account Number:	3200002116
Project/Grant Reporting Period:	8/1/19 - 7/31/21
Reporting Period End Date:	7/31/2023

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Accelerating the Development of FHB-Resistant Soft Red Winter Wheat Varieties	$ 69,915
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance	$ 953
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials	$ 3,556
	FY19 Total ARS Award Amount	**$ 74,424**

(signature)   August 31, 2021

Principal Investigator   Date

---

* MGMT – FHB Management
  FST – Food Safety & Toxicology
       R – Research
       S – Service (DON Testing Lab)
  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

FY19 Final Performance Progress Report
Cooperating PI: Van Sanford, David
USDA-ARS NACA #: 58-6070-8-020
Reporting Period: 8/1/19 - 7/31/21
Project 1: *Accelerating the Development of FHB-Resistant Soft Red Winter Wheat Varieties*

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

   1) Develop and release improved scab resistant varieties; 2) Develop and release improved scab resistant germplasm; 3) generate new knowledge on the inheritance of FHB resistance to expedite the breeding process; and 4) communicate the importance of BMP to all stakeholders in the wheat industry: growers, crop consultants, extension agents, millers, bakers and consumers.

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

   a) **What were the major activities?**
      1) Screening: More than approximately 3500 individual headrows were planted to be screened in the scab nursery at Lexington, KY. Material screened included breeding lines, uniform scab nurseries, other cooperative nurseries, released cultivars, segregating populations and genetic studies. Unfortunately freezes on April 15 and May 9 killed all of the material planted.

      2) Breeding: Approximately 470 crosses were made during FY17, all of which involved at least one scab resistant parent. Breeding populations from F_2 through F_5 were selected for advancement.
      3) Collaboration – grew uniform scab nurseries, other collaborative nurseries and participated in male sterile project, grew barley lines for collaborators at Virginia Tech.
      4) Outreach – communicated findings to stakeholders through newsletters, web and at virtual meetings and virtual field days

   b) **What were the significant results?**
      - We observed significant differences among breeding lines in the resistance to FHB as indicated by FHB index. We are now grinding samples to submit for mycotoxin testing. Unfortunately the late infection this year reduced kernel damage so we do not have estimates of Fusarium damaged kernels.

      - We obtained FHB resistance predictions for > 700 lines which we will consider in concert with the FHB index and mycotoxin data as we decide on the fate of these lines.

   c) **List key outcomes or other achievements.**
      We released Pembroke 2021 a moderately resistant cultivar with 3 resistance QTL.

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

   Yes, we have been very short-handed during Covid-19. It is difficult to hire students due to regulations and students' desire to reduce exposure. We got everything done in the field but are scrambling now to process all of our samples.

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

   Excellent opportunities. During this period a total of 5 graduate students associated with the breeding program have learned about scab resistance breeding from designing crosses, to scoring material in the field through harvest and processing. Professional development opportunities have been limited because most if not all meetings have been virtual.

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

   Our scab data is posted on our website and on the variety testing website and is provided to the NFO to be posted on ScabSmart.

(Form –FPPR19)

Project 2: *Male Sterile Facilitated Recurrent Selection for FHB Resistance*

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

   The objective of this project is to develop male-sterile facilitated recurrent selection populations combining genes for FHB resistance derived from multiple sources in soft winter wheat backgrounds adapted to the eastern U.S. The objective of male sterile facilitated recurrent selection is to increase the frequency of desirable alleles for one or more traits while maintaining a high level of variability in the population.

   This project will result in male-sterile facilitated recurrent selection populations that will be available to all of the members of the NWW-CP and the SWW-CP. These populations provide both the opportunity for individual breeding programs to select genotypes with favorable local adaptation and the region-wide opportunity to recomposite and recombine local selections into an improved regional pool. As a result of this project breeding programs in the eastern regions will have several pools of germplasm from which to extract breeding lines with the potential for unique combinations of FHB resistance genes.

