USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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USDA-ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY06 ARS Award Amount:	$ 126,218

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
HGR	Introgression and Genetics of Novel Sources of Scab Resistance in Winter Wheat.	$ 47,810
VDUN	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	$ 78,408
	Total Award Amount	**$ 126,218**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Introgression and Genetics of Novel Sources of Scab Resistance in Winter Wheat.*

1. **What major problem or issue is being resolved and how are you resolving it?** The most economical solution to the problem of Fusarium head blight losses in wheat is the discovery and introgression of novel sources of resistance into advanced lines in breeding programs. The identification of genetically different sources of resistance will enable breeders to stack these genes into single cultivars thereby either enhancing the level of resistance per se or expanding the use of these resistances over broad geographical areas. This project sought to: (1) introgress unadapted winter wheat FHB resistant germplasm carrying putatively novel sources of resistance into widely adapted soft red winter wheat cultivars; (2) phenotype doubled haploid populations that contain novel FHB resistance alleles and (3) haplotype, 150 germplasm lines with verified, FHB resistance.

2. **List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):**

   Accomplishment 1: In collaboration with Dr. Gina Brown-Guedira, parents of lines for doubled haploid development were haplotyped with SSRs linked to known sources of resistance including Sumai 3, Frontana, Roane, W14, Ning 7840, Maringa, Ernie and Wuhan 1. Our goal was to identify novel sources among germplasm lines identified through previous USWBSI funded germplasm screening. Thirty-two lines acquired from the US National Collection including highly resistant lines from Argentina, Brazil, Japan, Italy, South Korea, China and Eastern Europe were haplotyped. Only 2 lines – both from Japan - had the critical 3BS marker set from Sumai 3/Ning 7840. Twenty-seven lines did not contain the 3BS, 3BSc or 5AS critical markers and six lines that were cultivated, from Brazil, Japan, and South Korea contained no known markers – suggesting resistance in these lines could be different from all other known sources.

   Impact: This preliminary genetic analysis suggests that these lines differ in their resistance to FHB. They will make ideal candidates for further genetic analyses. Once markers are identified within this group, they will be inherently valuable to breeders wishing to stack different FHB genes into their varieties thus enhancing resistance and reducing economic losses resulting from FHB.

   As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? Prior to haplotyping, all of these materials were distributed to interested breeders, thus they have access to these novel sources of resistance. Once markers are identified, they will be made available for marker-assisted-selection. Status of the work: doubled haploid populations have been developed for seven of these sources with previous funding. Populations were expected to be phenotyped but a severe reduction in the budget led to the loss of a technician who has yet to be replaced. Populations will be phenotyped and genotyped as funds/time permit.

   Accomplishment 2. A further set of 96 geographically diverse winter wheat lines, identified through previous USWBSI germplasm funding were haplotyped using 44 SSRs previously identified in the refereed literature as being associated with known sources of resistance. Lines were acquired through an earlier collaboration with CIMMYT, and included lines

from CIMMYT per se, Romania, China, Argentina, Brazil, Hungary, Italy, and Japan. As was the case with germplasm acquired from the National Collection described above, many of these lines did not contain critical 3BS, 3BSc, and 5AS markers that are common in known sources of resistance.

Impact: As indicated above, this preliminary genetic analysis suggests that these lines differ in their resistance to FHB. They will make ideal candidates for further genetic analyses. Marker work should be done on the most resistant and most adapted lines within this group. Once completed, they will add to the diverse sources of resistance available to wheat breeders nationally and once introgressed will aid in reducing economic losses resulting from FHB.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? As with germplasm from the National Small Grains Collection, these materials have all been made available over the past 5 years to interested breeders, thus they already have access to these novel sources of resistance. A manuscript is under preparation to transfer this knowledge to the scientific community through the peer-reviewed literature. Breeders will then be able to make more informed decisions regarding sources of FHB resistance.

Accomplishment 3. In 2006, heads were selected from 30 F5 populations developed from 3-4 FHB resistant parents that had undergone 4 cycles of mass selection for FHB resistance under heavy disease pressure. Population construction was a cross-composite of adapted and unadapted sources of resistance. Unadapted germplasm resources came from lines identified through germplasm screening efforts at Missouri. Adapted resources included well known FHB resistant soft red winter wheats including Ernie, Truman, Bess, Roane, Patton and Goldfield. 30-40 heads were selected from each plot and planted as head rows for evaluation of agronomic performance in the summer of 2007. Approximately 100 lines were identified in June 2007 for inclusion in preliminary yield trials in 2008.

Impact: Once we complete performance testing, these lines, which contain multiple sources of resistance, will be haplotyped to confirm resistance genes and made available to growers as alternatives to susceptible wheat varieties currently in the market place or will be used as parents in the Missouri breeding program. They will be shared with other breeders through the uniform scab nursery system. When grown, they will lessen the economic losses caused by FHB in the soft red winter wheat growing region.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? These lines, once sufficiently performance tested, will be made available to other USWBSI scientists through the cooperative nursery system. They will be made available as appropriate to growers in Missouri and surrounding states as complementary varieties to those FHB resistant varieties, including Ernie, Bess and Truman, already released from the Missouri breeding program. Where performance is not superior, they will be used as parents in the Missouri breeding program.

