USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY09 Final Performance Report
July 15, 2010

Cover Page

PI:	Frederic Kolb
Institution:	University of Illinois
Address:	Department of Crop Sciences 1102 S. Goodwin Ave. Urbana, IL 60801
E-mail:	f-kolb@uiuc.edu
Phone:	217-333-9485
Fax:	217-333-9817
Fiscal Year:	2009
USDA-ARS Agreement ID:	59-0206-9-080
USDA-ARS Agreement Title:	Development of Scab Resistant Soft Red Winter Wheat Varieties and Scab Resistance QTL Mapping.
FY09- USDA-ARS Award Amount:	$ 117,714

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
VDHR-NWW	Development of Scab Resistant Soft Red Winter Wheat Varieties and Scab Resistance QTL Mapping.	$ 91,721
VDHR-NWW	Fungicide x Variety Interaction Experiment.	$ 4,844
VDHR-NWW	Mapping FHB QTL in an IL97-1828 x Clark Derived RIL Population.	$ 21,149
	Total Award Amount	**$ 117,714**

Frederic L. Kolb

7/14/2010

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 Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Development of Scab Resistant Soft Red Winter Wheat Varieties and Scab Resistance QTL Mapping.*

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

The major issue is that producers need varieties with high levels of scab resistance. We are working on the development of high-yielding, well-adapted, scab resistant lines. As more lines with good scab resistance are identified we are using these parents in crosses, so that in many crosses both parents, or two parents out of three in a three-way cross, are scab resistant. We also believe that it is important to combine several types of resistance rather than rely solely on Type II resistance. We are addressing this by using the ISK index (0.3 x % incidence + 0.3 x % severity + 0.4 x % shriveled kernels) to select breeding lines with high levels of scab resistance. Development of varieties with low deoxynivalenol (DON) levels is also crucial; therefore, all breeding lines are evaluated each year for DON level.

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 (1): Fifty-seven varieties from the Illinois State Variety Trial were evaluated for FHB resistance in a FHB evaluation nursery, and data were made available to producers.

Impact (1): In order to use FHB resistance as a criterion in variety selection producers must have as much information as possible on FHB resistance. The FHB resistance data provide very useful information to Illinois seedsmen and producers and allows them to use FHB resistance as a criterion in variety selection. Producers and seedsmen have a three year summary of data of FHB resistance and DON level that can be used in decisions about what varieties to produce. The information on FHB resistance is available online at http://vt.cropsci.illinois.edu/wheat.html.

Accomplishment (2): About 260 breeding lines in cooperative nurseries including the Uniform Northern Winter Wheat Scab Nursery, the Uniform Preliminary Northern Winter Wheat Scab Nursery, the Uniform Southern Scab Nursery, the Uniform Eastern Soft Winter Wheat Nursery, and the Adv. and Prelim. Five-State Nurseries were evaluated for FHB resistance in a misted, inoculated FHB field nursery. Lines from the Univ. of Illinois program were submitted for all of the cooperative nurseries except the Uniform Southern Scab Nursery, thus, breeding lines with FHB resistance were made available to other breeding programs for use as germplasm. Five University of Illinois breeding lines (out of five entries) were among the most FHB resistant lines in the 2009 NUWWN and three University of Illinois breeding lines (out of five entries) were among the most FHB resistant lines in the 2009 PNUWWN.

Impact (2): The data provided were useful to many different breeding programs in making decisions about which breeding lines merit further evaluation as varieties and which breeding lines will be useful as germplasm. Exchange of FHB resistant breeding lines among programs is essential and will contribute to the development of FHB resistant varieties.

Obtaining FHB resistance data for entries in the cooperative nurseries from many environments allow wheat breeders to make better selection decisions about what lines to advance for further evaluation. Breeding lines from the University of Illinois breeding program were made available to other breeding programs for use as parents if the breeders wish to use them.

Accomplishment (3): In 2009, about 410 breeding lines from the University of Illinois wheat breeding program were evaluated in the misted, inoculated scab evaluation field nursery. Scab resistant lines were evaluated for many additional traits including grain yield, milling and baking quality, standability, and resistance to other diseases.

Impact (3): Sustained annual selection for FHB resistance in the inoculated, misted field nursery has significant long-term impact by assuring that new varieties will be FHB resistant. Constant selection for FHB resistance in the breeding program is essential in order to identify breeding lines with FHB resistance and also to discard FHB susceptible lines early so that resources are not wasted evaluating FHB susceptible lines. The constant selection pressure applied using evaluation in misted, inoculated nurseries is essential in reducing DON.

Accomplishment (4): In 2009, 2590 wheat samples were sent to the lab at the University of Minnesota for deoxynivalenol (DON) analysis.

