USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY13 Final Performance Report
July 15, 2014

Cover Page

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Fiscal Year:	FY13
USDA-ARS Agreement ID:	59-0206-9-081
USDA-ARS Agreement Title:	Improvement of Soft Winter Wheat is Resistant to FHB and Adapted to Indiana.
FY13 USDA-ARS Award Amount:	$ 85,244

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Improvement of Soft Winter Wheat that is Resistant to FHB and Adapted to Indiana.	$ 82,938
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	$ 633
VDHR-NWW	Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.	$ 1,673
	FY13 Total ARS Award Amount	**$ 85,244**

Joseph M. Anderson 7-15-2014
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: *Improvement of Soft Winter Wheat that is Resistant to FHB and Adapted to Indiana.*

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

   Fusarium head blight (FHB) is a devastating disease of wheat in Indiana, which has become more frequent and significant with the adoption of reduced soil tillage for soil conservation and reduced costs of crop management. I continue to develop soft winter wheat varieties that are adapted to Indiana and that have resistance to FHB as well as other important diseases. Emphasis is being placed on combining Type I and Type II FHB resistance, which is more effective than either type of resistance singly.

2. **List the most important accomplishments and their impact (i.e. how are they 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 2012 report two lines were described Line 05247 and 02444 that had both Type 1 and II FHB resistance. These lines were evaluated again in field conditions in 2013 and again in 2014 and again showed excellence resistance under this year's more conducive FHB infection conditions. Data from these trails will be evaluated by the new Assistant Professor of Small Grains Breeding when that person is hired – hopefully by December 2014. At that time a decision will be made on the potential release for commercialization.

   Impact:

   These lines have a significant advantage over pervious lines as they combine both Type I and Type II resistance, are high yielding with excellent flour quality and other disease resistance traits. For example Line 05247 also has good frost resistance and resistance to both leaf and stripe rust. Line 02444, a selection from the same parental line as INW1021, is a shorter higher yielding line than INW1021.

   Accomplishment (2):

   Work continued on combining Fhb1 and Qfhs.pur-7EL together with combinations of Type I resistance from Goldfield, Truman/Bess, and INW0412. Resistance is significantly augmented with combinations of these resistance factors. In 2011 we phenotyped a recombinant inbred population that is segregated for the Type I resistance of INW0412 to identify and map the resistance factor(s). The combination of Fhb1 and Qfhs.pur-7EL typically limits the spread of the disease after point inoculation to the inoculated spikelet, as determined in multiple greenhouse and field tests. We have developed lines with Fhb1, Qfhs.pur-7EL and the Type I resistance of Goldfield using marker genotyping and phenotyping, and hopefully combining these factors with Type I resistance of Truman and INW0412 by phenotyping. We have had considerable difficulty having a consistent field

evaluation of this material in both 2012 and 2013. In 2013, while the environmental conditions were more conducive to FHB disease progression than 2012, the disease spread and progress in this material was again not consistent leading to a less robust data set. Consequently we do not yet have a robust data set for selecting highly resistant lines with both type I and II resistance from this recombinant inbred population.

To supplement this recombination inbred population study we have performed an RNA-Seq comparison of wheat response to *Fusarium* infection of *Fusarium graminearum Tri5+* (DON producer) versus *Fusarium graminearum Tri5-* (DON deletion mutant) on both susceptible and resistant wheat lines. This will allow us to distinguish genes responding to the presence of the fungus versus genes responding primarily to the mycotoxin.

Impact:

While we do not yet have sufficient phenotypic data to map this population $F_{2:4}$ lines were phenotyped in two replicated field tests for FHB incidence and severity at Lafayette, IN in 2013 for Type I and Type II resistance separately. By using phenotypic and SSR marker selection, lines with both Type I and II FHB resistance were identified, and it was confirmed that lines with multiple markers associated with FHB resistance provide more FHB resistance than lines with few or no markers. Those lines will be beneficial for the improvement of FHB resistance in wheat. This research also developed lines that are sufficiently inbred and for which we now have sufficient seed supply to continue our disease evaluation and when appropriate to enter into regional FHB nurseries.

