

**USDA-ARS / USWBSI
FY04 Final Performance Report
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Cover Page

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Year:	FY2004 (approx. May 04 – April 05)
FY04 ARS Agreement ID:	59-0790-4-113
FY04 ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY04 ARS Award Amount:	\$ 171,322

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
GIE	Winter Wheat Germplasm Introduction and Evaluation.	\$ 92,723
VDUN	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	\$ 78,049
	Total ARS Award Amount	\$ 171,322

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?

Fusarium graminearum Schwabe (teleomorph *Gibberella zeae* (Schwein.), also known as scab, is an increasingly important problem in the north-central region of the United States. Host resistance has long been considered the most practical and effective means of control but breeding has been hindered by a lack of effective resistance genes and by the complexity of the resistance in identified sources. The objective of this project was to identify, through a world-wide search, additional sources of resistance to *Fusarium* head blight (scab) in winter wheat. In this continuing effort, accessions from France (400), Germany (271), Italy (39), Japan (24), and South Korea (10) were preliminarily screened while resistances identified in European accessions were verified prior to dissemination. A second objective was to continue to facilitate the introduction, quarantine, and distribution to interested breeders, elite scab resistant germplasm from international breeding programs.

2. What were the most significant accomplishments?

Of 744 lines screened, 85 lines were considered moderately resistant, with a spread of less than 1 spikelet under greenhouse inoculations including lines from France (47), Germany (22), Italy (9), and Japan (7). No resistance was identified in the 10 lines from South Korea. These lines had resistance measured as number of infected spikelets that was comparable to the resistant checks Truman (spread of 0.83), Ning (spread of 1.06), and Sumai 3 (spread of 0.59). Resistance was significantly better than the moderately resistant check Ernie which had a spread of 1.19 spikelets. The susceptible check in these experiments had a spread of 11.4 spikelets. Resistance was also assessed as the *Fusarium* head blight index (FHBI). Using this criterion, 134 lines had initial ratings that were under 10% which was comparable to the resistant checks Truman (4.9%), Ning 7840 (7.2%) and Sumai 3 (3.81%) including lines from France (74), Germany (56), Italy (13) and Japan (3). Initial verifications were done on putative sources of resistance in lines from Switzerland, Austria, Russia and China that were preliminarily screened in 2003. Thirty lines were confirmed to be moderately resistance with an FHBI less than 10% in greenhouse evaluations. Of these, 14 lines had field plot ratings of less than 20% scab. Finally, resistances were verified for the second time in a set of 35 lines from Poland, the Ukraine, and Slovakia and 29 lines were confirmed to have FHBI levels that were less than 10%, 14 of which had resistance levels less than 5%. Of these 14 lines, 7 lines also had verified field scab indices of less than 20%. In addition to this work, approximately 236 lines winter wheat lines were introduced from CIMMYT, half of which were quarantined prior to distribution to interested breeders.

Impact: This research continues to identify new and potentially novel sources of resistance to scab. Confirmed resistance data in 2004 were primarily in cultivated lines rather than landraces and therefore could be potentially quite useful in breeding programs, if marker analyses confirm that they do not carry the 3BS markers. 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 US farm economy and the economy of wheat production in particular.

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, and in particular, in Missouri. Objectives for research in 2004 included: to identify useful sources of scab resistance through continued greenhouse and field screening of all advanced breeding lines in the Missouri wheat breeding program; to identify and/or confirm further useful sources of scab resistance through field and greenhouse evaluation of the Northern and Southern Winter Wheat Scab Nurseries; to continue to incorporate and pyramid new sources of resistance, as they are verified, into elite Missouri soft red winter wheat breeding lines; to characterize the genetics of resistance to scab in the Missouri scab resistant cultivar, Truman.

