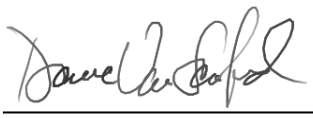
USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY12 Final Performance Report
July 16, 2013

Cover Page

PI:	David Van Sanford
Institution:	University of Kentucky
Address:	Department of Plant Science 327 Plant Science Bldg. Lexington, KY 40546-0312
E-mail:	dvs@uky.edu
Phone:	859-257-5020 x80770
Fax:	859-257-7125
Fiscal Year:	FY12
USDA-ARS Agreement ID:	59-0206-9-054
USDA-ARS Agreement Title:	Accelerating the Development of FHB-Resistant Soft Red Winter Wheat Varieties.
FY12 USDA-ARS Award Amount:	$ 68,134*

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.	$ 55,751
VDHR-NWW	Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.	$ 3,752
VDHR-NWW	Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.	$ 5,220
VDHR-NWW	Coordinated Evaluation and Utilization of Marker Assisted Selection.	$ 2,729
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	$ 682
	Total ARS Award Amount	**$ 68,134**



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Principal Investigator Date

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** 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: *Accelerating the Development of FHB-Resistant Soft Red Winter Wheat Varieties.*

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

   Many wheat varieties in KY are susceptible to FHB; thus, Kentucky wheat producers and end users are at risk for severe economic losses as a result of head scab epidemics. We are resolving this problem by breeding FHB resistant cultivars.

   Our breeding program involves: 1) evaluating germplasm and breeding lines as parents for FHB resistance; 2) incorporating known resistance into crosses with elite, high yielding lines and cultivars, and 3) evaluating resistance in the progeny of the crosses. We evaluate early generation populations in inoculated nurseries so that only resistant segregates are brought forward and developed into lines that can be evaluated for the usual array of traits at multiple locations.

   Field evaluation is carried out at two locations: Lexington, under mist irrigation with inoculum provided by the scabby corn method, and at Princeton in a non-irrigated nursery with a combination of conidial spray and scabby corn as inoculum sources.

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 (1): Approximately 10 lines homozygous for *Fhb*1 resistance or containing native resistance were evaluated in the state variety trial for the second or third year's testing during the period covered by this grant.

   Impact: These lines will provide breeders with additional germplasm and parental lines to use in crosses for the development of scab resistant germplasm and varieties. The combination of *Fhb*1 and native resistance QTL will be especially useful. Three lines have been increased for possible release as cultivars.

   Accomplishment (2): Approximately 30 breeding lines and varieties were grown at two locations, Lexington and Princeton in inoculated scab nurseries in the presence and absence of Prosaro® fungicide.

   Impact: This study gives KY growers the information they need to implement the best tools we have for fighting FHB: resistant varieties in combination with well-timed fungicides.

   Accomplishment (3): Breeding lines in the cooperative Mason Dixon nursery (VA, MD, NC, KY) were grown in a mist irrigated, inoculated scab nursery at Lexington for FHB phenotyping.

Impact: The data will help breeders develop a reliable scab profile for their breeding lines and increases the likelihood of FHB resistant variety release in the region.

Accomplishment (4): Approximately 3500 rows including UK breeding lines, varieties, populations, accessions and recombinant inbred lines were phenotyped in a mist irrigated, inoculated scab nursery at Lexington.

Impact: Elimination of very susceptible lines from the breeding program early on allows us to increase resistance in segregating populations prior to line derivation.

Accomplishment (5): Approximately 90 RIL from MPI 4, the genomic selection project of the NWW CP, were grown under mist irrigation.

Impact: This project provides crucial phenotypic data required for effective genomic selection for FHB resistance.

Accomplishment (6): Approximately 100 RIL from crosses with Roane, were grown under mist irrigation for phenotyping.

Impact: This project will elucidate the nature of the resistance in Roane and hopefully identify new resistance QTL that breeders can use to develop resistant varieties.