The RNASeq data will allow us to distinguish genes responding to the presence of the fungus versus genes responding primarily to the mycotoxin. We expect that DON-detoxification genes will be identified in resistant wheat whereas oxidative stress genes will be identified in susceptible wheat. The RNA-Seq data have been analyzed and we are currently in the process of verifying the expression by qPCR. The RNASeq data also has the potential for identify potential biomarkers for DON-detoxification genes.

Accomplishment (3):

In a separate project we have developed lines with Fhb1, Qfhs.pur-7EL and resistance to regional important diseases using new effective genes for resistance to leaf, stem and stripe rusts, and yellow dwarf viruses. Using a phenotypic and marker assisted selection approach a series of lines were identified that appeared to have a unique set of multiple disease resistance genes. However, analysis of subsequent generations showed an unexpected segregation pattern of the Qfhs.pur-7EL locus which is a very effective FHB-resistance gene previously introgressed from wheatgrass. This material was reevaluated using a Genotype by Sequencing (GBS) approach.

Impact:

The GBS approach identified that the molecular markers used in the MAS approach had been incorrectly mapped close to Qfhs.pur-7EL locus. The GBS experiment has identified

tightly linked flanking markers and has correctly mapped the location of this resistance gene. This finding will have significant utility in MAS for the Qfhs.pur-7EL locus in our breeding program and will lead to the development of FHB resistant cultivars.

Project 2: *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?** Bringing in new alleles that provide resistance to FHB requires laborious manual emasculation and pollination. Male-sterility in a self-pollinated species greatly facilitates hybridizations without these laborious manual emasculation and pollination. Furthermore, favorable resistance alleles can be accumulated without the requirement for numerous hand pollinations. The objective of this project is to advance male-sterile facilitated recurrent selection populations that have been developed to combine genes for FHB resistance from multiple sources in soft winter wheat backgrounds adapted to the eastern U.S. The goal is for this project to further develop several pools of adapted breeding lines with genes for FHB resistance derived from multiples sources. This project is a continuation of the project that was begun in 2009 to generate FHB male sterile facilitated recurrent selection populations with FHB resistance in the eastern soft wheat region.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment:

   Effected a fourth cycle of crosses among a diverse set of elite wheat lines in the field in 2014.

   Impact:

   There are some lines that are clearly identified as FHB resistant and have been selected. However more significant impacts are expected in the next several years.

Project 3: *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?**

   Testing and identification of the agronomically highest performing and widely adapted lines that also have consistently effective FHB resistance takes many years and is not as reliable when done in individual breeding programs due to limitations on number and diversity of locations of testing.

2. **List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:**

   Accomplishment:

   This research initiative has significantly enhanced the regional collaboration of wheat improvement and of phenotyping and genotyping for resistance to FHB and other important diseases.

   Impact:

   The ability to evaluate multiple potential cultivars across an array of soil types and environmental conditions across a wide geographical region provides data that identifies new cultivars that are more widely adapted and have more reliable and effective resistance to FHB and other diseases.

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI during the FY13 award period. List the release notice or publication. Briefly describe the level of FHB resistance.

None

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 FY13 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Jin Sun, J., H. Ohm and C. Williams. 2013. Mapping and Combining Genes for FHB Resistance in Wheat. National Fusarium Head Blight Forum, Milwaukee, WS

Jin Sun, J., H. Ohm and C. Williams. 2014. Mapping Type I and Combining Type I and Type II Fusarium Head Blight Resistance. Plant and Animal Genome XXII, San Diego, CA

Xiao, X., H. Ohm and C. Williams. 2013. Determine the Augmentation Effect of FHB Resistance Genes in Wheat. National Fusarium Head Blight Forum, Milwaukee, WS

Xiao, X., H. Ohm and C. Williams. 2014. Utilization of wheatgrasses in breeding elite wheat lines with improved disease resistance. Plant and Animal Genome XXII, San Diego, CA