

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY05 Final Performance Report (approx. May 05 – April 06)
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Cover Page

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FY05 ARS Agreement ID:	59-0790-4-113
Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY05 ARS Award Amount:	\$ 158,651

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
GIE	Winter Wheat Germplasm Introduction and Evaluation.	\$ 76,700
VDUN	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	\$ 81,951
	Total Award Amount	\$ 158,651

Principal Investigator

Date

* BIO – Biotechnology
 CBC – Chemical & Biological Control
 EDM – Epidemiology & Disease Management
 FSTU – Food Safety, Toxicology, & Utilization
 GIE – Germplasm Introduction & Enhancement
 VDUN – Variety Development & Uniform Nurseries

Project 1: Winter Wheat Germplasm Introduction and Evaluation.**1. What major problem or issue is being resolved and how are you resolving it?**

Host plant resistance has long been considered the most practical and effective means of control for Fusarium head blight (FHB; scab) caused by *Fusarium graminearum* Schwabe (teleomorph *Gibberella zeae* (Schwein.)), however, breeding for FHB resistance has been hindered by a lack of effective, highly resistant genetic resources. Since 1999, this project has been involved in aggressively searching for new sources of resistance by systematically screening accessions in the national collection from targeted geographical regions where FHB is a known problem. To date, more than 7500 accessions have been screened. In 2005, this project evaluated lines from Eastern Europe, particularly from Turkey (345 accessions), and the Czech Republic (48) that were breeding lines, cultivated lines or cultivars. A second objective was to introgress new sources of resistance into widely adapted soft red winter wheat backgrounds while a third was the increase of mapping populations for genetic characterization of newly identified sources of 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. Of 345 accessions evaluated under field conditions, 107 lines had resistance levels below 20% infection (compared to 80% for susceptible checks) which is a level of resistance comparable to that found in Ernie soft red winter wheat. Eight were from the Czech Republic while the remaining 99 were from Turkey. This level of resistance in Turkish material is higher than the typical frequency of resistance lines identified from other targeted regions of Europe. Of the 107 lines, 25 were considered highly resistant, with a FHB index (incidence x severity) of less than 10% while 5 lines had a field index under 5%. All but one of the best lines were cultivated lines from Turkey and hence had better breeding value than resistances identified in land races in earlier years of the work. In 2006, resistance in these top 25 lines will be verified and lines continuing to show resistance will be haplotyped to determine if they are genetically unique.

Impact: This research continues to identify new and potentially novel sources of resistance to scab. If novel, these sources will provide breeders with additional sources of resistance for their breeding programs, thereby broadening the base of scab resistance and enabling breeders to develop lines either with improved levels of resistance or resistance that is effective over broader geographic regions. Once incorporated into adapted lines, these new sources of resistance should lessen the losses associated with scab, thereby enhancing the economy of wheat production nationally.

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?:

This research, once completed, should provide breeders with potentially novel sources of resistance that otherwise would not have been discovered. Novel sources, when incorporated into advanced breeding lines, should help to lessen the devastating impact of scab on the US farm economy.

Accomplishment: 2. Doubled haploid mapping populations for 7 lines that do not carry markers for known sources of FHB (shown through haplotyping) were completed and increased. These lines include two lines from Italy, one line from Japan, a line from South Korea, and 3 Chinese land races that were identified through germplasm evaluation efforts at Missouri.

Impact: These mapping populations will enable the genetic characterization of resistance in these diverse resources which will, once completed, increase the utilization of these resources in breeding programs nationally. Combining these new genes with those derived from other cultivars should increase resistance levels per se or enable the development of resistance that is effective over broader geographic regions.

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 research is complete, the breeding community potentially will have new scab markers for use in marker assisted selection programs. This should accelerate the development of scab resistant wheat varieties and in turn, lessen the impact of FHB on wheat production in regions where scab is a major threat.

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 graminearum Schwabe (teleomorph *Gibberella zeae* (Schwein.), is an increasingly important problem in the north-central region of the United States because of the lack of resistant cultivars. The objectives of this project included: (1) the verification of useful sources of scab resistance through routine greenhouse and field screening of all advanced breeding lines in the Missouri wheat breeding program; (2) the identification and verification of useful sources of scab resistance through evaluation of both the Northern and Southern Uniform Winter Wheat Scab Nurseries in greenhouse and field screening environments; and (3) the incorporation of new sources of resistance, as they are verified, into elite Missouri soft red winter wheat breeding lines; (4) the completion of a mapping population to characterize the genetics of resistance in Truman.

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. The most significant accomplishment in 2005 was the region-wide release of the early maturity variety Bess which was released to Missouri growers in 2004. This variety, which is a full sib of Truman, has broad based scab resistance comparable to Truman, excellent yield and test weight potential and resistance to stripe rust.

