

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
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Cover Page

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USDA-ARS Agreement Title:	Fusarium Head Blight Research in Winter Wheat.
FY07 ARS Award Amount:	\$ 116,352

USWBSI Individual Project(s)

USWBSI Research Area *	Project Title	ARS Adjusted Award Amount
HGG	Mapping QTL Associated with Scab Resistance in the Soft Red Winter Wheat Truman.	\$39,024
VDUN	Accelerating the Development of Scab Resistant Soft Red Winter Wheat.	\$ 77,328
	Total Award Amount	\$ 116,352

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
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Mapping QTL Associated with Scab Resistance in the Soft Red Winter Wheat Truman.*

What major problem or issue is being resolved and how are you resolving it? Fusarium head blight (FHB) resistance in the soft red winter wheat variety Truman developed and released at the University of Missouri is broad-based, having excellent levels of types I and II resistance as well as good kernel quality retention and low DON under heavy disease pressure. Little, however, is understood about the genetics of this source of resistance, other than that haplotype data suggests it differs from the resistance in Sumai 3 and its derivatives as well as the resistance in Ernie. In that Truman has good levels of all four types of resistance, this project will involve several steps. In 2007/2008, our objectives were: (1) identify QTL associated with type II resistance to FHB in a set of 250 F_{2:8} recombinant inbred lines developed from the cross Truman/MO 94-317; (2) Phenotype type I resistance to FHB in Truman using the above mapping population; (3) phenotype kernel quality retention in Truman following field inoculations of the above mapping population; (4) phenotype the above mapping population for DON levels following greenhouse and field inoculation with FHB.

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

Accomplishment: A replicated (3 replication; randomized complete block design) greenhouse phenotyping experiment was conducted on a set of 250 recombinant inbred lines (RILs) developed from the cross Truman/MO 94-317 in 2007/08. For each RIL, eight plants per RIL per replication were phenotyped (total 6000 plants). The population was also increased for field screening in the 2008/09 crop season. Analysis of the data indicated that resistance is quantitative and distributions which were skewed towards resistance, suggest both additive and dominant components of the phenotypic variance. Diallel analysis indicated that Truman had among the best breeding values for FHB resistance of lines evaluated. Type II resistance was highly heritable (72%) and appears to be conditioned by a minimum of 3 genes. Replicated (2 replications; RCBD) field evaluations have been completed for type I resistance, percentage of Fusarium damaged kernels (FDK) and DON content of the harvested grain. Whole genome polymorphisms between Truman and MO 94-317 will be initiated this fall in preparation for mapping resistance in this background.

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 regions where it is grown. Haplotyping indicates that it 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.

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. This ongoing project has focused largely on the exploiting native resistance identified in Missouri wheat germplasm; an approach we believe accelerates the development and release of FHB resistant cultivars. In 2007 our objectives were: (1) the continued identification and verification of useful sources of FHB resistance in the Missouri wheat breeding program; (2) the verification of potentially useful sources of FHB resistance through evaluation of both the Preliminary and Advanced Northern Uniform Winter Wheat Scab Nurseries, and the Southern Uniform Winter Wheat Scab Nurseries; (3) the incorporation of new sources of resistance, as they are verified, into elite Missouri soft red winter wheat breeding lines; (4) preliminary genetic characterization through haplotyping of Missouri resistant breeding germplasm; (5) evaluation of lines with diverse sources of resistance derived in 2006 from mass selection populations; (6) to convey information on scab resistance of commercially available wheat cultivars through evaluation of the 2008 Missouri Winter Wheat Performance Tests.

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: A severe FHB outbreak provided heavy disease pressure for Missouri trials and a good test of newly developed materials. Highly susceptible lines had more than 80% loss. Of 250 advanced lines carrying only native resistance, 112 (45%) had resistance ratings assessed as the Fusarium head blight index (incidence x severity) that were equal to or better than Truman (<10%). Of 1700 preliminary lines with complex pedigrees involving both native and exotic FHB sources of resistance, 534 (31.5%) had resistance levels similar to or better than Truman. Among the most resistant lines are lines that appear to combine the resistance in Truman (or its sibs) with that in Ning 7840, lines that combine the resistance in Ernie with that in Sumai 3, and lines that could potentially contain resistance from Truman, Sumai 3 and Ernie in one background. Resistant lines will be culled based on pedigree, agronomic performance (yield, test weight, resistance to other pathogens) and grain quality (milling and baking). They will then be advanced into replicated state-wide testing. Each line that is retained will be moved into the greenhouse/field shuttle screening program to confirm resistance and concurrently screened with known SSR markers to determine FHB gene combinations.

