USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
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Cover Page

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0206-9-084
USDA-ARS Agreement Title:	Evaluation, Breeding, and Genomics of FHB Resistance in Wheat and Barley.
FY10 USDA-ARS Award Amount:	$ 153,655

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Development of Winter Barley Cultivars with Enhanced Resistance to FHB and DON.	$ 29,268
VDHR-SWW	Improving FHB Resistance in SRW Wheat via Integrated Mapping, Phenotypic and MAS.	$ 124,387
	Total ARS Award Amount	**$ 153,655**

Carl A. Griffey 6/19/11

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 Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Development of Winter Barley Cultivars with Enhanced Resistance to FHB and DON.*

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

Until recently, little was known about the presence or extent of FHB resistance in Virginia Tech's winter barley germplasm. Also, the hypothesis that DON is stable and becomes concentrated in the Distiller's Dry Grains with Solubles (DDGS) during ethanol production needs to be confirmed as this could render this valuable by-product unusable. Our program is conducting collaborative research with Dr. David Schmale and with USDA scientists at the Eastern Regional Research Center to: 1) identify and characterized FHB resistance in Virginia Tech winter barley germplasm; 2) ascertain the fate of DON during ethanol production and; 3) identify solutions to minimize the treat of FHB and DON in winter barley.

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) FHB resistance and lower DON levels have been identified and confirmed in the hulled winter barley cultivar Nomini (FHB Index = 12, FDK = 7%, DON = 2.7 ppm) and the hulless cultivar Eve (FHB Index = 11, FDK = 6%, DON = 2.5 ppm). The susceptible cultivar Doyce had an FHB index = 48, FDK = 31%, and DON = 30 ppm. Crosses were made this spring to develop mapping populations to characterize FHB resistance in these cultivars. Association mapping analysis also is being used to identify potential QTL conferring FHB resistance. Pure lines from populations derived from crosses between known FHB resistant spring barley lines and adapted winter barley lines are being evaluated for FHB resistance and agronomic performance.
2) Barley fuel ethanol studies are being conducted and confirm that DON is stable and becomes concentrated in DDGS. Barley milling methods and use of transgenic yeast strains to degrade DON are being evaluated and show promise in minimizing DON.

Impact:

1) Identification and characterization of FHB resistance within Virginia Tech's winter barley germplasm including the validation of known QTL and potential identification of novel QTL will facilitate marker assisted breeding for enhanced levels of resistance.
2) Development of FHB resistant winter barley cultivars having lower DON levels in the grain, and further reduction of DON levels via hull removal and milling, and use of transgenic yeast strains capable of degrading DON during ethanol production will result in DDGS having minimal DON and ensure the viability of this profit making by-product.

Project 2: *Improving FHB Resistance in SRW Wheat via Integrated Mapping, Phenotypic & MAS.*

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

   Development of competitive wheat cultivars having FHB resistance derived from exotic sources, such as *Fhb1* derived from Sumai 3, has been hindered by linkage drag. In addition progress has been hindered by the lack of adequate characterization and validation of FHB resistance in adapted native sources and unavailability of diagnostic markers needed to implement marker assisted incorporation and pyramiding of diverse QTL for FHB resistance. FHB resistance in the SRW wheat cultivar Massey was mapped and resistance in Ernie was validated and fine mapped. Recombinant inbred lines derived from crosses including the FHB resistant SRW wheat cultivars Roane and Jamestown were obtained and a northern and southern set of lines were sent to relevant cooperators in AR, GA, KY, LA, MD, MO, NC, and VA for FHB phenotyping during fall 2010. Marker assisted selection (MAS) is being used to both enhance the level of scab resistance and to accelerate the development of superior scab resistant cultivars. Markers linked to scab resistance genes located on wheat chromosomes 3BS and 5AS of Ning 7840 (Sumai 3 derivative), 2B, 3BSc, 4B and 5A of Ernie are being used to screen, characterize and select parents and their progeny for scab resistance genes. Twelve top cross populations developed between 2008 and 2010 with either Ernie or Ning 7840 (or other Sumai3 derivatives) in their pedigrees were screened via MAS to enrich FHB resistance in these breeding populations. In 2010, FHB breeding materials evaluated in scab nursery and/or field tests included: 210 populations, 8,000 headrows, and more than 800 pure lines.

