USDA-ARS / USWBSI
FY04 Final Performance Report
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Cover Page

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Year:	**FY2004** (approx. May 04 – April 05)
FY04 ARS Agreement ID:	**59-0790-4-120**
FY04 ARS Agreement Title:	**Breeding and Genetics of Fusarium Head Blight Resistance in Barely**
FY04 ARS Award Amount:	**$ 137,260**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
BIO	Developing Marker Information for Genetic Diversity and FHB Resistance in Barley.	$ 59,903
VDUN	Accelerated Development of Fusarium Resistant Barley Varieties.	$ 77,357
	Total ARS Award Amount	**$ 137,260**

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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: ***Developing Marker Information for Genetic Diversity and FHB Resistance in Barley.***

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

Dramatic declines in barley acreage in the Upper Midwest have been attributed to a great extent to the increased risk of FHB rendering the crop unusable by the malting and brewing industry. There are currently no barley varieties available with levels of FHB resistance that will minimize this risk enough to encourage more growers to raise barley. Maker assisted selection for FHB resistance in barley could greatly increase the efficiency of breeding new resistant varieties. The major barrier to implementing marker assisted selection (MAS) for FHB resistance in barley is the availability of useful markers that flank QTL for FHB. Several of the more promising QTL for FHB that have been identified in barley are problematic for six-rowed barley breeding because resistance co-segregates with undesirable traits such as late heading, high grain protein concentration, or two-rowed spike type. In order to utilize these resistance alleles, we must first determine whether the co-segregation of resistance with other traits is the result of pleiotropy or tight linkage of independent genes. If the latter is true, then the next step is to identify genetic markers that flank the resistance QTL, but not the locus controlling the undesirable trait. Once this is accomplished the resistance allele can be manipulated through MAS without the "linkage drag" of the undesirable traits. We are resolving this issue by fine-mapping three regions in barley that contain coincident QTL for FHB and other undesirable traits. In addition, we are continuing to map disease resistance in the source of resistance Atahualpa to identify novel resistance genes.

2. What were the most significant accomplishments?

During the FY04 funding period, we made significant progress toward fine-mapping FHB QTL regions and mapping QTL in the source of resistance Atahualpa. In the fine mapping work, we mapped a region of bin 8 of chromosome 2H that was associated with FHB resistance and heading date (HD). This association between FHB resistance and late HD in this region of chromosome 2H has been identified in several mapping studies. Using a fine mapping population, derived from one of the progeny of the Chevron (resistant) x M69 (susceptible) mapping population, we were able to map two distinct loci for FHB and HD located less than 3 cM apart. The recombinants that we identified in this population, specifically resistant and early heading, along with the SSR markers that flank only the FHB QTL will allow us to utilize this resistance allele in MAS to develop improved resistance with acceptable HD. We have also completed the development of a fine-mapping population for the QTL region on chromosome 6H that is also associated with grain protein concentration. Disease and protein data collected in the 2005 field season will be used to conduct a similar fine-mapping analysis and identify useful recombinants and markers for utilization of this resistance allele through MAS. Fine mapping of the FHB QTL region on chromosome 2H that is linked to the gene controlling two-rowed / six-rowed spike morphology has not yet answered the question of linkage vs. pleiotropy since the distance between the FHB and Vrs1 loci is less than 0.6 cM. Further work will be necessary to determine if this locus will be useful in MAS. In the Atahualpa mapping population, we have identified several QTL for FHB resistance that have not been identified in previous mapping studies and that warrant further investigation.

Project 2: ***Accelerated Development of Fusarium Resistant Barley Varieties.***

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

Growers in the Upper Midwest have been discouraged from producing barley due to the increased risk of FHB and the lack of varieties that provide resistance to this disease. New FHB resistant barley varieties with acceptable agronomic and quality performance are essential for the future viability of barley production in the Upper Midwest. Major barriers to breeding for FHB resistance in barley include: relatively few promising sources of resistance, sources of resistance are poorly adapted to the Midwest and have very poor malting quality requiring multiple cycles of breeding, disease screening is laborious and must be conducted in the field on adult plants, and expression of disease resistance is variable across environments so that many evaluations must be conducted to confidently identify resistant breeding lines. To meet these challenges, we are conducting a comprehensive breeding effort utilizing extensive field screening nurseries at multiple locations, marker assisted selection, and off-season nurseries for disease screening and seed increase.

