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

Cover Page

PI:	William Bockus
Institution:	Kansas State University
Address:	Department of Plant Pathology 4733 Throckmorton Hall Manhattan, KS 66506
E-mail:	Bockus@ksu.edu
Phone:	785-532-1378
Fax:	785-532-5692
Fiscal Year:	FY13
USDA-ARS Agreement ID:	59-0206-1-110
USDA-ARS Agreement Title:	Development of Scab Resistant Wheat Cultivars for Kansas.
FY13 USDA-ARS Award Amount:	$ 37,270

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Development of Scab Resistant Wheat Cultivars for Kansas.	$ 37,270
	FY13 Total ARS Award Amount	**$ 37,270**

William H. Bockus — June 12 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: *Development of Scab Resistant Wheat Cultivars for Kansas.*

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

Serious scab (Fusarium head blight) epidemics occurred in Kansas in 1982, 1990, 1993, 1995, 2008, and 2009 and annual losses average $6.5 million. Approximately one million acres of wheat in the eastern part of Kansas are annually at risk from scab where rainfall is higher during heading and corn residue is more prevalent. Since 1980, wheat acreage in the eastern one quarter of Kansas has declined by two thirds and a major cause of the decline has been farmer aversion to the risk of scab epidemics. Therefore, the availability of cultivars with resistance to scab is highly desirable for eastern Kansas. Additionally, there are two main reasons that scab has the potential to become much more prevalent in central Kansas where wheat is the traditional dominant crop (about 4 million additional wheat acres). First, there is a trend for increasing cultivation of corn in that part of the state, the main reservoir of inoculum of the scab pathogen. Second, there is a strong trend for decreasing tillage, which enhances spore production and release from the residue. Resistant wheat cultivars adapted to this area of Kansas would also be highly desirable. Genetic resistance offers the best hope for economic management of this disease. The long-term goal of this research is to develop hard red and hard white winter wheat cultivars adapted for Kansas with improved resistance to scab. Short term objectives are to: 1) test existing local cultivars for resistance, 2) test advanced breeding lines for resistance, 3) test exotic germplasm lines for resistance, 4) test the Hard Winter Wheat (Kansas, Nebraska, South Dakota, North Dakota) Scab Nursery for reaction to scab, and 5) incorporate new sources of scab resistance into the Kansas wheat breeding program. Testing will be done in misted field nurseries using soil-applied infested corn grain inoculum and in the greenhouse using single-floret inoculations. Visual disease evaluation methods will be used to rate the percentage spikelets killed by the pathogen and ground grain samples will be analyzed for the toxin DON. Data will be disseminated to wheat producers and used by wheat breeders as they make selections for future Kansas cultivars.

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:

<u>Accomplishment:</u>

Until involvement in the USDA Scab Initiative, there was virtually no effort to identify sources of scab resistance in Kansas breeding programs. The Initiative has resulted in the development of accurate and efficient greenhouse and field testing nurseries that are providing useful ratings for current cultivars in Kansas and advanced breeding lines, and allow participation in the regional scab nurseries. Respectively, these nurseries allow dissemination of information to growers on the reaction of current commercial cultivars, selection by breeders for scab resistance in their breeding lines, and identification of additional sources of resistance from other breeding efforts in the region that can be

incorporated into Kansas breeding lines. Kansas has also taken the lead in organizing a Hard Winter Wheat Scab Screening Nursery for the hard winter wheat breeding programs of Kansas, Nebraska, South Dakota, and North Dakota. This latter nursery provides valuable data on the reaction of hard winter wheat cultivars to scab in their area of adaptation. The long-term goal of the research is to develop, deploy, and advertise winter wheat cultivars adapted for Kansas with improved levels of resistance to scab. In 2009, Kansas released the first hard red winter wheat cultivar adapted to Kansas with improved levels of resistance to scab.

Impact:

Two commercial cultivars in Kansas (Hondo and Heyne) were identified in 2000 (and confirmed in later years) as having good levels of scab resistance (3 and 4 on the 1-9 scale where 1=immune and 9=highly susceptible). These cultivars averaged only 12 and 15% scab, respectively compared with about 50% in susceptible cultivars. Similarly, the cultivar Lakin has shown moderate levels of resistance with 22-34% scab. Six other commercial cultivars have also displayed moderate levels of resistance equal to, or better than, Lakin. Therefore, we have identified a few sources of scab resistance already present in cultivars adapted to Kansas that can be used by producers and may be potential sources of "native" resistance for the development of future cultivars. Both KSU wheat breeders and the USDA wheat geneticist have been involved in the project by having their breeding lines evaluated for resistance to scab. Several breeding "populations" are tested each year from which the breeders make selections of promising lines showing resistance. Also, there are approximately 40 advanced breeding lines (The Kansas Intrastate Nursery) that are tested each year. Because of the scab testing efforts, a new column for reaction to "Head Scab" was added to the popular KSU extension publication *Wheat Variety Disease and Insect Ratings* for the fall, 2000 issue and has been updated in each subsequent year. For the first time, this has allowed producers in Kansas to use the reaction to scab to help select cultivars for planting. Similarly, data produced from nurseries funded by the Scab Initiative have recently been incorporated into another popular extension publication (*Kansas Performance Tests with Winter Wheat Varieties*). Both publications are available as "hard copy" or online. The involvement of breeders and the wheat geneticist has resulted in significant progress to improve the level of resistance to scab in future commercial wheat cultivars. This research has resulted in a germplasm release in 2004 from Kansas State University with resistance to scab derived from *Triticum timopheevii* ssp. *armeniacum*. It normally takes 10-12 years to produce a new cultivar from the time initial crosses are made. Right on schedule, the first Kansas scab-resistant cultivar (Everest) produced directly from the activity of the Initiative was released in Fall 2009, 10 years after beginning to receive funding from the Initiative. It has increased in popularity so that it is now is the number one planted cultivar in Kansas. The adoption of this cultivar has significantly lowered the susceptibility of the state's wheat crop to scab; 17% statewide and 33% in the eastern part of the state where scab is prevalent.

