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:	59-0206-1-114
USDA-ARS Agreement Title:	FHB Resistant Soft Wheat for Michigan and the Eastern Soft Wheat Region.
FY11 USDA-ARS Award Amount:	$ 80,072

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	FHB Resistant Soft White and Red Wheat Varieties for Michigan and Region.	$ 58,691
VDHR-NWW	Coordinated Evaluation and Utilization of Marker Assisted Selection.	$ 8,640
VDHR-NWW	Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Lines and Cultivars.	$ 1,862
VDHR-NWW	Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.	$ 10,879
	Total ARS Award Amount	**$ 80,072**

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: *FHB Resistant Soft White and Red Wheat Varieties for Michigan and Region.*

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

The overall goal of this project is to accelerate development of commercially viable varieties and advanced generation lines of soft white and red winter wheat which exhibit resistance to FHB and are adapted to Michigan and/or the eastern U.S. region. Michigan State University's wheat breeding program is one of two public programs in the eastern U.S. that focuses the majority of the program on soft white winter wheat (SWWW). FHB is a particularly serious threat to the SWWW acreage in Michigan because of the products produced from soft white wheat (SWW), with a large proportion being used by Michigan's cereal food industry. Michigan produces over 70% of the white wheat in the Great Lakes area. The importance of lowering levels of DON in SWW is amplified by the fact that bran mill fractions are regularly used in ready-to-eat cereal products, and bran fractions have been shown to contain higher levels of DON than flour streams.

We have been addressing this problem through breeding and research. We have targeted crossing, Marker Assisted Selection, and field phenotypic screening followed by post-harvest toxin evaluation. My graduate students are helping to further define the genetics and other aspects of FHB. Our achievements are highlighted below.

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): In the spring of 2012, one-hundred and eight different crosses were made, the majority of which were made to combine FHB resistance with high yield. The FHB resistance parents included MSU lines as well as cooperators lines selected from the Northern Uniform Winter Wheat Scab Nursery and the Preliminary Northern Uniform Winter Wheat Scab Nursery.

Impact (1): The emphasis on FHB resistance in the crosses made at MSU will hasten the development of FHB resistant varieties for Michigan. In addition, though many of the MSU sources of FHB resistance are derived originally from the well-known Asian sources of resistance, many cooperators have additional native sources of resistance that are now also being incorporated into the MSU germplasm.

Accomplishment (2): The research conducted by Swasti Mishra (graduate student) showed that visual measures for FHB are better correlated with toxin data in spray inoculation with bagging (with or without heat stress) compared to grain spawn inoculation followed by misting. We also found that DON in whole grain can predict DON quantities in bran and flour in both SWW and SRW, but they have different equations.

Impact (2): Two white lines (E6003 and E6055) were identified that have DON levels comparable to the most resistant red lines. These will be used in our breeding program.

Accomplishment (3): In 2011 we screened F3 and F4 generations for FHB resistance in single row plots in the MSU artificially inoculated FHB nursery. A corresponding plot of each F3 and F4 line was present in the breeding nursery. Lines that performed well for FHB resistance are the focus of further selection in the breeding nursery (while the vast majority of those that performed poorly in the FHB nursery are discarded). As with selections in previous years, selected lines will be sent for toxin evaluation to the University of Minnesota DON testing lab.

Impact (3): The identification of FHB resistance and lower DON accumulation in these earlier generations focuses our resources towards developing advanced lines with better FHB resistance.

Accomplishment (4): MSU's preliminary and advanced yield trials were phenotyped for FHB resistance in replicated trials in MSU's artificially inoculated FHB nursery. Selected entries were harvested and sent for DON analysis at the University of Minnesota DON testing lab.

Impact (4): The focused selection of high yielding lines with improved levels of FHB resistance will help us develop FHB resistant varieties adapted to Michigan and help us avoid releasing highly susceptible lines. The use of the University of Minnesota DON testing lab helps ensure that lines with reasonable phenotypic levels of FHB are not high in DON.