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.**
3. **Accomplishment:** FHB resistance was mapped in Becker/Massey (BM) and Ernie/MO94-317 (EM) populations. In BM, four QTLs consistently conferring scab resistance across environments were identified. The QTL on chromosome 3BSc was associated with flowering date, greenhouse severity, FHB incidence and index in the field, and DON toxin levels. The QTL on chromosome 4A was associated with FHB index and FDK. The QTL on chromosome 4B was associated with FHB incidence and index in the field, severity in greenhouse, and FDK and DON. The QTL on chromosome 4D was associated with FHB severity and DON. In the EM population, 47 new markers were added to saturate the known scab resistance QTL on chromosomes 2B, 3BSc, 4B and 5A. The QTL from Ernie on 2B was associated with greenhouse severity, plant height and flowering date. The QTL from Ernie on 3BSc was associated with greenhouse severity. A QTL at 4B from MO94-317 was associated with field scab severity, index, and FDK. The resistance QTL from Ernie at 5A was associated with field incidence, severity and grain weight and overlapped the awn suppressor gene, B_1.

   Impact: The molecular markers associated with the QTL in Massey were Xwmc827.214.5 on chromosome 3BSc, XwPt6668 on chromosome 4A, XwPt3908 on chromosome 4B, and XwPt3743 on chromosome 4D. The sequence of the three DArT markers will be requested

and microsatellite or sequence tagged site makers may be designed and validated. The tightly linked markers associated with QTL in Ernie were Xgwm319 and Xgwm501 for the 2B QTL, Xwmc1, Xwmc418 and Xwmc471 for 3BSc QTL, Xgwm149 and Xgwm513 for 4B QTL, and Xgwm304 and wmc705 for 5A QTL. These diagnostic markers can be used in marker-assisted selection to pyramid various multiple QTL for scab resistance.

Include below a list of 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.

Brooks, W. S. M. E. Vaughn, C. A. Griffey, W. E. Thomason, J. J. Paling, R. M. Pitman, D. W. Dunaway, R. A. Corbin, J. C. Kenner, E. G. Hokanson, H. D. Behl, B. R. Beahm, S. Y. Liu, P. G. Gundrum, A. M. Price, D. E. Brann, D. L. Whitt, J. T. Custis, D. E. Starner, S. A. Gulick, S. R. Ashburn, E. H. Jones Jr., D. S. Marshall, M. O. Fountain, T. D. Tuong, D. P. Livingston, R. Premakumar, M. J. Kurantz, F. Taylor, R. A. Moreau, and K. B. Hicks. 2011. **Registration of 'Dan' Winter Hulless Barley.** Journal of Plant Registrations 5: 4 pages. doi: 10.3198/jpr2010.03.0161crc. **In comparison to 'Doyce', Dan barley is moderately resistant to FHB with an Index of 33 versus 48, FDK of 24 versus 31 and DON of 16 versus 30 ppm.**

Griffey, C. A., W. E. Thomason, R. M. Pitman, B. R. Beahm, P. G. Gundrum, S. Y. Liu, J. Chen, J. J. Paling, D. W. Dunaway, W. S. Brooks, M. E. Vaughn, J. E. Seago, B. C. Will, E.G. Hokanson, H. D. Behl, R. A. Corbin, T. R. Lewis, M. D. Hall, J. T. Custis, D. E. Starner, S. A. Gulick, S. R. Ashburn, D. L. Whitt, H. E. Bockelman, J. P. Murphy, R. A. Navarro, E. J. Souza, G. L. Brown-Guedira, J. A. Kolmer, D. L. Long, Y. Jin, X. Chen, and S. E. Cambron. 2011. **Registration of 'SW049029104' Wheat.** Journal of Plant Registrations 5:91-97. doi: 10.3198/jpr2010.03.0146crc. **FHB resistance of SW049029104 (USG3315) is similar to that of 'Jamestown' with a three year index of 6 versus 22 for USG 3592.**

Hall, M. D., W. Rohrer-Perkins, C. A. Griffey, S. Y. Liu, W. E. Thomason, A. O. Abaye, A. Bullard-Schilling, P. G. Gundrum, J. K. Fanelli, J. Chen, W. S. Brooks, J. E. Seago, B. C. Will, E. G. Hokanson, H. D. Behl, R. M. Pitman, J. C. Kenner, M. E. Vaughn, R. A. Corbin, D. W. Dunaway, T. R. Lewis, D. E. Starner, S. A. Gulick, B. R. Beahm, D. L. Whitt, J. B. Lafferty, and G. A. Hareland. 2011. **Registration of 'Snowglenn' Wheat.** Journal of Plant Registrations 5: 6 pages. doi: 10.3198/jpr2010.03.0160crc. **The winter durum wheat cultivar Snowglenn has moderate resistance to FHB with a four year average index of 21 and a DON level of 2.0 ppm. The most susceptible lines had an index of 67 and a DON level of 14 ppm.**