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

   a) **What were the major activities?**
      Identifying male fertile segregates and harvesting selfed seeds.

   b) **What were the significant results?**
      Some promising lines were harvested.

   c) **List key outcomes or other achievements.**
      NA

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

   Yes, we have been very short-handed during Covid-19. It is difficult to hire students due to regulations and students' desire to reduce exposure. We got everything done in the field but are scrambling now to process all of our samples.

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

   Excellent opportunities. During this period a total of 5 graduate students associated with the breeding program have learned about scab resistance breeding from designing crosses, to scoring material in the field through harvest and processing.

Professional development opportunities have been limited because most if not all meetings have been virtual.

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

Results have been communicated to other breeders in the region who might be able to use the germplasm.

FY19 Final Performance Progress Report
Cooperating PI: Van Sanford, David
USDA-ARS NACA #: 58-6070-8-020
Reporting Period: 8/1/19 - 7/31/21
Project 3: *Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials*

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

   Our specific objectives are: 1) Phenotype advanced breeding lines that are candidates for release; 2) place FHB and other agronomic, disease resistance, and quality data in database; and 3) report on purification and seed increase of the best lines.

   The coordinated testing of advanced lines in the various uniform trials and OVTs plus the data summaries for lines that are candidates for release is an efficient method to determine the FHB resistance of nearly all germplasm that is currently released, or likely to be released in the near future. Each breeder in this coordinated project has breeding lines with improved levels of FHB resistance and other traits that warrant their release. The purification and seed increase of these lines is funded by non-USWBSI sources. We propose to summarize the information that supports the release of the advanced lines and to make that information available to all breeders and extension personnel when appropriate.

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

   a) **What were the major activities?**
      Scab screening data was collected on lines entered in three uniform scab nurseries, the Mason-Dixon nursery and the KY Official Variety Trial.

   b) **What were the significant results?**
      We observed significant differences in FHB index; DON data is forthcoming.

   c) **List key outcomes or other achievements.**
      NA

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

   Yes, we have been very short-handed during Covid-19. It is difficult to hire students due to regulations and students' desire to reduce exposure. We got everything done in the field but are scrambling now to process all of our samples.

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

Excellent opportunities. During this period a total of 5 graduate students associated with the breeding program have learned about scab resistance breeding from designing crosses, to scoring material in the field through harvest and processing. Professional development opportunities have been limited because most if not all meetings have been virtual.

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

Compiled in reports and posted on the web.

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY20 award period (8/1/19 - 7/31/21). 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?**
   ☐Yes   ☒**No**   ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐**Yes**   ☒No   ☐ Not Applicable
   If yes, how many?   One

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?**
   ☐Yes   ☒**No**   ☐ Not Applicable
   If yes, how many? Click to enter number here.

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?**
   ☐Yes   ☒No   ☐ **Not Applicable**
   If yes, how many? Click to enter number here.

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with <u>full or partial</u> support through the USWBSI during the **FY19 award period (8/1/19 - 7/31/21)**. 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	FHB Rating (0-9)	Year Released
Pembroke 2021	SRW - Soft Red Winter	MR - Moderately Resistant	3	2020
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year
Click here to enter text.	Select Grain Class	Select what represents your most resistant check	Enter as text 0-9 rating	Select Year

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

Publications, Conference Papers, and Presentations

Instructions: Refer to the PR_Instructions for detailed more instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY20 grant award. Only citations for publications <u>published</u> (submitted or accepted) or presentations <u>presented</u> during the **award period (8/1/19 - 7/31/21)** should be included. If you did not publish/submit or present anything, state 'Nothing to Report' directly above the Journal publications section.

