USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
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Cover Page

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Fiscal Year:	2006
USDA-ARS Agreement ID:	59-0790-4-102
USDA-ARS Agreement Title:	Validation, Fine Mapping Marker Assisted Selection, and Accelerated Breeding for Scab Resistance in Soft Red Winter Wheat.
FY06 ARS Award Amount:	$ 106,978

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
HGR	Marker Assisted Selection for Improved FHB Resistance in Adapted SRW Wheat Backgrounds.	$ 40,044
VDUN	Accelerated Breeding for Scab Resistance in Soft Red Winter Wheat and Barley.	$ 66,934
	Total Award Amount	**$ 106,978**

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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
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Marker Assisted Selection for Improved FHB Resistance in Adapted SRW Wheat Backgrounds.*

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

This study was conducted to validate molecular markers linked to eight FHB resistance QTL previously identified in different mapping populations using elite breeding lines developed via backcross and top cross methods to incorporate FHB resistance to initial infection, spread, and DON accumulation into different genetic backgrounds. A total of 129 SSRs were characterized in the 145 breeding lines in collaboration with the genotyping centers at North Carolina State University and North Dakota State University, using an ABI 3130 capillary electrophoresis genetic analyzer. Forty-four SSRs (4 SSRs per chromosome) were used in background selection and the remaining SSRs were used in validation of target QTL. The 145 wheat lines were also evaluated in yield performance trials at two locations, Blacksburg and Warsaw, VA, and for type I, type II, and DON resistance in a scab nursery at Blacksburg, VA in 2005 and 2006.

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:

Molecular markers linked to scab resistance genes located on wheat chromosomes 2BS, 2DS, 3AS, 3BS, 5AS, and 6BS were confirmed and used in MAS of scab resistance in parental lines used in crossing and for pyramiding of multiple QTL in a three-way F_2 population (current FY07 project) as well as in haplotyping newly developed lines in our breeding program. Also, these markers are being used to characterize FHB resistance in 181 F_6 RILs derived from the cross VA00W-38/ Pion26R46 in pyramiding FHB resistance with good end-use quality and resistance to other prevalent diseases.

Forty-nine of 145 lines have FHB incidence below 60% and an average severity of 15%. These backcross-derived lines were derived mainly from five genetic backgrounds, including Renwood 3260, Ernie, Roane, Pion2684, and VA96W-234 (Table 1). Renwood 3260 and its derived lines have good overall resistance and high yield potential. These lines have unique resistance with alleles differing from those of known resistance sources W14 and Sumai 3 at marker loci Gwm429, Gwm120, Gwm261, Barc133, and Gwm186 in the chromosome 2BS, 2DS, 3BS, and 5AS QTL regions. Such lines include VA04W-515 and VA05W-633.

Ernie and its derived lines have good overall resistance but didn't produce promising grain yields in Virginia. These lines have unique resistance comprised of same resistant alleles as Renwood 3260 at loci Gwm429, Gwm120, and Gwm261 in 2BS and 2DS QTL regions. These lines also contain the same resistant alleles as donor parent W14 at loci Wmc264, Barc133, and Barc117 in 3AS, 3BS, and 5AS QTL regions. In addition, these lines have unique resistant alleles in their background at Gwm493 and Wmc152 in 3BS and 6BS QTL regions. Three of the 17 Ernie derived lines, VA04W-389, VA05W-693, and VA05W-799, had higher yields than Ernie.

Roane-derived FHB resistant lines have high yield potential and improved resistance with two to three QTL derived from donor parents. Such lines include VA05W-416, VA05W-417, VA05W-775, and VA05W-778.

Pioneer 2684 and VA96W-234 have the same resistant allele at the Gwm120 locus on 2BS as Renwood 3260 and Ernie. The derived lines have improved resistance combining 2BS with 3BS or 5AS and 6BS QTL from donor parents. Such lines include VA04W-574, VA04W-575, VA05W-711, and VA05W-718.

Impact:

This is the first study targeting six FHB QTL in the evaluation of pre-breeding lines. QTL-markers validated in the current study have been widely used in parental selection for gene pyramiding and in predicting FHB resistance of progeny derived from newly developed FHB resistant lines.

This is also the first study evaluating the effects of allelic differences and genetic backgrounds on FHB resistance. Newly developed FHB resistant lines with unique QTL/allele combinations have been used as parental lines in most of eastern wheat breeding program. Some of these lines will be released as varieties and/or adapted germplasm.

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?

The newly developed FHB resistant lines and unique QTL/marker allele profiles identified in this study will set the stage for using MAS not only for FHB resistance but also in combining FHB resistance with other important agronomic traits.