2. What were the most significant accomplishments?

The most significant accomplishment was the wide spread acceptance of the Missouri cultivar Truman, which was released in 2003. Foundation seed is being grown in Illinois, Ohio and Michigan as well as in Missouri. The second major accomplishment is the release of Bess (tested as MO 981020), an early maturing sib of Truman with comparable broad based scab resistance. Bess is in high demand in Missouri where it placed in the top yield group in the commercial trials and is also expected to do well in southern Corn Belt states. Bess has been widely tested in the Eastern Nursery where it finished 6th in 2004. The 2004 outbreak was one of the worst in a number of years in the northern part of the state. This high level of natural infection enabled us to eliminate susceptible and moderately susceptible types from our breeding stream prior to the expense of yield testing. Ratings were taken on 25,000 head rows and 2,400 preliminary yield trial plots (PYN) at both Columbia and Novelty, MO. These were in addition to those already under evaluation in our scab nursery. Approximately 2000 head rows with a resistant or moderately resistant ratings, 34 advanced lines (from 31 pedigrees, 29 differing from Ernie and Truman), and 240 PYN lines were retained. PYN lines represented 136 different pedigrees, 20 of which were derived from Ernie, and 14 from the Truman source of resistance based on pedigree. Eight resistant lines may contain genes from both resistance sources. One of the most promising lines has Ernie maturity combined with Truman scab resistance, 12% Septoria, yield equaling 115% of the checks and 101% of the check test weight. Also tested were 442 F₂ through F₅ plots of 2- 3-, or 4-way scab crosses containing Chinese and other non-Missouri sources of resistance crossed with Missouri scab resistant lines. Under heavy disease pressure in 2004, the best of these segregating plots out-yielded Truman by 15 bu/acre (122.4%) and had a test weight that exceeded that of Truman by 4 lb/bu (109%). Finally, recombinant inbred lines of Truman by MO 94-317 were increased to the F₄ generation and doubled haploid lines of the same cross were increased for screening in 2005/2006.

Impact: The release of Truman and Bess from the Missouri breeding program has provided growers in the soft red winter wheat region with two widely adapted cultivars that have excellent agronomic performance coupled with scab resistance levels more broadly based than the best Asian resistance source. Both 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 both are public releases, they will provide potentially unique sources of resistance for other U.S. breeders to utilize.

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 your grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Peer Reviewed:

- McKendry, A.L., D.N. Tague, R.L. Wright, J.A. Tremain, and S.P. Conley. 2005. Registration of Truman Wheat. *Crop Science* Vol 45:421-422.
- Liu, S., A.Z. Abate, and A.L. McKendry. 2005. Inheritance of Fusarium head blight resistance in the soft red winter wheat Ernie. *Theor. Appl. Genet.* 110:454-461.
- R. A. Browne, R.A., J.P. Murphy, B.M. Cooke, D. Devaney, C.A. Griffey, J. Hancock, S.A. Harrison, F.L. Kolb, A.L. McKendry, E.A. Milus, C. Sneller, and D.A. Van Sanford. 2005. Evaluation of components of Fusarium head blight resistance in soft red winter wheat germplasm using a detached leaf assay. *Plant Disease* 89:404-411.
- Liu, S., Z. A. Abate, G.L. Davis, and A.L. McKendry. QTL associated with Fusarium head blight resistance in the soft red winter wheat Ernie. *Theor. Appl. Genet.* 2005 (under review)

Proceedings:

- A.L. McKendry, A.L., S. Liu, Z. A. Abate, and G.L. Davis. 2004. Inheritance of Fusarium head blight resistance in the US wheat cultivar 'Ernie'. In: Canty, S.M., Boring, T., Wardwell, J. and Ward, R.W. (Eds). *Proceedings of the 2nd International Symposium on Fusarium Head Blight; incorporating the 8th European Fusarium Seminar; 2004, 11-15 December; Orlando, FL, USA. Michigan State University, East Lansing, MI pp 107-110.*
- McKendry, A.L., L.J. Shaw, and J.A. Tremain. 2004. Evaluation of Fusarium resistant germplasm introduced through the USWBSI/CIMMYT collaboration. In: Canty, S.M., Boring, T., Wardwell, J. and Ward, R.W. (Eds). *Proceedings of the 2nd International Symposium on Fusarium Head Blight; incorporating the 8th European Fusarium Seminar; 2004, 11-15 December; Orlando, FL, USA. Michigan State University, East Lansing, MI pp 103-106.*
- R. A. Browne, J.P. Murphy, B.M. Cooke, D. Devaney, C.A. Griffey, J. Hancock, S.A. Harrison, F.L. Kolb, A.L. McKendry, E.A. Milus, C. Sneller, and D.A. Van Sanford. 2005. Identification of Fusarium head blight resistance in soft red winter wheat germplasm using a detached leaf assay. In: Canty, S.M., Boring, T., Wardwell, J. and Ward, R.W. (Eds). *Proceedings of the 2nd International Symposium on Fusarium Head Blight; incorporating the 8th European Fusarium Seminar; 2004, 11-15 December; Orlando, FL, USA. Michigan State University, East Lansing, MI pp 22.*

Poster Presentation

- A.L. McKendry, S. Liu, Z. A. Abate, and G.L. Davis. 2004. Inheritance of Fusarium head blight resistance in the US wheat cultivar 'Ernie'. Presented at the 2nd International Symposium on Fusarium Head Blight; incorporating the 8th European Fusarium Seminar; 2004, 11-15 December; Orlando, FL, USA. Michigan State University, East Lansing, MI pp 107-110.