USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY13 Final Performance Report
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Cover Page

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Fiscal Year:	FY13
USDA-ARS Agreement ID:	59-0206-9-080
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Red Winter Wheat Varieties and Scab Resistance QTL Mapping.
FY13 USDA-ARS Award Amount:	$ 105,153

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Development of Scab Resistant Soft Red Winter Wheat Varieties.	$ 88,941
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.	$ 15,579
	FY13 Total ARS Award Amount	**$ 105,153**

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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: *Development of Scab 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?**

   The major issue is that producers need varieties with high levels of scab resistance. We are working on the development of high-yielding, well-adapted, scab resistant lines. As more lines with good scab resistance are identified we are using these parents in crosses, so that in many crosses both parents, or two parents out of three in a three-way cross, are scab resistant. We also believe that it is important to combine several types of resistance rather than rely solely on Type II resistance. We are addressing this by using the ISK index (0.3 x % incidence + 0.3 x % severity + 0.4 x % shriveled kernels) to select breeding lines with high levels of scab resistance. Development of varieties with low deoxynivalenol (DON) levels is also crucial; therefore, all breeding lines are evaluated each year for DON level.

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:
   Data on FHB resistance of varieties in the Illinois State Variety Trial in a FHB evaluation nursery were made available to producers. In 2010 we developed a new index that incorporates the severity, incidence and FDK % into a single number. Using this index we can adjust ratings to the same disease level for each season (50% ISK index). We are continuing to use this index which allows producers and others to compare the FHB resistance of varieties evaluated in different seasons. FHB resistance information for entries in the Illinois Variety trial are made each year to producers via field day handouts and talks and the Variety trial website at http://vt.cropsci.illinois.edu/wheat.html.

   Impact:
   In order to use FHB resistance as a criterion in variety selection producers must have as much information as possible on FHB resistance. The FHB resistance data provide very useful information to Illinois seedsmen and producers and allows them to use FHB resistance as a criterion in variety selection. Producers and seedsmen have a three year summary of data of FHB resistance and DON level that can be used in decisions about what varieties to produce.

   Accomplishment:
   In 2013, about 450 breeding lines from the University of Illinois wheat breeding program were evaluated. Scab resistant lines were evaluated for many traits including grain yield, milling and baking quality, standability, and resistance to diseases.

   Impact:
   Sustained annual selection for FHB resistance in the inoculated, misted field nursery has significant long-term impact by assuring that new varieties will be FHB resistant.

Constant selection for FHB resistance in the breeding program is essential in order to identify breeding lines with FHB resistance and also to discard FHB susceptible lines early so that resources are not wasted evaluating FHB susceptible lines. The constant selection pressure applied using evaluation in misted, inoculated nurseries is essential in reducing DON. Using the field based selection for FHB each year is having a major impact in developing FHB resistant lines. In our Advanced, Preliminary and single plot experiments we are seeing more and more lines with FHB resistance combined with excellent adaption and high yield.

Accomplishment:
In 2013-14 we produced about 250 single crosses and about 180 three-way and four-way crosses were made involving FHB resistance sources. Marker assisted selection (MAS) was used for F_2 enrichment for the 3BS resistance locus was done in nine single-cross populations (MAS done in cooperation with Gina Brown-Guedira, USDA-ARS). About 24 F_3 and F_4 bulks were grown in the inoculated and mist-irrigated FHB nursery and heads were selected.

Impact:
The crosses of scab resistant parents by adapted high yielding parents will provide populations that can be used for development of scab resistant varieties. These crosses are the source of variability that will be used for future development of scab resistant soft red winter wheat varieties.

Accomplishment:
Soft red winter wheat breeding lines with a high level of FHB resistance (better than Ernie) with high yield potential were increased for potential release for licensing and potential commercial production.

