USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
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Cover Page

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0206-9-055
USDA-ARS Agreement Title:	Enhance Variety Development of Scab Resistant Hard Winter Wheat Varieties in Nebraska.
FY10 USDA-ARS Award Amount:	$ 56,293

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	To Enhance Variety Development of Scab Resistant Hard Winter Wheat Varieties and their Management in Nebraska to Reduce DON.	$ 53,976
HWW-CP	Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.	$ 2,317
	Total ARS Award Amount	**$ 56,293**

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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: *To Enhance Variety Development of Scab Resistant Hard Winter Wheat Varieties and their Management in Nebraska to Reduce DON.*

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

In 2007 and 2008, major scab epidemics occurred in eastern NE (approximately 600,000 acres of wheat production). In 2009, scab was found in every part of the state (1,700,000 acres), fortunately at low levels. In 2010 and 2011, scab was found mainly in the southeastern, south central and southwestern NE, again fortunately at low levels. Genetically improved seed coupled with appropriate management practices (cultural practices and fungicide uses) are the quickest and most cost effective ways to reduce DON in the grain supply. We are using conventional breeding methods of crossing elite adapted lines to lines with known scab resistance/tolerance QTLs (*Fhb1*, *5As*, and *Fhb3*) coupled with molecular markers to breed elite adapted lines with major scab resistance/tolerance QTLs. We are also making numerous crosses to elite lines with scab tolerance using native resistance (e.g. crosses to Overland, Lyman, Hitch, Art, Everest, and various hard spring and soft winter wheat cultivars). We continue to select lines on the basis of their haplotypes (when we have markers), and greenhouse and field resistance levels, as well as the full set of traits needed for a commercial cultivar. We are also evaluating elite Wesley *Fhb1* backcross populations (developed by Guihua Bai) with South Dakota State University to determine if any of the lines have merit as a cultivar release. Wesley remains a popular cultivar in Nebraska and in South Dakota and a replacement with a Wesley *Fhb1* line would have immediate impact. Minimally, we will identify an elite parent line for making better crosses and for studying disease management (e.g. fungicidal treatments may work on partially resistant or tolerant lines than on totally susceptible lines). In addition to studying the Wesley *Fhb1* backcross lines, we are studying a single seed descent derived population segregating for *Fhb1* to determine if the gene or gene(s) linked to it may reduce grain yield. We remain perplexed at why after making numerous crosses, we have relatively few *Fhb1* lines advanced to the elite trials. We tested all later generation lines in our mist nurseries to identify *Fhb1* and native resistance. We tested Northern Hard Winter Wheat FHB Nursery (coordinated by Dr. Bill Bockus) and NUWWSN nurseries along with the regional Germplasm Observations Nursery (RGON) at misted inoculated locations to provide regional data to better understand our germplasm and its level of tolerance to this devastating disease.

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: NE01481 was sold to certified seed producers for the first time in 2010 and will be marketed as Husker Genetics Brand McGill. McGill couples a moderate level of scab tolerance (superior to many other widely grown cultivars) with excellent wheat soilborne wheat mosaic virus resistance and agronomic performance and acceptable end-use quality. This combination of traits makes the lines highly desirable for production in the key scab prone regions of Nebraska.

Impact: It is too early to know the impact of McGill. Certified seed is being produced on 360 acres which means approximately 18,000 acres could be planted by producers in 2011-2012. A previous release with very good native resistance, Overland, is now the most popular cultivar in Nebraska and is grown in South Dakota, North Dakota, Minnesota, and Kansas. McGill will be an excellent complementary wheat cultivar to Overland and combined with Lyman (South Dakota State University), Art (Syngenta), Hitch (Westbred/Monsanto), and Everest (Kansas State University), wheat producers in the northern Great Plains have excellent lines to grow that will reduce the effects of scab.

Project 2: *Using Association Mapping to Identify and Validate New FHB Resistance QTL and Integrate the QTL into HWW.*