Project 2: *Accelerating the Development of Scab Resistant Soft Red Winter Wheat.*

1. **What major problem or issue is being resolved 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 because of the lack of resistant cultivars. This project has focused largely on the exploiting incidental sources of resistance identified in Missouri wheat germplasm, a process that accelerates the development and release of FHB resistant cultivars. In 2006 we had several objectives including: (1) identification, verification, and introgression of useful sources of FHB resistance through routine greenhouse and field screening of all advanced breeding lines in the Missouri wheat breeding program; (2) phenotypic characterization of 600 F_7 recombinant inbred lines (RILs) to study the FHB resistance in Truman; (3) diallel analysis of combining ability of 15 highly resistant winter wheat genotypes with and without the 3BS marker. We also evaluated the Northern and Southern Uniform Winter Wheat Scab Nurseries in field screening environments.

2. **List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):**

   Accomplishment 1: Preliminary greenhouse phenotyping of 630 RILs developed from the cross Truman/MO 94-317 was completed in 2006. The population was also increased for field screening in the 2008 crop season. Analysis of the data indicates that resistance is quantitative and distributions are skewed towards resistance, suggesting it will be a good parent for FHB-resistance breeding. A sub-sample of the population (about 250 RILs) will be re-evaluated in replicated experiments in the greenhouse and field in 2007/08 and mapping will begin in that season.

   Impact: Truman, the resistant check in the Northern Scab Nursery, is arguably the most FHB resistant cultivar available to growers in the soft red winter wheat region. It is widely adapted and has excellent yield potential along with excellent test weight and stripe rust resistance. It has immediately lessened economic losses due to FHB in many regions. Haplotying indicates that is potentially carries FHB alleles that differ from others now in use. Once markers are identified and published, this will be a valuable resource for marker-assisted selection.

   As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? Once identified and published through the peer-reviewed literature, markers from Truman will be an extremely valuable addition to the set currently in use for marker-assisted-selection.

   Accomplishment 2: Diallel analyses of a diverse set of winter wheat FHB resistant resources were completed in 2006, providing information on both general- and specific-combining-ability. Results indicated that Truman, R243 (a Hungarian line developed from Sumai 3 and Nobeokabouzu in an adapted background) and a Chinese land race Ling Hai Mao Yang Mo, (identified at Missouri) were the best general combiners of the twenty sources evaluated.

Impact: Knowledge of the FHB resistance level is often not enough to make informed decisions about which resources to use in breeding programs in that resistance may, or may not combine well when used in crosses. This information, once published, will provide interested breeders with information on both general and specific combining ability of a number of FHB-resistant resources and will facilitate more informed decisions when selecting parents. Ultimately this should accelerate the development of FHB-resistant soft red winter wheats.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? Once this information is transferred through the peer-reviewed literature, breeders will have one more piece of information to help inform their decisions on parental selection in programs aimed at developing FHB-resistant winter wheats.

Accomplishment 3: The Missouri program continues to focus on incidental sources of resistance. Resistant varieties have been identified and released through this process including Ernie, Truman and Bess and potentially new sources continue to be identified. In 2006, we verified resistances in advanced yield trials and preliminarily screened approximately 300 lines from preliminary yield trials. Most of our material now has at least one FHB-resistant parent and much of it has two FHB resistant parents. In 2006, 45 lines (33 pedigrees) in advanced Missouri testing had verified resistance levels exceeding that of Ernie, and 15 lines had verified resistance levels that equal or exceed those of Truman and Sumai 3.

Impact: The release of FHB-resistant cultivars is the primary goal of the USWBSI. Our program has had considerable success focusing on incidental resistance through screening and recombining in adapted backgrounds, these unique resistances. These 15 lines, in advanced stages of testing, have most of the attributes necessary for release and will immediately lessen the devastating impact of FHB in Missouri and the surrounding states.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before? These lines, identified or developed within the Missouri program will provide the agricultural community I serve in Missouri and the surrounding state with continued access to FHB-resistant wheat varieties. When these lines are shared, through the uniform scab nursery system, breeders in other states will also be able to utilize these resources, either as parents or directly as cultivars through joint release.

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.

Published:

Liu, S., Z.A. Abate, H. Lu, T. Musket, G.L. Davis, and A.L. McKendry. 2007. QTL associated with Fusarium head blight resistance in the soft red winter wheat Ernie. Theor. Appl. Genet. DOI 10.1007/s00122-007-0577-2.

McKendry, A.L., D.N. Tague, R.L. Wright, and J.A. Tremain. 2007. Registration of 'Bess' Wheat. Journal of Plant Registrations, 1:21-23.

Abate, Z.A., D.N. Tague, and A.L. McKendry. 2006. Diallel analysis of Fusarium head blight resistance in genetically diverse winter wheat germplasm. In: Cant, S.M., Clark, A., and Van Sanford, D. (Eds.) Proceedings of the 2006 National Fusarium Head Blight Forum. 2006 Dec. 10-12; Research Triangle Park, NC. pp. 73-77.

Abate, Z.A., S. Liu, and A.L. McKendry. 2006. QTL associated with low deoxynivalenol and kernel quality retention in the Fusarium head blight resistant cultivar Ernie. In: Cant, S.M., Clark, A., and Van Sanford, D. (Eds.) Proceedings of the 2006 National Fusarium Head Blight Forum. 2006 Dec. 10-12; Research Triangle Park, NC. pp. 78-81.

Under Review/In Preparation

Abate, Z.A., S. Liu, and A.L. McKendry. 2007. Quantitative trait loci associated with deoxynivalenol content and kernel quality in the soft red winter wheat Ernie. Submitted: Crop Sci.

Abate, Z.A., D.N. Tague, and A.L. McKendry. 2007. Diallel analysis of Fusarium head blight resistance in genetically diverse winter wheat germplasm. In final preparation: Crop Sci.