Impact:
Lines that enter commercial production provide seedsmen and producers with additional FHB resistant varieties. The availability of improved varieties with FHB resistance provides additional choices for seedsmen and producers and contributes to an overall reduction in DON and decreased susceptibility to FHB. For the seed industry in this part of the Midwest, release of breeding lines for licensing results in breeding lines being grown on larger acreages than release as a named variety. Thus, licensing results in greater impact than release as a public variety because there is no marketing for a public variety.

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?**

   The cooperative male sterile facilitated recurrent selection populations were developed as a way to generate FHB resistant breeding lines and facilitate the combination of FHB resistant genes from different sources. Recurrent selection has the objective of increasing the frequency of desirable alleles for one or more traits while maintaining a high level of variability in the population. Intermating among selected parents each generation allows recombination to occur thus combining genes from different sources. Male sterility provides a mechanism to easily allow recombination among FHB resistance sources. The dominant male-sterile gene was utilized to create recurrent selection populations segregating for FHB resistance because the progenies of the male-sterile plants always segregate 1:1 for sterility and a generation of selfing is not required to obtain true-breeding fertile genotypes. Our objective was to create four populations with FHB resistance adapted to different regions of the eastern U.S. Seed from the sterile heads were planted, and their sterile offspring were tagged for harvest to repeat the process. These populations were developed over several seasons at the Ohio Agricultural Research and Development Center in Wooster, Ohio. Breeding programs in the eastern U.S. contributed FHB resistant lines to serve as pollinators. Sterile plants were selected; those highly susceptible to FHB were discarded.

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:
   In 2013 the male-sterile population was grown in the field at Urbana, IL. Sterile heads were identified and tagged. Sterile heads that were very susceptible to *Fusarium graminearium* were removed. After being harvested and threshed, *Fusarium* damaged kernels were removed by aspiration, removing approximately 50% of the kernels. Remaining seed was space planted in the fall of 2013. A mixture of FHB resistant lines from the University of Illinois breeding program were planted as pollinators in adjacent rows. Additional cycles of mating and selection for FHB resistance will be carried out.

   Impact:
   Male-sterile facilitated recurrent selections populations developed in the eastern soft wheat region can be used with local FHB resistant breeding lines as pollinators to further develop recurrent selection populations as a source of potential FHB resistant breeding lines with resistance from different sources.

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?**

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

   Coordinated evaluation of breeding lines among the programs in the NWW provides all breeding programs in the CP with FHB resistance data from multiple locations in a single season. This coordinated evaluation of breeding material plays an important role in the identification of breeding lines with high levels of FHB resistance. Our objective is to cooperatively obtain information on breeding lines from various programs within the CP and the SWW CP to allow the breeders involved to make better decisions about which breeding lines to advance and release.

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:
   Lines from the Univ. of Illinois program were submitted for all of the cooperative nurseries, thus, breeding lines with FHB resistance were made available to other breeding programs for use as germplasm. Two University of Illinois breeding lines (out of four entries) were among the most FHB resistant lines in the 2013 NUWWN and four University of Illinois breeding lines (out of six entries) were among the most FHB resistant lines in the 2013 PNUWWN. Nine out of the ten Illinois entries in these two nurseries had low average DON levels.

   Impact:
   Exchange of FHB resistant breeding lines among programs is essential and will contribute to the development of FHB resistant varieties. Obtaining FHB resistance data for entries in the cooperative nurseries from many environments allow wheat breeders to make better selection decisions about what lines to advance for further evaluation. Breeding lines from the University of Illinois breeding program were made available to other breeding programs for use as parents if the breeders wish to use them.

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.

As reported last year eleven lines from the University of Illinois were released in 2012 for commercial production as licensed varieties. All lines released have FHB resistance equal to, or better than, Bess. For comparison IL02-18228 is a line that has been identified from numerous trials to have a high level of FHB resistance. No additional lines were released in the spring of 2013. Several additional lines are under increase for possible release in 2014, but have not been released to date.

Performance of University of Illinois lines and checks averaged over years 2012 and 2013 in the Advanced trial. Data for scab evaluations are from 2013 only. All data are from Urbana except yield data are from four locations in Illinois.