Accomplishment 5: In 2011 we assessed Fusarium damaged kernel (FDK) evaluations as part of our FHB screening. White and red grained control standards were used for comparison against samples harvested from the FHB screening nursery, and evaluated the majority of our harvested lines (both early and advanced generations).

Impact 5: By conducting this additional type of FHB assessment, we will have a better understanding of the effects of FHB on the grain, and further improve our ability to identify lines with better FHB resistance.

Project 2: *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?

Chinese spring wheat sources of resistance have been well characterized for the levels of FHB resistance that they provide, but have not been characterized for their impact on other traits, such as yield and grain quality, in Eastern soft winter wheat. The objectives of this project are to 1) evaluate the effectiveness of use of FHB-resistance QTL in the NWW

breeding programs through marker assisted selection (MAS); 2) quantify the effects of these QTL in reducing FHB and DON, and 3) 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: Molecular marker analysis was used to identify sister lines were identified at Michigan State University (and other collaborating programs) with and without QTL from Chinese sources of resistance. Increased seed of the identified sister lines were harvested and planted at in Michigan and Kentucky for yield trial evaluation. Phenotyping for FHB related traits is also being conducted in 2012.

Impact: This project will result in immediate sharing of germplasm lines with QTL-derived resistance, often paired with native resistance. The extensive phenotyping and testing of these lines should expedite the release of those lines with variety release potential. Beyond individual institution releases, it is possible that the regional evaluation of these lines will identify some candidates for joint release as improved FHB-resistant, low DON varieties. Finally, this project will provide crucial information on the variability of QTL effects across genetic backgrounds. This will inform breeders in the SWW region on the probability of success of deploying these QTL in high yielding resistant, low DON varieties and thus make the breeding process more efficient.

Project 3: *Coordinated Evaluation of FHB Resistance of Advanced Soft Winter 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 problem being resolved is FHB evaluation of elite breeding lines that are candidates for release, and cultivars that are grown in Michigan. Such evaluation is necessary so that farmers and industry are aware of the risks of varieties and breeders can make informed decisions before release.

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 Michigan State Performance Trial (the official variety trial of Michigan), as well as multiple regional trials (the Northern Uniform Winter Wheat Scab Nursery, the Preliminary Northern Uniform Winter Wheat Scab Nursery, the Uniform Eastern Soft Red Winter Wheat Nursery, and the Uniform Eastern Soft White Winter Wheat Nursery) were visually evaluated for FHB resistance in replicated trials in MSU's artificially inoculated FHB nursery. Incidence, severity and index data were taken. All but the Uniform

Eastern Soft Red Winter Wheat Nursery were harvested, evaluated for Fusarium damaged kernels, and sent for DON analysis at the University of Minnesota DON testing lab.

Impact: The evaluation of regional trials provides useful data to all contributors not only of the lines that each contributor submitted, but also of the performance of each other's germplasm across regions. For the MSU Wheat Breeding Program, valuable data is collected from collaborating sights about MSU's germplasm. These data help confirm the performance of MSU's lines for FHB over multiple environments. In addition, MSU benefits from evaluating collaborator's entries, helping us to easily identify germplasm that would be effective for using as an FHB resistance donor parent in crossing, or as a potential variety for cultivation in Michigan. Both FHB and DON data are used in considering variety release and characterization of varieties when released for the knowledge of growers and the use of breeders. Farmers and seed dealers can also view this FHB data on our web site to make their selection of wheat varieties to plant and/or sell.

Project 4: *Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.*

3. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?** The major problem being resolved is the identification of QTL contributing FHB resistance within Eastern Soft Wheat germplasm. There are many sources of resistance that have been identified that we expect, according to pedigree, to be independent of the frequently used and well-characterized Chinese sources of resistance. Early generation populations were identified having parents with native sources of resistance. These populations were combined and distributed to multiple participating breeders for phenotyping.