Project 2: *Accelerated Breeding for Scab Resistance in Soft Red Winter Wheat and Barley.*

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

Release of FHB resistant wheat cultivars that are competitive with traditional SRW wheat cultivars is the primary objective being addressed by our breeding program. Several hundred crosses involving known and diverse FHB resistant parents are made each year and FHB breeding populations are advanced, evaluated and selected in an inoculated and irrigated nursery. In 2007, nearly 300 F_1s, including 48 single crosses, 236 three-way crosses, and 10 McCormick/Nobeoka Bozu BC_1F_1 topcross populations involving elite wheat lines were advanced in the field. More than 500 advance and elite wheat lines developed at Virginia Tech, 149 wheat lines in three uniform FHB nurseries, and 61 elite hulled and hulless barley lines were evaluated for FHB resistance in our scab nursery. In conjunction with this endeavor the breeding program is using marker-assisted breeding to discern FHB QTL haplotypes of parental lines including entries in Virginia's State Wheat Test, elite scab resistant lines developed in our program and germplasm selected from other breeding programs. The objective is to use marker-assisted breeding to identify, pyramid, and select elite wheat lines having diverse and multiple FHB resistance QTL.

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:

'JAMESTOWN' SRW wheat cultivar was released in 2007. In addition to FHB resistance, other notable traits of JAMESTOWN include its early maturity, resistance to Hessian fly, powdery mildew, leaf rust and stripe rust. In the 2006 Uniform Southern SRW Wheat Nursery, JAMESTOWN ranked 7th among 45 entries for grain yield over 26 locations. Breeder seed of FHB resistant wheat line VA02W-713 (Ning7840 / Pioneer2691 //Roane) was developed in 2007 in anticipation of its release in 2008. In addition to FHB resistance this line is resistant to powdery mildew and ranked 10th for grain yield in the 2006 Uniform Southern SRW Wheat Nursery.

Impact:

Availability of competitive FHB resistant cultivars such as JAMESTOWN, possessing other traits of importance to producers such as early maturity and resistance to multiple diseases, will promote its adoption and production and have a direct impact on reducing FHB and DON in grain in the marketplace. In addition, JAMESTOWN provides other breeding programs with an elite parental line possessing multiple traits of interest.

Accomplishment:

In addition to FHB QTL on chromosomes 3BS and 5AS, markers for putative QTL on chromosomes 2BS, 2DS, 2DL, 3AS, and 6BS are being used to haplotype, identify and direct pyramiding of potentially diverse FHB resistance sources. FHB resistance in the SRW wheat cultivar Renwood 3260, developed at Virginia Tech, appears to be unique and resistance may be governed by QTL on chromosomes 2DS, 2DL, and 3AS. Markers for these QTL have been used in our program to characterize and identify elite lines and parents having multiple and diverse resistance genes. Availability of additional diagnostic markers for these and other unique FHB QTL is critical to efforts in identifying and pyramiding diverse resistance genes.

Impact:

Identification of wheat lines having diverse, multiple, and potentially unique QTL conferring resistance is paramount to reducing FHB and DON. Such knowledge is critical in facilitating gene pyramiding and enhancing overall resistance. Elite lines have potential for release as cultivars and these and other lines offer other breeding programs with a source of unique and desirable germplasm.

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.

Zhou, Kequan, Junjie Hao, Carl Griffey, Hyun Chung, Sean O'Keefe, Jianli Chen, and Shelly Hogan. 2007. Antioxidant properties of Fusarium head blight-resistant and –suscpetible soft red winter wheat grains grown in Virginia. J. of Agricultural and Food Chemistry: 55:3729-2736.

Chen, J., C.A. Griffey, M.A. Saghai Maroof, E.L. Stromberg, R.M. Biyashev, W. Zhao, M.R. Chappell, T.H. Pridgen, Y. Dong, and Z. Zeng. 2006. Validation of two major quantitative trait loci for fusarium head blight resistance in Chinese wheat line W14. Plant Breeding 125: 99-101.

Chen, Jianli., Jody Fanelli, Carl Griffey, Joe Paling, M.A. Saghai Maroof, and Gina Brown-Guedira. 2006. Progress in developing and MAS of FHB resistant wheat cultivars and germplasm at Virginia Tech. p.91. *In*: Susan M. Canty, Anthony Clark and David Van Sanford (eds.) Proceedings of the 2006 National Fusarium Head Blight Forum. Dec. 10-12, 2006. Research Triangle Park, NC.