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.

Friebe, B., Bockus, W. W., Chen, P.D., Qi, L. L., Cainong, J., Wilson, D. L., Raupp, W. J., Poland, J., Bowden, R. L., Fritz, A. K., and Gill, B. S. 2013. Notice of release of KS14WGRC61 Fusarium head blight-resistant wheat germ plasm. The Kansas Agricultural Experiment Station, Manhattan.

This germ plasm line expresses moderate resistance to Fusarium head blight.

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, F., Zhang, D., Bockus, W., Baenziger, S., Carver, B., and Bai, G. 2013. Fusarium head blight resistance in U.S. winter wheat cultivars and elite breeding lines. Crop Science 53:2006-2013, doi: 10:2135/cropsci2012.09.0531

Wegulo, S. N., Bockus, W. W., Hernandez Nopsa, J. F., Peiris, K. H. S., and Dowell, F. E. 2013. Integration of fungicide application and cultivar resistance to manage Fusarium head blight in wheat. Pages 35-54 in: Fungicides – Showcases of Integrated Plant Disease Management from Around the World. M. Nita (Ed.). InTech. Rijeka, Croatia.

Bockus, W. W., De Wolf, E., and Wegulo, S. N. 2013. Effect of foliar fungicide application on Fusarium head blight in eight winter wheat cultivars, 2012. (online) Plant Disease Management Reports 7:CF018. DOI:10.1094/PDMR07. The American Phytopathological Society, St. Paul, MN.

Bockus, W. W., Zhang, G., Fritz, A., Davis, M., Baenziger, P., and Berzonsky, W. 2013. Reaction of Kansas, Nebraska, and South Dakota winter wheat accessions to Fusarium head blight (FHB), 2012. (online) Plant Disease Management Reports 7:CF019. DOI:10.1094/PDMR07. The American Phytopathological Society, St. Paul, MN.

Lingenfelser, J., Bockus, B., DeWolf, E., Fritz, A., Knapp, M., Whitworth, J., Miller, R., Shoryer, J., Adee, E., Cramer, G., Kimball, J., Nelson, R., Evans, P., Kusel, K., Schlegel, A., Seaman, C., Spangler, M., Zhang, G., Chen, M., Chen, R., and Knopf, J. 2013 Performance Tests. Pages 6-29 in: 2013 Kansas Wheat Seed Book. Kansas State University Agricultural Experiment Station and Cooperative Extension Service Report of Progress No. 1090. 52 pp.

De Wolf, E. D., Bockus, W. W., and Whitworth, J. R. 2013. Wheat Variety Disease and Insect Ratings 2013. Kansas Cooperative Extension Service publication MF-991. 4 pp.

Appel, J. A., De Wolf, E., Bockus, W. W., and Todd, T. 2013. Preliminary 2013 Kansas Wheat Disease Loss Estimates. Kansas Cooperative Plant Disease Survey Report. (http://agriculture.ks.gov/docs/default-source/pp-disease-reports-2012/2013-ks-wheat-disease-loss-estimates44D2D289EE71.pdf?sfvrsn=6)

Peiris, K.H.S., Dong, Y., Bockus, W.W., and Dowell, F. E. 2013. Estimation of bulk DON content of small grain samples for comprehensive evaluation of Fusarium head blight resistance in wheat. Full-length paper and presentation at the 2013 meeting of the American Society of Agricultural and Biological Engineers. Kansas City, MO.

Peiris, K.H.S., Dong, Y., Bockus, W.W., and Dowell, F. E. 2013. Estimation of bulk deoxynivalenol and moisture content of wheat grain samples by FT-NIR spectroscopy. Full-length-paper and presentation at the 2013 meeting of the American Society of Agricultural and Biological Engineers. Kansas City, MO.

Cai, J., Bai, G., Jin, F., St. Amand, P., Bockus, W. and Beenziger, S. 2013. "Effects of *Fhb1* on resistance to wheat FHB in different hard winter wheats." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 12). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Peiris, K. H. S., Bockus, W. W., and Dowell, F. E. 2013. "Patterns of single kernel deoxynivalenol levels in artificially inoculated wheat spikes as a detected by near infrared spectroscopy." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 36). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Eckard, J. T., Gonzalez-Hernandez, J. L., Berzonsky, W. A., Bockus, W., and Marais, G. F. 2013. "Native Fusarium head blight resistance from 'Lyman', 'Overland', 'Ernie' and 'Freedom" wheat cultivars pyramided onto Wesley-*FHB1* backgrounds using a family-based mapping approach." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 17). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.

Friebe, B., Cainong, J. Chen, P., Bockus, W. W. and Gill, B. S. 2013. "Transfer of Fusarium head blight resistance from *Elymus tsukushiensis* to wheat via a T1AL.1AS-1E^{TS}#1S translocation." In: S. Canty, A. Clark, Y. Salat and D. Van Sanford (Eds.), *Proceedings of the 2013 National Fusarium Head Blight Forum* (p. 68). East Lansing, MI/Lexington, KY: U.S. Wheat & Barley Scab Initiative.