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

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USDA-ARS Agreement ID:	59-0206-9-077
USDA-ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY13 USDA-ARS Award Amount:	$ 88,415

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	$ 79,274
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.	$ 8,508
	FY13 Total ARS Award Amount	**$ 88,415**

Anne L. McKendry 07/14/14
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: *Accelerating the Development of Scab Resistant Soft Red Winter Wheat.*

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

   Fusarium head blight, in wheat continues to be an important problem in the north-central region of the United States. This ongoing project has focused largely on the exploiting the broadly based, effective, genetically different, native sources of resistance identified in Missouri wheat germplasm; an approach that has been shown to accelerate the development and release of FHB resistant cultivars for the soft red winter wheat region. In FY13 our major objectives were: (1) continue our history of designing crosses that include FHB-resistant parents with native and/or exotic sources of resistance; (2) systematically screen all lines developed at the University of Missouri from preliminary yield testing for FHB resistance; (3) enter lines that combine FHB resistance with excellent agronomic performance into the Northern and Preliminary Scab Nurseries and other relevant breeding nurseries; (4) collaborate with Dr. Paul Murphy to validate Truman markers in the doubled haploid population Bess/Neuse where Bess is a full sib of Truman, (5) continue to develop a set of recombinant inbred lines developed from the cross Bess/MO 94-317 for validation of Truman markers. Germplasm is shared with interested breeders through the FHB nursery system.

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.**

   Accomplishment:

   500 advanced breeding lines were evaluated for FHB resistance for the first time in both the field and greenhouse nurseries. Resistance (FHBI and DON) was also verified in a set of 50 advanced lines. Verification FHBI data ranged from 7.0 to 28.5 compared with a range of 0.8-46.2% in 2012. Of these lines, 76 lines were retained that had excellent agronomic performance in terms of yield, test weight, maturity, height, lodging, resistance to BYDV, Septoria tritici blotch and Fusarium head blight (FHBI, FDK, DON). FHBI in these lines ranged from 2.0 to 25.9 and averaged 14.7%. DON content in retained lines ranged from less than 1.0 to 3% with 17 lines under 1.0%, 57 lines between 1 and 2% and 2 lines between 2 and 3% DON content. Average DON values of check varieties were: 3.2 ppm for Truman, and 15.7 ppm for the susceptible check MO 94-317. Of note was that of 204 advanced lines sent for DON analysis, 75 lines had DON levels less than 2.0 ppm; 118 lines had DON levels less than 3 ppm; and 156 lines had DON levels less than 4.0 which was statistically equal to the value for Truman in the 2013 nursery. Although not all of these lines were retained because of agronomic performance that was inferior in some aspect, these data do suggest that we continue to make progress in our FHB screening program. It is of note also that mean FHBI for lines being verified (18.3%) was higher than the mean FHBI for lines undergoing their first field screening (14.2%). Again, this suggests progress. Ten retained lines were entered into the Northern and Preliminary Northern Nurseries for multi-location evaluation and can be freely crossed by other FHB interested scientists. These facts, coupled with the

fact that most of these lines contain 'native' sources of resistance, truly accelerates the development of FHB resistant varieties.

Impact:

Using sources of resistance that have been discovered in U.S. wheat (previously called 'native' resistance) has enabled us to have FHB resistance (including low FDK and low DON) in adapted and desirable genetic backgrounds. Coupling these factors with photoperiod insensitivity (a breeding goal for some of our material) will extend the range of these lines and when grown, immediately lessen the risk of FHB and mycotoxin contamination of the grain broadly across the soft red winter wheat region.

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?

Combining genetically different sources of FHB resistance into individual cultivars may increase the level of resistance, maintain resistance over broad geographical areas, and/or enhance resistance levels under heavy epidemics in any one geographical area. The use of native sources of resistance that are in broadly adapted genetic backgrounds, should accelerate the development of FHB resistant lines that also possess the agronomic traits necessary for immediate adoption within areas where FHB is a serious problem. Because wheat is self-pollinated, combining several sources of resistance into individual cultivars is labor intensive, requiring hand emasculation and pollinations. The use of genetic male sterility should enable these genetic combinations to be produced more easily resulting in highly useful, cross-composites of several different sources of resistance. These populations can be easily recombined with locally adapted sources, thereby shifting adaptation to the target environment of the local breeding program. Subsequently these populations can be used for selection for FHB, grain yield and relevant agronomic traits and those populations may also be shared among breeders in the target 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:

During the FY13 crop season, early and mid-season populations segregating for genetic male sterility were grown in Missouri. Each was surrounded with a composite of 7 elite Missouri lines that spanned the maturity of each male sterile population. Male sterile heads were identified, tagged, and intercrossed seed was harvested. Because of the lack of seed, screening for FHB has been postponed until several cycles of intercrossing were accomplished. Each year has resulted in more crossed seed being produced. The populations

will be screened for FHB resistance in 2014 and where desired, a few grams of intercrossed seed will be shared with interested breeders.