Accomplishment (6): Approximately 500 crosses were made in the fall and spring greenhouse crossing cycles. All of them involved at least 1 scab resistant parent.

Impact: These crosses will generate populations and lines with increased and diverse resistance that will benefit other breeding programs as well as our own.

Accomplishment (7): BC4 *Fhb1* derived lines in seven different recurrent parent backgrounds were entered in yield tests at three locations.

Impact: This effort will combine outstanding yield potential with known, QTL derived resistance. Two of the recurrent parents would have been released but for scab susceptibility. It is possible that scab resistant versions of these lines may be released as varieties.

Accomplishment (8): 508 breeding lines were screened for Type II resistance in the greenhouse in March.

Impact: This will combine identify those lines with resistance to spread of the fungus in the head and will eliminate those lines that lack this trait from further testing.

Project 2: *Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.*

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

   The major issue is the level of FHB resistance among SRW wheats in our region. We are resolving this by screening multiple breeding lines at multiple locations.

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:

   We completed FHB evaluation of the NUWWSN, PNUWWSN, and SUS and our advanced and regional nurseries.

   Impact:

   Regional uniform testing is an essential component of variety development. By collecting the data in multiple locations, the data collection required for variety release is accelerated as is the entire process. Every year is different in terms of environmental conditions. Growing this material at multiple locations maximizes the likelihood that useful scab resistance information will be generated at a subset of locations, even if some locations do not produce data for environmental reasons beyond their control (e.g. temperature, drought etc.).

Project 3: *Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.*

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

The issue being resolved is the efficiency and effectiveness of selection for FHB resistance. The problem is being resolved through genomic selection and association analysis of small effect QTL for all types of resistance.

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 KY breeding project identified a number of lines with a high level of resistance and a larger set of lines derived from crosses involving parents with native resistance. These lines and 70 common lines were planted in our FHB screening nursery and screened for incidence, severity, FDK and DON. Native sources of FHB resistance were identified.

Impact:

If genomic selection is optimized, it will expedite the release of resistant varieties. It is critical to conduct these experiments to provide a comparison of genomic vs phenotypic selection. If genomic selection works as predicted by theory, the time savings will be huge.

Project 4: *Coordinated Evaluation and Utilization of Marker Assisted Selection.*

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

   The primary purpose of this project was to evaluate the effectiveness of use of FHB-resistance QTL in the northern winter wheat breeding programs through marker assisted selection, quantify the effects of these QTL in reducing FHB and DON, and measure their impact on other important traits such as yield and milling and baking quality.

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:

   Seventy breeding lines that were plus/minus QTL were yield tested at two locations (KY,MI) and grown in scab nurseries at four locations (IN,IL,MO,OH). Fhb1 reduced scab in many but not all instances; native resistance was also effective. Milling quality was not seriously affected.

   Impact:

   This project will provide information on the effect of genetic background on QTL expression, which lines to use as parents in the breeding programs, and lines worthy of joint germplasm and/or cultivar release.

Two Year (2011-12) Least Squares Entry Means for Yield and Test Wt of Advanced Breeding Lines and Cultivars from the NWW Breeding Programs with QTL-Based or Native Scab Resistance.

