

USDA-ARS / USWBSI
FY03 Final Performance Report (approx. May 03 – April 04)
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Cover Page

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Year:	FY2003 (approx. May 03 – April 04)
FY03 ARS Agreement ID:	59-0790-9-050
FY03 ARS Agreement Title:	Molecular Marker Research and Development of Scab Resistant Wheat Varieties.
FY03 ARS Award Amount:	\$ 139,979

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Molecular Markers for a 7A QTL and Type III Scab Resistance in Wheat.	\$ 67,784
VDUN	Development of Scab Resistant Soft Red Winter Wheat Varieties.	\$ 72,195
	Total Amount Recommended	\$ 139,979

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: *Molecular Markers for a 7A QTL and Type III Scab Resistance in Wheat.*

1. What major problem or issue is being resolved and how are you resolving it?

Scab resistance in wheat is complex and different “types” of resistance have been described. As is well known, Type II (resistance to spread within the head) has been studied the most, and the Type II resistance derived from Sumai 3 has been widely used in breeding for scab resistance. Information about QTL other than those on 3BS and QTL for types of resistance other than Type II is useful in developing genotypes with a higher level of resistance by combining different types of resistance from different sources. Our objectives are to identify SSRs associated with a putative scab resistance QTL on chromosome 7A, and to begin research on identification of QTL for Type III scab resistance. Based on research already conducted using chromosome substitution lines, we hypothesized that a QTL for scab resistance may be present on chromosome 7A. This hypothesis is based on data from substitution lines with individual Sumai 3 chromosomes inserted into the Chinese Spring background. This material is quite different from most populations that have been previously used for mapping Sumai 3 derived resistance.

The second thrust of this proposal is to examine lines that exhibit “kernel retention” type resistance. In these lines the percentage of shriveled kernels produced is lower than would be expected on the basis of the level of symptoms observed in the heads. This type of resistance has been described previously. We have observed that Coker 9474 and IL 94-1953 exhibit this type of resistance. Populations involving Coker 9474 and IL 94-1653 crossed to scab susceptible lines need to be developed before we can work on identification of SSRs associated with QTL for this type of scab resistance.

2. What were the most significant accomplishments?

Chinese Spring was crossed with a Chinese Spring (Sumai 3) 7A substitution line, F₁ plants were selfed, and F₂ seeds were harvested. About 300 F₂ plants were grown in the greenhouse. Plant tissue for DNA isolation was harvested from individual plants three weeks after transplanting. At least one head from each plant was inoculated for evaluation of Type II scab resistance using the single floret inoculation method. Percentage of scabbed spikelets (PSS) on inoculated heads was determined 21 days after inoculation. PSS values recorded from inoculation of more than one head on the same plant were analyzed as sub-samples.

We genotyped 196 F₂ plants from the cross Chinese Spring/ Chinese Spring (Sumai 3, 7A) with Xbarc49, which is polymorphic between Sumai 3 and Chinese Spring. This marker separated the 196 F₂ plants into three genotypic groups: 48 plants were homozygous for the allele from Sumai 3, 100 plants were heterozygotes, and 48 plants were homozygous for the allele from Chinese Spring. There were significant differences among average PSS values of the three groups. Based on the preliminary mapping data the F₂ plants derived from a cross between Chinese Spring and Chinese Spring (Sumai 3, 7A) segregated in a typical ratio of 1:2:1. Significant differences among the three genotypes indicated a possible scab resistance gene on chromosome 7A from Sumai 3.

Two populations were selected to use in the research on the “kernel retention” type of resistance. These populations are being advanced to a higher generation before phenotypic evaluation and evaluation using molecular markers. As indicated in the proposal this project will take several years.

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

1. What major problem or issue is being resolved and how are you resolving it?

The major issue is that producers need varieties with high levels of scab resistance. We have lines with very good levels of scab resistance; however, many lines with excellent scab resistance are poor for other traits such as grain yield, milling and baking quality, standability, or resistance to other diseases. This problem is not resolved, but we working on developing well-adapted scab resistant lines. We are also continuing to select and evaluate as many lines as possible. In addition, 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.