Impact:

This project is necessarily long term but has tremendous potential for impact by providing a mechanism to accumulate genes for FHB resistance from diverse sources in locally adapted backgrounds. These populations are simultaneously regional and local, providing both the opportunity for individual breeding programs to select genotypes with favorable local adaptation and the region-wide opportunity to 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. The breeding lines extracted from these populations have the potential to have unique combinations of FHB resistance genes.

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?**

Resistance in newly developed germplasm produced in all breeding programs where FHB resistance is an objective requires verification. The nursery systems including the Northern and Southern FHB nurseries as well as other cooperative performance nurseries including the Eastern Soft Red Winter Wheat Nursery and 5-State Advanced and Preliminary Nurseries provide an excellent opportunity to screen the most advanced soft red winter wheat varieties for FHB resistance and provide breeders with a number of location years of data each year. This multi-location testing would be cost prohibitive for most individual breeding programs. This cooperative effort also enables the exchange of information and germplasm throughout the participating breeding community. Finally, evaluation of the Official Variety Trials, immediately transfers FHB resistance information to the growers and permits more informed decisions regarding variety selection.

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.**

Accomplishment:

In FY13, we again entered 10 lines into either the Preliminary Northern or Northern FHB Winter Wheat Nurseries. We endeavored to enter only those lines with good agronomic performance and intentionally kept back lines with poorer agronomic performance so that breeders who crossed with our material would not have as much negative linkage drag. We phenotyped the replicated nursery for incidence, severity, FHBI, FDK and DON and provided this information to respective breeders by dissemination through the annual nursery

report. No Missouri entries were susceptible. Some were in the best group while others were 'middle of the road'. In 2013, we also phenotyped the Missouri Official Variety Trial (OVT) which had 119 entries. Average FHBI for the OVT was 11.6% disease (ranging from 1.8% to 37.6%). Most resistant was USG 3993. Other varieties that were highly resistant included Direct Edge, Merschman Katie 12, Delta Grow 7000, and XL Coop 180, all of which had an FHBI that was lower (although not statistically) than Truman. Fifty three varieties had an FHBI of less than 10%. Among the most susceptible were USG 3555, Medoc Valley MVI-16 Pioneer 26R50, VA10W-119, Medoc Valley MVI-exp and AgSouth 2038, all of which had an FHBI greater than 25%. Average DON content of these lines was 6.5 ppm with Truman averaging 3.2 ppm in this nursery set. More lines in this nursery had higher levels of resistance and this bodes well for reducing the threat of FHB in Missouri. Most were brands and probably originated from breeding programs supported by USWBSI funds. Finally, we phenotyped the Uniform Eastern Nursery and the 5-State Advanced and Preliminary Nurseries sharing information with the respective breeders through routine nursery reporting mechanisms.

Impact: This work helps validate sources of resistance from other breeding programs as well as from the Missouri program, thereby providing information on stability of resistance of newly developed germplasm. Evaluation of official breeding nurseries gives those breeders in public institutions and private companies who participate, multi-location FHB data that will inform their selection of superior lines. Finally, evaluation of the Official Variety Trials will immediately provide growers with FHB resistance levels on all commercial cultivars, thereby enabling more informed grower choices of varieties to plant on their respective farms which should lessen the threat of FHB across the region.

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.

No lines were released in 2013.

Two very early lines, however, were entered into preliminary increase (1 acre) with the Missouri Foundation Seed Organization and concurrently entered into the Eastern Nursery (MO 120187), and the 2014 5-State Advanced Nursery (MO 100172). MO 120187 is equal to or a day later than Ernie while MO 100172 is a day earlier than Ernie. In the 2013 Missouri environment, both out-yield Ernie by 112 and 115%, respectively. They out-yielded all checks by 104 and 107%, respectively. In 2013, MO 120187 finished second (statistically first) in 8 locations of the 5-State Advanced Nursery. Both lines carry FHB Truman family resistance. Levels are approximately equal to Bess.

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.

Liu S, Griffey CA, Hall MD, McKendry AL, Chen J, Brooks WS, Brown-Guedira G, Van Sanford D, Schmale DG (2013) Molecular characterization of field resistance to Fusarium had blight in two US soft red winter wheat cultivars. Theor Appl Genet 126:2485-2498

Wright E, Griffey C, Malla S, Van Sanford D, Harrison S, Murphy JP, Costa J, Milus G, Johnson J, McKendry A, Schmale III D, Clark A, McMaster N (2013) Characterization of FHB resistance in SRW Roane and Jamestown NAM Populations. In: S. Canty, A. Clark, Y. Salat, and D. Van Sanford (Eds), Proceedings of the 2013 National Fusarium Head Blight Forum (pp._) East Lansing MI/Lexington, KY:U.S. Wheat and Barley Scab Initiative