Impact (4): DON evaluation is an essential component of FHB resistance evaluation because new varieties must have not just lower FHB field symptoms but also reduced DON content. This is information that is primarily useful to the wheat breeder, but information on low DON producing varieties can also be used by the producer in variety selection.

Accomplishment (5): In 2009-10, 223 single crosses and 184 three-way and four-way crosses were made involving FHB resistance sources. Marker assisted selection (MAS) was used for F_1 enrichment for the 3BS FHB resistance locus in 39 three-way populations (MAS done in cooperation with Gina Brown-Guedira, USDA-ARS). About 48 F_3 and F_4 bulks were grown in the inoculated and mist-irrigated FHB nursery and heads were selected under heavy FHB disease pressure.

Impact (5): The crosses of scab resistant parents by adapted high yielding parents will provide populations that can be used for development of scab resistant varieties. These crosses are the source of variability that will be used for future development of scab resistant soft red winter wheat varieties.

Accomplishment (6): One soft red winter wheat breeding line with a high level of FHB resistance (better than Ernie) with high yield potential was increased and released for licensing and potential commercial production (see below). Two soft red winter wheat lines with FHB resistance approximately equal to Bess were also released.

Impact (6): Lines that enter commercial production provide seedsmen and producers with additional FHB resistant varieties. The availability of improved varieties with FHB resistance

provides additional choices for seedsmen and producers and contributes to an overall reduction in DON and decreased susceptibility to FHB. For the seed industry in this part of the Midwest, release of breeding lines for licensing results in breeding lines being grown on larger acreages than release as a named variety. Thus, licensing results in greater impact than release as a public variety because there is no marketing for a public variety.

Project 2: *Fungicide x Variety Interaction Experiment.*

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

   Suppression of FHB under heavy disease pressure frequently requires more than a single method of control. In this experiment we studied the control of FHB under heavy disease pressure using resistant and susceptible varieties in combination with and without fungicide application. Our hypothesis was that the best suppression of FHB will occur by growing a FHB resistant variety in combination with application of a fungicide at flowering.

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:

   The second year of this experiment was conducted in the 2008-2009 growing season. Six Fusarium head blight (FHB) susceptible and six FHB resistant breeding lines and varieties were grown and three treatments (no fungicide, Folicur® and Prosaro®) were applied to each variety. A split-plot design with three replications and fungicide treatment as the main plots was used. The plots were grown in a mist-irrigated, inoculated nursery to enhance disease pressure. Data were collected on FHB incidence, severity, % Fusarium damaged kernels, deoxynivalenol content (ppm), grain yield and test weight. The experiment was conducted in the 2008 season and was repeated in the 2009 season. Useful data were obtained from both years, and the following results are based on the combined data from both years.

   - Averaged over all cultivars, both Prosaro® and Folicur® significantly reduced incidence, severity, FHB index, and ISK index (0.3 x % incidence + 0.3 x % severity + 0.4 x % shriveled kernels) while also increasing grain yield and test weight.
   - In 2008 the fungicide treatment did not significantly change the DON concentration. In 2009, both Folicur® and Prosaro® significantly reduced DON concentration.
   - Prosaro® increased yield by an average of 12.4 bu/A, while decreasing FHB incidence by 32% and severity by 10%. Folicur® increased yield by an average of 8.98 bu/A, while decreasing FHB incidence by 20% and severity by 8.6%.
   - The six resistant cultivars outperformed the susceptible cultivars for all measured variables. When no treatment was applied, the resistant varieties yielded 12.7 bu/A

more than the susceptible varieties. The resistant varieties also had significantly ($P<.0001$) lower FHB incidence and severity than susceptible varieties. Resistant cultivars had a mean FHB incidence 26% lower than susceptible varieties and a mean severity 17% lower than susceptible varieties.

Impact:

Based on the 2008 and 2009 data we clearly demonstrated that best management practices for suppression of FHB under heavy disease pressure include combining a resistant variety with fungicide application. The results from the trial were presented in a poster at the 2009 Scab Forum, and the results of this experiment have been used extensively locally in Illinois in a number of presentations at field-days and grower meetings to provide producers with important information on best management practices to use for suppression of FHB (see list of presentations below).

Project 3: *Mapping FHB QTL in an IL97-1828 x Clark Derived RIL Population.*

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

Many breeding lines in our program (and other soft winter wheat programs) exhibit FHB resistance that cannot be traced to a Chinese source or other known FHB resistance source. We are using this resistance ("native resistance") extensively in our breeding program and in many cases we are combining the native resistance with other resistance sources. The purpose of this experiment is to determine if the QTL controlling the resistance in IL97-1828 are the same as known FHB resistance QTL and to identify molecular markers associated with new QTL.