Impact: The release of FHB-resistant cultivars is the primary goal of the USWBSI. Our program has had considerable success focusing on native resistance through screening and recombination in adapted backgrounds. The verification of resistance in these lines under good levels of natural infection over a broad heading window will accelerate our decision making on both retention of lines, and elimination of lines, in the breeding program. Because of the adapted backgrounds in these lines, they have most of the necessary attributes for release and will immediately lessen the devastating impact of FHB in Missouri and 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, which have been developed within the Missouri program will provide the agricultural community we serve in Missouri and the surrounding states 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.

Accomplishment 2: Dissemination of information on FHB resistance to growers is a newly identified goal of the USWBSI. One mechanism by which that can be done is to evaluate all commercial varieties available to growers and extend information on their respective resistance to FHB through field day events and through publication (both web-based and hard copy) of the data in wheat variety test publications. In 2007/2008, we evaluated type II resistance for 64 entries in the Missouri Winter Wheat Performances tests under greenhouse conditions, and the FHB field scab index (incidence x severity) in our FHB inoculated nursery. In addition, a significant outbreak in Missouri enabled us to take FHB resistance notes under natural infection at two additional Missouri locations. Less than 10% of entries tested had good FHB resistance. As anticipated, the best public lines in these commercial trials were Truman, Bess and Roane. These data will be published in the 2008 Missouri Winter Wheat Performance Tests Special Report and on the Agricultural Education Bulletin Board <http://agebb.missouri.edu> under crop performance testing for soft red winter wheat.

Impact: These data will provide growers with previously unavailable information on the FHB resistance of commercial cultivars. The availability of these data, particularly in a year in which FHB has been a problem for growers, and the availability of resistant varieties in the test including Truman, Bess, and Roane, should move growers decision making on variety selection towards selection of varieties with FHB resistance. This will have an immediate impact lessening the devastating effects of FHB in Missouri and surrounding states where the data will be available.

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?: Fusarium head blight resistance data on commercial cultivars developed by private companies, and on brands that are widely used has not been widely available to Missouri growers. As a consequence of the publication of these FHB data, growers will be able to make more informed decisions on variety selection that should, with adoption of resistant varieties, less their risk of crop loss associated with FHB.

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.

- Abate, Z.A., Liu, S., McKendry, A. 2008. Quantitative trait loci associated with deoxynivalenol content and kernel quality in the soft red winter wheat Ernie. *Crop Sci.* 48:1408-1418.
- Abate, Z.A., D.N. Tague, and A.L. McKendry 2007. Diallel analysis of Fusarium head blight resistance in genetically diverse winter wheat germplasm. *American Society of Agronomy Annual Meeting Abstracts.* New Orleans, LA. Nov. 4-8, 2007.
- Dowell, F.E., E.B. Maghirang, P.S. Baenziger, A.L. McKendry, E.A. Milus, P. Horevaj, S.N. Wegulo, J.A. Breathnach. 2007. Applying single kernel sorting technology to developing scab resistant lines. In: Canty, S.M., Clark, A., Ellis, D., and Van Sanford D. (Eds) *Proceedings of the National Fusarium Head Blight Forum.* 2-4 December 2007; Westin Crown Center, Kansas City, MO.
- Liu, S., C.A. Griffey, A.L. McKendry, and M.D. Hall. 2007. Meta-analyses of QTL associated with Fusarium head blight resistance. In: Canty, S.M., Clark, A., Ellis, D., and Van Sanford D. (Eds) *Proceedings of the National Fusarium Head Blight Forum.* 2-4 December 2007; Westin Crown Center, Kansas City, MO.
- McKendry, A.L., *Breeding For Fusarium Head Blight Resistance in Winter Wheat - What's Ahead.* Presented at the 2007 US Wheat and Barley Scab Forum, in Kansas City Missouri. (Associated Abstract In: Canty, S.M., Clark, A., Ellis, D., and Van Sanford D. (Eds) *Proceedings of the National Fusarium Head Blight Forum.* 2-4 December 2007; Westin Crown Center, Kansas City, MO)

Under review:

- Abate, Z.A., A.L. McKendry. 2008. Diallel analysis of Fusarium head blight resistance in genetically diverse winter wheat. Under review: *Euphytica.*