Entry	Yield (bu/a	Test Wt (lb/bu)	FHB1	QTL
25R32	75.5	57.9	1	1
MSU Line E9047	73.2	54.8	1	1
03625A1-1-3-2	73.1	56.9	1	1
TRUMAN	71.4	57.2	0	0
KY03C-1237-39	71.3	58.4	0	0
Caledonia	70.6	53.8	0	0
03207A1-7-3-6	69.7	57.1	0	0
KY03C-1237-28	69.5	57.9	1	1
NY09091-33	69.5	54.9	0	0
Saranac	69.3	54.0	1	1
KY03C-1221-01	69.2	58.3	0	0
03625A1-1-3-4	68.8	56.1	0	0
MSU Line E9061	68.1	55.2	0	0
MSU Line E9053	68.0	52.2	1	1
KY03C-1195-10-2-1	67.9	57.0	0	0
MSU Line E9042	67.3	54.0	1	1
KY03C-1195-10-2-5	67.1	58.2	1	1
NY09091-83	67.1	55.5	1	1
MSU Line E9059	66.9	55.8	0	1
OH09-134-64	66.8	59.1	1	1
04703A1-1-1-6	66.8	57.7	0	0
011007A1-50	66.5	56.6	0	0
NY09090-22	66.0	54.4	1	1
MSU Line E9046	65.6	52.7	0	0
KY03C-1221-04	65.6	55.5	1	1
NY09092-59	65.5	56.2	0	0
09-12167	65.3	55.5	0	0
09-12166	64.7	56.8	0	1
OH09-270-70	64.7	58.7	1	1
KY03C-2022-16-18-3	64.3	58.3	1	1
OH09-270-49	64.2	58.8	0	0
09-12138	64.0	55.9	0	0
03207A1-7-3-1	63.8	58.4	0	0
MSU Line E9041	63.7	54.4	0	0
NY09092-8	63.6	55.4	1	1
09-12142	63.5	59.0	0	0
09-13670	63.5	57.1	1	1
NY09090-47	62.5	54.2	0	0
NY09093-58	62.4	55.4	1	1
OH09-136-24	62.1	57.1	0	0
09-13653	62.0	56.3	0	0
0527A1-9-10-8	61.8	54.5	0	0

Entry	Yield (bu/a	Test Wt (lb/bu)	FHB1	QTL
MSU Line E9062	61.7	52.9	0	0
04703A1-1-1-3	61.6	57.1	0	0
09-9038	61.1	56.9	0	0
MSU Line E9060	60.9	50.9	1	1
NY09093-24	60.3	54.4	0	0
011007A1-8	60.0	53.7	0	0
KY03C-2022-20-5-1	60.0	56.1	0	0
09-9056	59.7	58.7	1	1
KY04C-2151-22	59.5	59.6	1	1
09-10464	59.3	57.7	1	1
OH09-134-17	59.1	58.0	0	0
09-10531	58.0	58.6	0	0
MSU Line E9052	57.1	55.0	0	0
OH09-97-46	56.1	56.0	1	1
OH09-98-39	55.2	55.8	0	0
OH09-136-38	55.0	57.1	1	1
KY04C-2151-24	54.3	59.4	1	1
0527A1-7-9-9-4-5	52.6	57.0	1	1

Yield

LSD(0.05)	8.9
CV %	9.2

Project 5: *Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**
   The NWW CP developed male sterile recurrent selection populations that will ultimately yield scab resistant breeding lines which contain FHB resistant genes from different sources. Intermating selected individuals each generation facilitates recombination among genes from different sources. These populations segregate 1:1 for the dominant male-sterile gene and selfing is not required to generate fertile individuals. Four populations adapted to different regions of the eastern US were developed in Wooster, Ohio by using pollinators from different breeding programs. Resistant male sterile plants were selected each generation.

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:
   We grew a DMS population in 2012, at Lexington, KY. Sterile heads tagged and susceptible ones were discarded. After harvest Fusarium damaged kernels were removed and the remaining seed was planted back into the scab nursery in the fall of 2012. Numerous FHB resistant lines were planted around the population in nearby rows.

   Impact: These populations can be pollinated by our best scab-resistant breeding lines to generate new recurrent selection populations and ultimately new breeding lines with increased resistance from different sources.

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance.

Germplasm line 11-3-10; release notice submitted (Clark, Anthony J., Jose M. Costa, Carl A. Griffey, Gina L. Brown-Guedira, Yanhong Dong, Edward J. Souza, J. Paul Murphy, and David A. Van Sanford. 2013. Registration of Scab-Resistant 11-3-10 Soft Red Winter Wheat Germplasm. Submitted to J. Plant Registrations).

This line has a very high level of resistance derived from the native resistance of McCormick with the addition of 3 exotic QTL – Fhb1 plus QTL on 5A and 2D.