2. What were the most significant accomplishments?

- IL94-1653 was released to seedsmen for brand labeling. IL 94-1653 is moderately resistant to FHB with a level of resistance similar to Ernie.
- Five lines from the Illinois program were entered into the 2003 Northern Uniform Winter Wheat Scab Nursery. Entering these lines into the nursery made them available to other breeders. Three of the Illinois lines were among the most FHB resistant lines in the nursery.
- In 2003, about 420 breeding lines from the University of Illinois wheat breeding program were evaluated in replicated rows in the misted, inoculated scab evaluation field nursery. We also evaluated about 280 varieties, germplasm lines, and breeding lines from other programs in the scab evaluation field nursery, including a number of cooperative nurseries, and a germplasm evaluation trial. In addition, about 1540 entries from single plots were evaluated. Scab resistant lines were evaluated for many additional traits including grain yield, milling and baking quality, standability, and resistance to other diseases.
- Heads were selected from 33 F₃ bulk populations grown in the field scab nursery, and headrows from these selections are being grown in 2004. Several recurrent selection populations were grown in the scab evaluation nursery for another cycle of selection. Well-filled kernels are selected from bulk-harvested seed samples of these populations.
- In 2003 about 160 single and 100 three-way crosses were made with one or more scab resistant parents in each cross. In addition, 24 germplasm crosses involving scab resistant parents were made for parent building.
- About 78 doubled haploid (DH) lines were evaluated in the scab nursery and in performance trials at two locations, and 28 DH lines were selected for further evaluation in 2004.
- Varieties from the University of Illinois Wheat Variety Trial were evaluated for scab resistance in the misted, inoculated field nursery. Summaries of scab resistance data were made available to producers and were presented at three producer meetings in August 2003.
- The FHB index is widely used by researchers working on FHB. We proposed a new index (the ISK index) that incorporates a third factor, the evaluation of harvested grain. Mean separation is better with the ISK index than with the FHB index.
- Two NILs were developed through five backcrosses with Clark (recurrent parent). The NILs retained a 3BS region from Ning 7840 (donor parent) of less than 8 cM with the FHB resistance QTL from Ning 7840. These NILs will be useful for further molecular characterization of the major QTL on 3BS.

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 publications:

Bai, G-H., P-G. Guo and F. L. Kolb. 2003. Genetic relationships among scab resistant cultivars of wheat based on molecular markers. *Crop Sci.* 43:498-507.

Zhou, W-C., F.L. Kolb, G-H Bai, L.L. Domier, L.K. Boze, and N.J. Smith. 2003. Validation of a major QTL for scab resistance with SSR markers and use of marker-assisted selection in wheat. *Plant Breeding* 122:40-46.

Zhou, W-C, F.L. Kolb, J-B Yu, G-H Bai, L. K. Boze, and L.L. Domier. 2004. Molecular characterization of Fusarium head blight resistance in Wangshuibai with SSR and AFLP markers. *Genome* (accepted)

Non-refereed bulletins, reports, and proceedings:

Kolb, F.L. Scab resistant wheat varieties: just around the corner, or way down the road? Agronomy Day booklet. August 21, 2003. (presentation also)

Malvick, D. and F.L. Kolb. 2003 NCR-184 State Report from Illinois: Management of Small Grain Diseases. NCR-184 Annual Meeting Report.

Zhou, W-C, F.L. Kolb and L.K. Boze. 2003. Segregation of an SSR associated with a QTL for FHB resistance on chromosome 7A in hexaploid wheat. In 2003 National Fusarium Head Blight Forum Proceedings, Minneapolis, MN, Dec. 13-15, 2003 p. 56-57.

Zhou, W-C, F.L. Kolb and G-H Bai. 2003. Marker-assisted backcrossing selection of near-isogenic lines for a 3BS Fusarium head blight resistance QTL in *Triticum aestivum*. In 2003 National Fusarium Head Blight Forum Proceedings, Minneapolis, MN, Dec. 13-15, 2003, p. 300-303.

Abstracts:

Kolb, F. L. and L. K. Boze. 2003. An alternative to the FHB index: Incidence, severity, kernel rating (ISK) index. Proceedings 2003 National Fusarium Head Blight Forum Proceedings, Minneapolis, MN, Dec. 13-15, 2003.

Zhou, W-C., F.L. Kolb, J. Yu, G-H. Bai, L.K. Boze, and L.L. Domier. 2003. Molecular mapping of scab resistance QTL in Wangshuibai. ASA Abstracts, Meeting in Denver, CO, Nov. 1-5, 2003. p.55.

Zhou, W-C., F.L. Kolb, J. Yu, G-H. Bai, L.K. Boze, and L.L. Domier. 2003. Molecular mapping of scab resistance QTL in Wangshuibai. 2003 National Fusarium Head Blight Forum Proceedings, Minneapolis, MN, Dec. 13-15, 2003.

Zhou, W-C., F.L. Kolb, and G-H. Bai. 2003. Marker-assisted backcrossing selection of near isogenic lines for 3BS Fusarium head blight resistance QTL in hexaploid wheat. Proceedings of the 3rd Canadian FHB Workshop. Dec. 9-12, 2003. Can. J. of Plant Pathology.

Zhou, W-C., F.L. Kolb, J. Yu, G-H. Bai, L.K. Boze, and L.L. Domier. 2003. Molecular characterization of Fusarium head blight resistance in Wangshuibai with SSR and AFLP markers. Proceedings of the 3rd Canadian FHB Workshop. Dec. 9-12, 2003. Can. J. of Plant Pathology.