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

Major scab epidemics have occurred in the HWW region. Genetically improved seed coupled with appropriate management practices are the quickest and most cost effective way to reduce DON in the grain supply. However, little is known concerning the genetic basis of native resistance in the Great Plains germplasm and how best to effectively utilize it. Using association mapping techniques, we will be able to validate reported QTLs and identify new QTLs in HWW germplasm, and move from molecular mapping to marker-assisted breeding. For this research we used selected lines from numerous sources that we have identified as being important in the creation of hard winter FHB tolerant lines. The key to this research will be to maximize the information we are already collected from our existing FHB screening nurseries, such as advanced regional lines and lines that were tested in our state variety trials. Our goal is to use 188 wheat lines including native sources of resistance (e.g. Henye. Lakin, Arapahoe, Everest, Overland, Settler CL, Lyman, Art, Hitch); DON accumulators (e.g. Harry and Trego); a series of backcross lines (Fhb1 and/or Fhb3 in Trego, Wesley, Harding, Overley, Jagger and Overland); and some accessions with various levels of FHB resistance from China and/or Japan (to look for new alleles and increase our diversity). ***Phenotypic data:*** All accessions are phenotyped for FHB resistance by needle inoculation in the greenhouse at KSU and SDSU, respectively and irrigated FHB winter wheat nurseries in KS, NE, and SD. Bulk samples from these phenotpying nurseries are submitted for objective FHB evaluation and DON analysis (in cooperation with Dr. Floyd Dowell). ***Genotyping Using Molecular Markers:*** For marker analysis, all accessions will be analyzed for structure with at least 100 genome-wide SSR markers at the USDA Genotyping Lab in Manhattan. We will also genotype the accessions using all reported markers linked to known FHB QTLs (about 50) and 9K single nucleotide polymorphism (SNP) chip for higher resolution QTL mapping. The diversity of lines should be adequate for association mapping studies and allow most important alleles to be identified, as well as some of their epistatic interactions. We believe that between the SSR and SNP markers (as well as some STS markers linked to QTLs) we will have adequate genome coverage for

association mapping. ***Data Analysis:*** The data will be analyzed using the software developed by Dr. Dong Wang to identify major genes and epistatic gene interactions that control FHB tolerance and help reduce DON. PowerMarker software will be used to calculate values of gene diversity, and distance-based cluster analysis using the UPGMA algorithm. A model-based (Bayesian) software package Structure 2.1 (Pritchard and others 2000) will be used to assess the number of subpopulations among all accessions. Information on marker distribution in wheat genomes was obtained from the consensus map (Somers et al 2004). Pair-wise LD will be calculated using TASSEL 1.9.4 (http://www.maizegenetics.net). A database with all marker allele information will be developed for all the evaluated accessions and breeders will use them to select appropriate parents for crosses. We have chosen this approach because it directly compares our native sources of resistance (including our commercial lines), with known Asian sources of resistance at both phenotypic and genotypic levels.

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: Phenotypic data for FHB have been obtained for one field and two greenhouse experiments in Manhattan, KS. About 110 SSR markers have been screened for the population. In addition, the population was also screened with 9K SNP chip from Illumina and data scoring and analysis are in progress.

Impact: The phenotypic data of the population collected from both field and greenhouse environment will be important for breeders to select right parents for crosses because the population mainly consisted of elite breeding materials and new varieties that they use most often as parents in their crosses. The 9K SNP data for the population will be a useful resource for developing SNP markers linked to important QTLs in HWW.

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.

NE01481 (will be sold as Husker Genetics Brand McGill) and NI04421 (will be sold as Husker Genetics Brand Robidoux).

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.

Baenziger, P.S., R. A. Graybosch, L. A. Nelson, T. Regassa, R. N. Klein, D. D. Baltensperger, D. K. Santra, A. M. H. Ibrahim, W. Berzonsky, J. M. Krall, L. Xu, S. N. Wegulo, M. L. Bernards, Y. Jin, J. Kolmer, J. H. Hatchett, Ming-Shun Chen, and Guihua Bai. 2011. Registration of 'NH03614 CL' Wheat. J. Plant Registrations 5: 75-80.

Baenziger, P.S., R. A. Graybosch, T. Regassa, L. A. Nelson, R. N. Klein, D. K. Santra, D. D. Baltensperger, L. Xu, S. N. Wegulo, Y. Jin, J. Kolmer, Ming-Shun Chen, and Guihua Bai. Registration of 'NE01481' (Husker Genetics Brand McGill) Hard Red Winter Wheat. J. Plant Registrations: accepted.

Bockus, W. W., Baenziger, P. S., and Berzonsky, W. 2011. Reaction of Kansas, Nebraska, and South Dakota winter wheat accessions to Fusarium head blight (FHB), 2010. Plant Disease Management Reports (online). Report 5:CF008. DOI:10.1094/PDMR05 The American Phytopathological Society, St. Paul, MN.

Graybosch, R. A. C.J. Peterson, P. S. Baenziger, D. D. Baltensperger, L. A. Nelson, Y. Jin. J. Kolmer, B. Seabourn, and B. Beecher. Registration of ‘Anton’ hard red winter wheat. Journal of Plant Registrations., In Press.

Wegulo, S. N., Bockus, W. W., Hernandez Nopsa, J., De Wolf, E. D., and Eskridge, K. M., Peiris, K. H. S., and Dowell, F. E. 2011. Effects of integrating cultivar resistance and fungicide application on Fusarium head blight and deoxynivalenol in winter wheat. Plant Dis. 95:554-560.