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 Journal Articles:

Liu, Shuyu, Carl A. Griffey, Marla D. Hall, Anne L. McKendry, Jianli Chen, Wynse S. Brooks, Gina Brown-Guedira, David Van Sanford, David G. Schmale. 2013. Molecular characterization of field resistance to Fusarium head blight in two US soft red winter wheat cultivars. Theor. Appl. Genet. doi:10.1007/s00122-013-2149-.

Balut, Ana L., Anthony J. Clark, Gina Brown-Guedira, Edward Souza, and David A. Van Sanford . 2013. Validation of Fhb1 and Qfhs.Nau-2DL in Several Soft Red Winter Wheat Populations. Crop Sci. doi: 10.2135/cropsci2012.09.0550; Posted online 31 Jan. 2013.

Rasyad, Aslim, Gulat M.E. Manurung1 and David A. Van Sanford. 2012. Genotype X Environment Interaction and Stability of Yield Components among Rice Genotypes in Riau Province, Indonesia. 2012. SABRAO Journal of Breeding and Genetics 44 (1).

Souza, Edward J., Clay Sneller, Mary J. Guttieri, Anne Sturbaum, Carl Griffey, Mark Sorrells, Herbert Ohm and David Van Sanford. 2012. Basis for Selecting Soft Wheat for End-Use Quality. Crop Science 52: 1: 21-31.

Marcia McMullen, Gary Bergstrom, Erick De Wolf, Ruth Dill-Macky, Don Hershman, Greg Shaner , Dave Van Sanford. 2012. A Unified Effort to Fight an Enemy of Wheat and Barley: FusariumHead Blight. Plant Disease 96: 1712-1728

Non-Peer Reviewed:

Anthony Clark and David Van Sanford. 2012. "Characterization of Wheat Mutants with Reduced Fusarium Head Blight Symptoms." In: S. Canty, A. Clark, A. Anderson-Scully

and D. Van Sanford (Eds.), *Proceedings of the 2012 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 55.

Daniela Sarti, Anthony Clark, Gina Brown-Guedira, Yanhong Dong and David Van Sanford. 2012. "Soft Winter Wheat Responses to *Fhb1* and *Qfhs.Nau-2DL* QTL for Fusarium Head Blight Resistance in F2 Derived Populations." In: S. Canty, A. Clark, A. Anderson-Scully and D. Van Sanford (Eds.), *Proceedings of the 2012 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 95.

C.H. Sneller, A. Cabrera, P. Paul, D. Van Sanford, A. Clark, A. Mckendry, F. Kolb, H. Ohm, R. Freed and M.E. Sorrells. 2012. "Phenotypic Analysis of a Soft Wheat Population that will be used for Association Analysis and Genomic Selection." In: S. Canty, A. Clark, A. Anderson-Scully and D. Van Sanford (Eds.), *Proceedings of the 2012 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 99.

David Van Sanford, Fred Kolb, Anne McKendry, Herb Ohm, Clay Sneller, Mark Sorrells, Gina Brown-Guedira, Janet Lewis, Russ Freed and Lee Siler. 2012. "Coordinated Evaluation and Utilization of Marker Assisted Selection for FHB Resistance." In: S. Canty, A. Clark, A. Anderson-Scully and D. Van Sanford (Eds.), *Proceedings of the 2012 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 107.

E. Wright, C. Griffey, S. Malla, D. Van Sanford, S. Harrison, J.P. Murphy, J. Costa, G. Milus, J. Johnson, A. McKendry, D. Schmale III, A. Clark and N. McMaster. 2012. "Mapping of FHB Resistance in SRW Wheat Cultivar Jamestown." In: S. Canty, A. Clark, A. Anderson-Scully and D. Van Sanford (Eds.), *Proceedings of the 2012 National Fusarium Head Blight Forum*. East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative. p. 108.

Presentations:

Van Sanford, D.A. 2012. Deoxynivalenol: A Problem For The Wheat Industry. Presented at the Mid South Assn. of Wheat Scientists Meeting, Madison, AL, April 4.