								Scab Evaluation Nursery			
Name	Yield	TW	Height	Heading Date	Ht	Lodg	Sept. Leaf Blight	FHB Index	ISK Index	Kernel Rating	DON
	(bu/A)	(lb/bu)	(inches)	(d)	(in)	(0-9)	(1-9)	(%)	(%)	(%)	(ppm)
Kaskaskia (CK)	66.3	61.9	43.5	143	40	0.8	7.0	83.3	77.0	55.0	7.5
Bess (CK)	70.1	61.1	40.5	140	35	1.8	3.0	20.7	42.7	28.3	9.5
Pio 25R47 (CK)	77.5	58.0	37.0	140	34	1.5	2.3	78.7	73.0	48.3	11.8
Pio 25R62 (CK)	80.4	58.8	37.0	140	36	2.3	2.0	49.2	77.5	83.3	12.1
IL00-8530 (CK)	72.4	61.5	40.5	139	38	3.9	3.3	26.2	52.0	43.3	5.6
IL02-18228 (CK)	71.0	62.3	41.5	139	38	2.3	2.3	17.5	38.4	25.0	2.6
IL06-13721	71.6	61.9	38.5	138	37	2.2	4.7	35.8	50.6	28.3	4.6
IL06-14262	73.1	62.0	39.5	138	36	3.3	8.3	17.3	40.2	23.3	5.3
IL06-14303	73.7	60.2	41.0	140	37	-0.1	3.3	45.9	53.0	28.3	5.1
IL06-23571	75.9	62.4	41.5	138	36	1.1	5.3	25.1	47.9	35.0	4.4
IL07-4415	77.6	60.3	40.0	138	39	0.7	3.0	12.5	41.6	25.0	2.8
IL07-6861	76.7	61.4	40.0	138	36	2.7	2.7	38.1	53.0	31.7	7.2
IL07-12948	72.9	61.0	40.0	139	36	1.7	2.3	38.3	52.5	31.7	5.6
IL07-16075	74.8	61.9	39.5	139	37	-0.4	3.7	32.5	53.0	36.7	3.9
IL07-19334	86.0	60.1	39.5	139	36	1.3	3.0	14.5	35.9	26.7	4.4
IL07-20728	86.3	63.1	39.0	142	37	0.6	1.0	25.9	44.7	30.0	3.9
IL07-20743	72.6	63.4	42.5	141	36	1.4	2.0	18.7	43.3	33.3	3.9
IL07-24841	71.0	60.9	41.5	142	36	1.4	2.3	17.7	41.9	35.0	2.9
Trial average	71.4	61.2	40.2	140	36	1.9	4.0	33.4	53.3	39.2	5.7
LSD (0.05)	4.3	0.8	1.4					16.1	10.2	19.0	3.0
CV (%)	7.6	1.2	3.0					29.9	11.9	30.2	26.7

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.

Bernardo, A., G. Bai, J. Yu, **F.L. Kolb,** W. Bockus, and Y. Dong. 2014. Registration of Near-Isogenic Winter Whet Germpalsm Contrasting in Fhb1 for Fusarium Head Blight Resistance. Journal of Plant Registration 8:106-108.

Abstracts:

Merrill, K.R., G. L. Brown-Guedira, M. Pais de. Arruda, and F.L. Kolb, 2013. Comparative Genotyping-by-sequencing analyses in a soft red winter wheat bi-parental mapping populations with differing levels of sequencing coverage. Plant and Animal Genome, Jan 14, 2013. P0210 https://pag.confex.com/pag/xxi/webprogram/Paper7645.html

Arruda, M.P., K.R. Merril, G. L. Brown-Guedira, C. Thompson and F.L. Kolb. 2013. FHB resistance QTL mapping using native source of resistance and SNP-GBS markers. In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum (* p 7). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Bissonnette, KM., K.A. Ames, F. L. Kolb, Y. Dong, and C.A. Bradley, 2013. Effect of cultivar and fungicide on *Fusarium* mycotoxins in wheat straw. In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum (* p 95). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.