The SRW wheat germplasm lines VA04W-433 (PI 657945) and VA04W-474 (PI 657946) were developed by the Virginia Agricultural Experiment Station and released in March 2009. VA04W-433 was derived from a three-way cross of 'Ning 7840' / Pioneer Brand '2684'// VA96-54-244. VA04W-474 is a doubled haploid line derived from the F_1 of the three-way cross 'Roane' // W14 / 'Coker 9134'. VA04W-433 has *Fhb*1 and VA04W-474 has the 5AS QTL. FHB incidence, severity, index, and DON levels of the two lines are similar to those of the resistant check cultivar Ernie. A registration article will be submitted in 2011.

The SRW winter wheat line VA05W-251 was released in 2011. It has a similar level of FHB resistance as Jamestown with a three year mean index value of 8 versus 22 for USG 3592.

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.

Other Journal Publications

Kang, J., A. Clark, D. Van Sanford, C. Griffey, G. Brown-Guedira, Y. Dong, and J. Costa. 2011. **Exotic scab resistance quantitative trait loci (QTL) effects on soft red winter wheat.** Crop Science (In Press).

Presentations

Berger, G., P. Khatibi, W. Brooks, S. Liu, M. Hall, A. Green, C. Griffey, and D. Schmale, III. 2010. **Phenotypic characterization of Fusarium head blight resistance in hulled and hulless winter barley grown in the mid-Atlantic region.** Pp. 129-130. In: S. Canty, A. Clark, A. Anderson-Scully, D. Ellis, and D. Van Sanford (Eds.). Proceedings of the 2010 National Fusarium Head Blight Forum; Dec 7-9; Milwaukee, WI. University of Kentucky Press, Lexington, KY.

Berger, G. L., S. Liu, M. D. Hall, W. S. Brooks, S. Chao, C. A. Griffey, and G. J. Muehlbauer. 2010. **Association mapping of molecular markers linked to key traits in the Virginia Tech winter barley program.** Fourth Annual Meeting of National Association of Plant Breeders. Johnston, IA.

Brown-Guedira, G., C. Griffey, and M. D. Hall. 2010. **Marker assisted breeding to develop superior wheat cultivars.** Fourth Annual Meeting of National Association of Plant Breeders. Johnston, IA.

Gao, J. Y. Wang, T. Werner, L. Cardwell, J. P. Murphy, G. Brown-Guedira, C. Griffey, Y. Dong, and J. Costa. 2010. **Mapping scab resistance in the winter wheat line MD01W233-06-1.** pp. 138-141. In: S. Canty, A. Clark, A. Anderson-Scully, D. Ellis, and D. Van Sanford (Eds.). Proceedings of the 2010 National Fusarium Head Blight Forum; Dec 7-9; Milwaukee, WI. University of Kentucky Press, Lexington, KY.

Liu, S., G. L. Berger, M. D. Hall, W. S. Brooks, S. Chao, C. A. Griffey, and G. J. Muehlbauer. 2010. **Identification of molecular markers for important traits in winter barley using association mapping.** Plant and Animal Genome XVIII Conference. Jan 9-13. San Diego, CA.

Liu, S., C. A. Griffey, M. D. Hall, A. L. McKendry, W. S. Brooks, J. Chen, G. Brown-Guedira, and D. Van Sanford. 2010. **Linkage and association of genes for morphological traits and scab resistance in U.S. soft red winter wheat.** Annual Meetings of the American Society of Agronomy. Oct. 31-Nov. 3. Long Beach, CA. Agronomy Abstracts. ASA, Madison, WI.

Shoots, J., M. Guttieri, F. Kolb, J. Lewis, A. McKendry, H. Ohm, C. Sneller, M. E. Sorrells, E. Souza, D. Van Sanford, J. Costa, C. Griffey, S. Harrison, J. Johnson, and P. Murphy. 2010. **Development and distribution of male-sterile facilitated recurrent selection populations.** Pp. 165-166. In: S. Canty, A. Clark, A. Anderson-Scully, D. Ellis, and D. Van Sanford (Eds.). Proceedings of the 2010 National Fusarium Head Blight Forum; Dec 7-9; Milwaukee, WI. University of Kentucky Press, Lexington, KY.