Impact: The release of Bess from the Missouri breeding program provides growers in the soft red winter wheat region with a widely adapted cultivar that has excellent agronomic performance coupled with scab resistance levels that are more broadly based than the best Asian resistance sources. It has been widely accepted in Missouri for those growers seeking an earlier maturing scab resistant line for double crop environments. Because of its broad adaptation, its release outside Missouri will provide immediate impact for growers by improving the economic viability of winter wheat across the region, particularly in years when the impact of scab is severe. As Bess is public release known to differ from Asian sources, it will provide a potentially unique source of resistance for other U.S. breeders to utilize.

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 a result of this accomplishment and previous accomplishments (release of Truman in 2004), growers in Missouri and beyond have a choice of highly scab resistant, agronomically desirable varieties that either fit a full-season wheat cropping environment (Truman) or a double cropping environment (Bess). Researchers have a source of resistance that differs (based on haplotyping) from other known sources of resistance for use in their breeding programs.

Accomplishment: 2. Beyond the release of Bess, resistance levels within the Missouri breeding program continue to improve and many advanced lines now contain resistance from Truman, Ernie, the 3BS source and combinations of these sources. In 2005, 357 advanced lines from preliminary yield trials were evaluated for FHB resistance in the greenhouse. Of these, 228 (64%) were identified with levels of type II resistance necessary for good field performance.

Under field evaluations, the mean FHBI (incidence x severity) of these 228 lines was 24.2%. 136 lines from 100 pedigrees had an FHBI that was less than 20% (comparable to or better than Ernie) and among these, 47 advanced lines were classified as highly resistant with an FHBI less than 10% and 10 lines had an FHBI of less than 5% under heavy disease pressure. Of the 136 lines retained for further evaluation, 3 combined resistances from Truman and the 3BS source, 11 carried 3BS, 22 carried the Ernie source, 23 carried the Truman source, 1 combined the 3BS source with that from Ernie, and 3 combined resistances from Ernie and Truman. 73 lines carried incidental sources known to be in the Missouri breeding material but as yet are uncharacterized.

Impact: Advanced lines in Missouri are field evaluated for scab only after they have been shown to have superior agronomic performance. These lines serve as the breeding pipeline for scab resistant lines in Missouri and beyond and will ensure new, competitive scab resistant cultivars. Releases from among these lines should ensure that the impact of scab on the farm economy is lessened into the future.

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 a consequence of this research, new sources of scab resistance have been identified in adapted, agronomically superior, soft red winter wheat backgrounds and previously known sources of resistance have been combined into individual cultivars. As most Missouri lines are public releases this accomplishment will provide researchers with potentially novel sources of resistance for their various breeding programs and growers with choice of genetically divergent, resistant cultivars.

Accomplishment: 3. A set of recombinant inbred lines developed from the cross Truman/MO 94-317 was completed.

Impact: Truman is a highly resistant wheat cultivar that has broad-based resistance including type I, type II, low DON and good kernel quality. Haplotyping has shown that it does not contain known FHB markers and therefore may be a unique source of resistance. This mapping population will enable the genetic characterization of these four components of resistance, which should facilitate the utilization of this source of resistance in breeding programs nationally.

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 research is complete, the breeding community potentially will have new scab markers for use in marker assisted selection programs. Additionally, because the variety possesses 4 components of resistance, the interrelationships among these types of resistance will be better understood. This should accelerate the development of scab resistant wheat varieties.

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.

Refereed Publications

McKendry, A.L., D.N. Tague, R.L. Wright, J.A. Tremain. 2006. Registration of Bess Wheat. Crop Science (Under Review)

S. Liu, Z. Abate, H. Lu, T. Musket, G. L. Davis, and A. L. McKendry. 2006. QTL associated with Fusarium head blight resistance in the soft red winter wheat Ernie. Theor. Appl. Genet. (Under review)

S. Liu, Z. Abate, G. L. Davis, and A. L. McKendry. QTL analyses of traits related to the Fusarium head blight resistance in the soft red winter wheat Ernie. Theor. Appl. Genet. (In preparation).

Proceedings:

Abate, Z.A., and A.L. McKendry. 2005. Quantitative trait loci associated with reduced deoxynivalenol in the soft red winter wheat Ernie. In: Proceedings of the 2005 National Fusarium Head Blight Forum, Milwaukee, Wisconsin. Dec 11-13, 2005. p 3-5

Poster Presentations

Abate, Z.A., S. Liu, and A.L. McKendry. 2005. QTL associated with reduced deoxynivalenol in Ernie. Presented at the American Society of Agronomy Meetings, Salt Lake City, UT. November 2005.