<u>NOTE:</u> 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. See <u>example below</u> for a poster presentation with an abstract:

> Winn, Z.J., Acharya, R., Lyerly, J., Brown-Guedira, G., Cowger, C., Griffey, C., Fitzgerald, J., Mason R.E., and Murphy, J.P. (2020, Dec 7-11). Mapping of Fusarium Head Blight Resistance in NC13-20076 Soft Red Winter Wheat (p. 12). In: Canty, S., Hoffstetter, A. and Dill-Macky, R. (Eds.), *Proceedings of the 2020 National Fusarium Head Blight Forum*. https://scabusa.org/pdfs/NFHBF20_Proceedings.pdf.
> <u>Status:</u> Abstract Published and Poster Presented
> <u>Acknowledgement of Federal Support:</u> YES (Abstract and Poster)

Journal publications.

Rupesh Gaire, Clay Sneller, Gina Brown-Guedira, David A. Van Sanford, Mohsen Mohammadi, Frederic L. Kolb, Eric Olson, Mark Sorrells, and Jessica Rutkoski. 2021. Genetic trends in Fusarium head blight resistance due to 20 years of winter wheat breeding and cooperative testing in the Northern US. *Plant Disease.* 20 Jul 2021. https://doi.org/10.1094/PDIS-04-21-0891-SR.
<u>Status:</u> Published
<u>Acknowledgement of Federal Support:</u> YES

Virginia L. Verges, Gina L. Brown-Guedira, David A. Van Sanford. 2021. Genome-Wide Association Studies Combined with Genomic Selection as a Tool to Increase Fusarium Head Blight Resistance in Wheat. *Crop Breeding, Genetics and Genomics.*
<u>Status:</u> Published
<u>Acknowledgement of Federal Support</u>: YES

Rebecca K. McGrail, David A. Van Sanford, David H. McNear Jr. 2021. Semi-dwarf winter wheat roots contain fewer organic acids than wild-type varieties under phosphorus stress. *Crop Science.* First published: 06 February 2021. https://doi.org/10.1002/csc2.20470.
<u>Status</u>: Published
<u>Acknowledgement of Federal Support:</u> NO

W Jesse Carmack, Anthony J Clark, H Jeanette Lyerly, Yanhong Dong, Gina Brown-Guedira, David Anthony Van Sanford. 2021. Optical sorter–augmented genomic selection lowers deoxynivalenol accumulation in wheat. *Crop Science*. https://doi.org/10.1002/csc2.20494.
Status: Published
Acknowledgement of Federal Support: YES

Ammar Al-Zubade, Timothy Phillips, Mark A. Williams, Krista Jacobsen, David Van Sanford. 2021. Impact of Nitrogen Rate and Production System on Yield and Bread Baking Quality of Soft Red Winter Wheat in Kentucky. *Agronomy* **2021**, *11*(9), 683; https://doi.org/10.3390/agronomy11091683.
Status: Published
Acknowledgement of Federal Support: NO

Rod, K. S., Bradley, C., Van Sanford, D. A., Knott, C. A. (2020). Integrating Management Practices to Decrease Deoxynivalenol Contamination in Soft Red Winter Wheat, *Lausanne: Frontiers in Plant Science* (vol. 11) Impact Factor of Journal: 4.402; Journal Total Cites: 47627.
Status: Published
Acknowledgement of Federal Support: YES

Verges, V. L., Lyerly, J., Dong, Y., Van Sanford, D. A. (2020). Training Population Design With the Use of Regional Fusarium Head Blight Nurseries to Predict Independent Breeding Lines for FHB Traits, (vol. 11) *Frontiers in Plant Science.*
Status: Published
Acknowledgement of Federal Support: YES

Russell, K. G., Van Sanford, D. A. (2020). Breeding wheat for resilience to increasing nighttime temperatures, (4 ed., vol. 10) *Agronomy*.
Status: Published
Acknowledgement of Federal Support: NO

Verges, V. L., Van Sanford, D. A. (2020). Genomic selection at preliminary yield trial stage: Training population design to predict untested lines, (1 ed., vol. 10) *Agronomy*.
Status: Published
Acknowledgement of Federal Support: YES

Carmack, W. J., Clark, A. J., Dong, Y., Van Sanford, D. A. (2019). Mass selection for reduced deoxynivalenol concentration using an optical sorter in SRW wheat, (12 ed., vol. 9) *Agronomy*.
Status: Published
Acknowledgement of Federal Support: Yes