2. What were the most significant accomplishments?

The most significant outcomes of this accelerated breeding effort were the designation of two variety candidates with increased levels of FHB resistance that will be entered into industry pilot malting evaluations. Evaluation in the American Malting Barley Association (AMBA) pilot malting and plant-scale brewing tests is required before any variety can be added to the AMBA approved list of varieties. Identification of variety candidates for the AMBA program requires extensive testing to insure that the lines will have a good chance of meeting industry standards. The two breeding lines, M122 and M123, are the first lines with improved FHB resistance from our breeding program that we have entered into the AMBA testing program. The line M122 traces back to two sources of resistance (Zheddar and MNBrite) and has been shown to have a 50% reduction in FHB severity and deoxynivalenol (DON) concentration relative to the variety Robust. M123 has about a 20% reduction in severity and DON and its resistance traces back to Hor211. Both of these lines yield similar to the variety Lacey and appear to have an acceptable malting profile. If these lines have favorable evaluations in the pilot and plant-scale programs, they could be released as varieties as early as 2008. These lines will also be used in conventional and marker-assisted breeding to combine genes from multiple sources of resistance.

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 you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Peer-Reviewed

Canci, P. C., L.M. Nduulu, R. Dill-Macky, G.J. Muehlbauer, D.C. Rasmusson, and K.P. Smith. 2004. Validation of Quantitative Trait Loci for Fusarium Head Blight and Kernel Discoloration Resistance in Barley. Mol. Breeding 14:91-104.

Smith, K. P., C. K. Evans, R. Dill-Macky, C. Gustus, W. Xie , and Y. Dong. 2004. Host genetic effect on deoxynivalenol accumulation in Fusarium head blight of barley. Phytopathology 94:766-771

Abstracts/Proceedings/Non-Peer Reviewed

Nduulu, L. M., Mesfin, A., Muehlbauer, G. J., Smith, K. P. Fine-mapping of Fusarium head blight resistance and heading date coincident QTL on chromosome 2H in Barley. In Proceedings of the American Society of Agronomy Annual Meeting, Seattle, WA. Oct 31 – Nov 3, 2004.

Smith, K.P, Nduulu, L., Gustus, C., Sallam, A., and Beaubien, K. 2004. QTL mapping Fusarium head blight resistance in barley. In *Proceedings of the 9th International Barley Genetics Symposium*, Brno, Czech Republic, June 20-26, 2004, p. 884-889.

Steffenson, B. J. and Smith, K. P. 2004. Breeding barley for multiple disease resistance in the Upper Midwest region of the USA. In *Proceedings of the 9th International Barley Genetics Symposium*, Brno, Czech Republic, June 20-26, 2004, p. 294-301.

Baluch, S. D., Muehlbauer, G. J., Smith, K. P., Somers, D. A., and Steffenson, B. J. 2004. Fine mapping the CRS1 region of chromosome 2(2H) of barley and analyzing a set of NILS for the VRS1 region for FHB severity. In: *Proceedings of the International Triticeae Mapping Initiative 2004 Summer Workshop. Minneapolis, MN May 22-25, 2004.*

Evans, C.K., Dill-Macky, R. and Smith, K.P. (2004). Characterizing barley near-isogenic lines for a QTL conditioning deoxynivalenol accumulation for Fusarium head blight severity and deoxynivalenol accumulation using five isolates of Fusarium graminearum under field conditions. In: Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar, Orlando, Florida, USA, December 11-15, 200

Baluch, S. D., Smith, K. P., Muehlbauer, G. J., Somers, D. A., and Steffenson, B. J. 2004. Investigating FHB QTL Associated with the Vrs1 (row-type) Locus on Chromosome 2 (2H) of *Hordeum vulgare.* In: Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar, Orlando, Florida, USA, December 11-15, 2004, Vol 1. p. 12.

Nduulu L. M., A. Mesfin, G.J. Muehlbauer, and K.P. Smith. 2004. High Resolution Mapping of Fusarium Head Blight Resistance and Heading Date QTL on Chromosome 2H of Barley. In: Proceedings of the 2nd International Symposium on Fusarium Head Blight, incorporating the 8th European Fusarium Seminar, Orlando, Florida, USA, December 11-15, 2004, Vol. 1 p. 246.

Horsley, R. and K. P Smith. 2005. Development of Scab Tolerant Barley Varieties at North Dakota State University and the University of Minnesota. 2005 Barley Improvement Conference, Jan. 11-12, 2005, Charleston, SC.

Dill-Macky, R., B. J. Steffenson, C. Hollingsworth and K. P. Smith. 2005. Management of Barley Diseases in the Upper Midwest. 2005 Barley Improvement Conference, Jan. 11-12, 2005, Charleston, SC.