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: The 283 recombinant inbred lines (RILs) and checks were phenotyped at Urbana, IL during the 2009 season, and the population was planted for phenotyping again during the 2010 season. DNA was sent for DArT analysis and reproducible DArT markers were obtained for 253 of the RILs. The results of the DArT analysis have been received with 218 polymorphic DArT markers identified. SSRs were evaluated on the two parents and, so far, 13 polymorphic SSRs have been evaluated on the RIL population.

Impact: The association of markers with QTL for FHB resistance in this native resistance source will enhance our capability to select for FHB resistance in breeding materials involving this source. Although the information generated by this research will not be of direct use to wheat producers or consumers, information from this project combined with knowledge gained from other research should enhance the selection efficiency for FHB resistance which will benefit producers and consumers in the long-term through the development of improved FHB resistant varieties.

Include below a list 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.

Performance of University of Illinois lines and checks averaged over years, 2007-2009.

		Over Locs.						Scab Evaluation Nursery			
Name	**Release**	**Yield**	**Test Weight**	**Height**	**Heading Date**	**SBMV**	**BYDV stunting**	**FHB Index**	**Kernel Rating**	**ISK Index**	**DON**
		(bu/A)	**(lbs/bu)**	**(in)**	**(after 4/30)**	**(0-9)**	**(%)**	**(0-100)**	**(%)**	**(0-100)**	**(ppm)**
IL02-18228	**2010**	**72.2**	**59.8**	**39.7**	**13.3**	**1.0**	**11.2**	**11.8**	**8.9**	**24.3**	**1.1**
IL04-8445	**2010**	**77.4**	**58.4**	**36.7**	**14.3**	**2.5**	**18.6**	**24.9**	**31.9**	**44.0**	**7.1**
IL04-9942	**2010**	**79.3**	**58.0**	**39.3**	**16.3**	**5.0**	**18.5**	**33.5**	**35.0**	**49.2**	**7.2**
Checks:											
Bess		65.5	57.3	38.3	16.7	8.5	8.5	20.1	25.3	40.7	7.0
Pioneer 25R35		79.6	57.4	38.7	16.7	5.0	8.7	16.6	30.3	39.0	4.8
Pioneer 25R47	**(sus. check)**	78.3	56.0	36.7	15.7	2.5	11.8	45.9	64.4	67.9	21.9
Trial average		**69.8**	**57.6**	**37.4**	**14.7**	**5.2**	**12.5**	**25.5**	**24.8**	**41.0**	**5.1**
No. of trials		**12**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**

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 publication:

Bonin, C.M. and F. L. Kolb**.** 2009. Resistance to Fusarium Head Blight and Kernel Damage in a Winter Wheat Recombinant Inbred Line Population. Crop Sci. 49: 1304-1312.

Abstracts:

Kolb, F.L., 2009. Successes in development of Fusarium head blight resistant soft red winter wheat varieties using phenotypic selection. Proceedings of the 2009 National Fusarium Head Blight Forum, Orlando, FL Dec. 7-8, 2009, p. 131.

Karplus, N.H. , E.A. Brucker, C.A. Bradley, and F.L. Kolb. 2009. Evaluation of host plant resistance and fungicide treatment for suppression of Fuarium head blight. Proceedings of the 2009 National Fusarium Head Blight Forum, Orlando, FL Dec. 7-8, 2009, p. 129.

Additional presentations by Carl Bradley related to Project #2:

Bradley, C. A. 2010. Fungicide research on corn, soybean, and wheat. Southern Illinois Crop Management Conference, February 2, 2010, Whittington, IL.

Bradley, C. A. 2010. Fungicide research on corn, soybean, and wheat. Central Illinois Crop Management Conference, February 3, 2010, Springfield, IL.

Bradley, C. A. 2010. Fungicide research on corn, soybean, and wheat. East-Central Illinois Crop Management Conference, February 16, 2010, Champaign, IL.

Bradley, C. A. 2010. Fungicide research on corn, soybean, and wheat. Northern Illinois Crop Management Conference, February 17, 2010, Malta, IL.

Bradley, C. A. 2010. Management of wheat diseases. Illinois Wheat Association Winter Forum, February 15, 2010, Mt. Vernon, IL.

Bradley, C. A. and Esker, P. 2010. Winter wheat disease identification and management. Joint University of Illinois – University of Wisconsin Winter Wheat Workshop, March 18, 2010, Rockford, IL.

Bradley, C. A. 2010. Management of wheat diseases. University of Illinois / Illinois Wheat Association Small Grains Field Day, June 24, 2010, DeKalb, IL.