Tessmann, E. W., Van Sanford, D. A. (2019). Associations between morphological and FHB traits in a soft red winter wheat population, (11 ed., vol. 215) *Euphytica*.
Status: Published
Acknowledgement of Federal Support: Yes

Kusunose, Y., Ma, L., Van Sanford, D. A. (2019). User responses to imperfect forecasts: Findings from an experiment with Kentucky wheat farmers, (4 ed., vol. 11, pp. 791-808) *Weather, Climate, and Society Impact Factor Journal*: 1.958
Status: Published
Acknowledgement of Federal Support: NO

Ward, B. P., Brown-Guedira, G., Tyagi, P., Kolb, F. L., Van Sanford, D. A., Sneller, C. H., Griffey, C. A. (2019). Multi-environment and multi-trait genomic selection models in unbalanced early-generation wheat yield trials, (2 ed., vol. 59, pp. 491-507) *Crop Science*.
Status: Published
Acknowledgement of Federal Support: YES

Ward, B. P., Brown-Guedira, G., Kolb, F. L., Van Sanford, D. A., Tyagi, P., Sneller, C. H., Griffey, C. A. (2019). Genome-wide association studies for yield-related traits in soft red winter wheat grown in Virginia, (2 ed., vol. 14) *PLoS ONE*.
Status: Published
Acknowledgement of Federal Support: YES

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

Nothing to report.

Other publications, conference papers and presentations.

E. De Wolf, 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 *(p. 12)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

Katherine Rod, Carrie Knott, Carl Bradley and David Van Sanford. 2019. Can Agronomic Practices Reduce DON *(p. 30)*? In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

(Form –FPPR19)

Katherine S. Rod, Carrie A. Knott, David Van Sanford, and Carl A. Bradley**.** 2019. Deoxynivalenol Contamination and *Fusarium graminearum* Infected Wheat Kernels from Various Production Practices *(p. 31)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract published.
Acknowledgement of Federal Support: YES

Sladana Bec, Franklin J. Machado, Mark Farman, Aline Vieirade Barros, Scott Schwartz, Richard Metz, Charles Johnson, David Van Sanford, Emerson Del Ponte and Lisa Vaillancourt. 2019. Highly Aggressive and Toxigenic Transgressive Progeny from a Cross of Model *Fusarium graminearum* Strains ph-1 and gz3639 are Associated with a Recombination Hotspot on Chromosome 2 *(p. 61)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

Gabdiel E. Yulfo Soto, Aline Vieira de Barros, Sladana Bec, Franklin J. Machado, Frances Trail, David Van Sanford and Lisa Vaillancourt. 2019. Exploring the Role of Mating-type Genes in *Fusarium graminearum (p. 79)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

W. Jesse Carmack, Anthony J. Clark,Yanhong Dong and David A. Van Sanford. 2019. Mass Selection for Reduced Deoxynivalenol Concentration using an Optical Sorter in SRW Wheat *(p. 89)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

Fitzgerald, J., C. Griffey, W. Brooks, N. Meier, D. Van Sanford, J.P. Murphy, N. McMaster and D. Schmale III. 2019. Evaluation of Winter Barley Cultivar Nomini for Resistance to Fusarium Head Blight *(p. 90)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
Status: Abstract Published.
Acknowledgement of Federal Support: YES

(Form –FPPR19)

Virginia L. Verges, Jeanette Lyerly and David Van Sanford. 2019. Application 0f Genomic Selection at Preliminary Yield Trial Stage: Training Population Design to Predict Untested Lines *(p. 121)*. In: S. Canty, A. Hoffstetter, H. Campbell and R. Dill-Macky (Eds.), *Proceedings of the 2019 National Fusarium Head Blight Forum*, Milwaukee, WI; December 8-10. University of Kentucky, Lexington, KY.
<u>Status:</u> Abstract Published.
<u>Acknowledgement of Federal Support:</u> YES