4. **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:
Early generation breeding materials were identified, and seed was distributed for phenotyping to collaborating institutions. A set of common genotypes were planted at each location and a subset of genotypes were divided amongst the locations. The overlap of a set of common genotypes will enable comparisons of the FHB performance between those evaluated in multi-sites and reduced sites. At each site, three replications were planted in a randomized design. To map resistance, genotypic and phenotypic data of the lines will be combined.

Impact:
Mapping Eastern Soft Wheat native resistance is necessary to expedite the use of these sources of resistance and better enable breeders to combine multiple sources of resistance in a single cultivar. The inclusion of multiple sources of resistance will lead to greater and more robust levels of FHB resistance.

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.

No germplasm or cultivars released in 2011.

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.

Swasti Mishra, Lee Siler, Sue Hammar, Janet Lewis. Comparison of different inoculation methods for evaluation of FHB resistance in wheat varieties. 1st Annual National Association of Plant Breeders Meeting, College Station, Texas. May 23-25, 2011. (Poster)

Falconí, E., L. Ponce, J. Ochoa, J. Lewis, J. Garófalo, J. Coronel, J. Velásquez, M. Cathme, S. Abad. 2011. Plan to recover wheat production in Ecuador. Borlaug Global Rust Initiative at Saint Paul, Minnesota. June 13th-16th, 2011. (Poster)

Lewis, Janet. MSU Wheat Breeding Program to Michigan State Miller's Association, June 2011. (Presentation)

Lewis, Janet. Presentation and Tour of MSU Wheat Breeding Program to Kellogg's ® Cereal Company, June 2011

Falconí, E., E. Duveiller, J. Crossa, R.P. Singh, J. Huerta-Espino, S.A. Herrera-Foessel, J. Ochoa, J. Garófalo, M. Cathme, L. Ponce, J. Lewis. 2011. Phenotypic Evaluation of CIMMYT Wheat Germplasm for Fusarium Head Blight and Yellow Rust Resistance. National Fusarium Head Blight Forum. St. Louis, MO-USA. December 3 - 6, 2011. (Poster)

Falconí, E., E. Duveiller, J. Crossa, R.P. Singh, J. Huerta-Espino, S.A. Herrera-Foessel, J. Ochoa, J. Garófalo, M. Cathme, L. Ponce, J. Lewis. 2011. Phenotypic Evaluation of CIMMYT Wheat Germplasm for Fusarium Head Blight and Yellow Rust Resistance. Plant Breeding, Genetics and Biotechnology Symposium. East Lansing, MI USA. December 16th, 2011. (Poster)

Swasti Mishra, Lee Siler, Sue Hammar, Yanhong Dong, Janet Lewis. Comparison of DON accumulation in bran and flour fractions of FHB infected winter wheat. National Fusarium Head Blight Forum, St. Louis, Missouri. December 4-6, 2011. (Poster)

Freed, Russell. Michigan State University Wheat Breeding Program Update. Michigan Millers Association Meeting, East Lansing, MI. January, 2012

Lewis, Janet. Review of MSU Line E6012 at Wheat Quality Council, February, 2012

Freed, Russell. MSU Variety Development Updates to Michigan Crop Improvement Association, March, 2012. (Presentation)

Mishra, Swasti, Fusarium Head Blight in Wheat - Study of Field Resistance and Mycotoxin Accumulation in Milled Fractions of Soft Red and Soft White Winter Wheat. Crop and Soil Sciences Department, April, 2012. (Presentation)

Mishra, Swasti, Fusarium Head Blight in Wheat - Study of Field Resistance and Mycotoxin Accumulation in Milled Fractions of Soft Red and Soft White Winter Wheat, April, 2012. (Abstract and MSc. Thesis)

Report:

Lewis J., L. Siler, S. Hammar, R. Laurenz, Y. Dong, E. Souza (2011) Michigan State Wheat Variety Trial