USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
July 15, 2011

Cover Page

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0206-9-070
USDA-ARS Agreement Title:	Breeding and Development of DNA Markers for Fusarium Head Blight Resistance in Wheat.
FY10 USDA-ARS Award Amount:	$ 161,464

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Breeding and Genetic Investigations of Fusarium Head Blight Resistance in Spring Wheat.	$ 115,285
VDHR-SPR	Mapping of an Inhibitor of Fhb1, the Major QTL for FHB Resistance in Wheat.	$ 38,906
VDHR-SPR	Genetic Characterization of Fusarium Head Blight Resistance in two Elite Spring Wheat Cultivars.	$ 7,273
	Total ARS Award Amount	**$ 161,464**

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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: *Breeding and Genetic Investigations of Fusarium Head Blight Resistance in Spring Wheat.*

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

Despite the dramatic increase in genetic resistance to FHB of released varieties in the spring wheat region in the past few years and the fact that these varieties are being widely adopted, there are still susceptible and moderately susceptible varieties in production. In addition, even the varieties with enhanced FHB resistance available today can suffer significant damage due to FHB and elevated DON in environments favorable for disease development. Therefore, the overall level of FHB resistance of regional varieties must be improved.

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):
'Rollag' hard red spring wheat was released in 2011. Rollag combines best available scab resistance (3 on 1-9 scale) and good straw strength.

Impact (1):
No other spring wheat cultivar available today combines the FHB resistance and straw strength of Rollag. This should be an attractive cultivar for growers who have had lodging problems with other moderately resistant cultivars. Among the four other spring wheat cultivars with good straw strength (3 or less on 1-9 scale), namely Samson, Vantage, Breaker, and Pivot only Breaker has some FHB resistance (4 on 1-9 scale). The other cultivars are moderately to highly susceptible.

Accomplishment (2):
Five experimental lines were entered and evaluated in the 2010 Uniform Regional Scab Nursery. These lines were identified in previous testing as having improved levels of FHB resistance. All five lines were below the mean of the trial for VSK and DON.

Impact (2):
These lines combine FHB resistance from different sources and are candidates for future germplasm release. These lines are available and have been requested by other wheat breeders in the region for use as crossing parents.

Accomplishment (3):
Scab nurseries were established at three field sites in 2010. A total of 2,824 genotypes were evaluated in 7,364 total rows among the locations. The Crookston and St. Paul FHB screening nurseries were excellent, and provided highly discriminatory data. The Morris location had moderate FHB symptoms but was valuable to distinguish among MR and MS lines. As a result of these nurseries and results from previous years, the FHB resistance of 30 spring wheat cultivars was assessed and reported to growers via print media and field day presentations.

Impact (3):
Good field screening nurseries are needed to maintain progress in breeding for FHB resistance. Our screening of more 2,000 F_5 lines for FHB reaction at two locations eliminates virtually all susceptible lines. Our FHB resistance ratings are an important part of growers' decision regarding which variety they will grow.

Accomplishment (4):
Marker-assisted selection was completed for 899 selected F_5 (pre-yield trial) lines, and 1185 plants from 57 BC_1 and top-cross families segregating for FHB resistance QTL and other important genes. The F_5 lines were processed by the USDA-ARS Genotyping Center in Fargo and the BC_1 and top-cross samples were processed in-house. *Fhb1* and the 5AS FHB QTL were selected in 37 and 27, respectively, of the 57 BC_1 and topcross populations subjected to MAS.

Impact (4):
The screening of BC_1 and top-cross lines enriches populations for FHB resistance QTL. Likewise, selecting F_5 lines containing the *Fhb1* and 5AS QTLs enhances the chances of advancing lines with high levels of FHB resistance.

Project 2: *Mapping of an Inhibitor of Fhb1, the Major QTL for FHB Resistance in Wheat.*

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

The literature contains many reports of QTLs for FHB resistance being derived from the "susceptible" parent in biparental crosses. Although some of these are minor QTL and may be statistical artifacts, others have moderate effects and have been validated in other populations. We observed what are consistent with inhibitory effects in *Fhb1* near-isogenic lines we developed. More recently, while investigating *Fhb1* candidate genes as part of our ongoing efforts to clone this gene, we discovered that the recipient genotype, 'Bobwhite' inhibited the effect of *Fhb1*.

The goal of this research is to identify and map this inhibitor, haplotype our germplasm to identify its prevalence in our lines, and selectively remove it from our breeding lines so the resistant phenotype conferred by *Fhb1* is fully expressed. To do so, we developed a population of RILs from a cross between the resistant *Fhb1* – containing near-isogenic-line 260-2 (Sumai 3/Stoa) and the susceptible non – *Fhb1* – containing variety Bobwhite.

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 mapping population consists of the 129 RILs that are homozygous for the presence of *Fhb1* as identified by the umn10 marker previously developed in our lab. These lines have gone through one season of greenhouse screening for Type II resistance and are currently in

the field to obtain a second season of Type II resistance data, as well as screening for visually scabby kernels and DON accumulation. Early this fall, the population will be genotyped using the Illumina 9,000 SNP chip, and subsequent mapping will be performed to locate the genomic region(s) contributing to the resistance gene inhibition.

Based on the Fall 2010 screening, the data is consistent with a one gene segregation but there is also the possibility of multigenic control.

Impact:

The major outcome of this research will be the knowledge of the location of gene(s) inhibiting the affect of *Fhb1*. This could be important for breeders as this knowledge may help explain why *Fhb1* (and possibly other FHB QTLs) show little or no affect in some genetic backgrounds. Breeders may avoid using parents shown to have inhibitory effects in their crossing program or use the marker(s) we intend to develop to eliminate this gene from progeny lines. If the inhibition is due to a single gene, it will make it much easier to remove it from breeding germplasm, and this will then make the expression of resistance conferred by *Fhb1* much more consistent and pronounced, thus leading to reduced levels of Fusarium head blight and the subsequent mycotoxins.

Project 3: *Genetic Characterization of Fusarium Head Blight Resistance in two Elite Spring Wheat Cultivars.*

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

After many years of breeding hard red spring wheat (HRSW) for FHB resistance at NDSU, U of MN, and SDSU and other breeding programs in the spring region, many cultivars with FHB resistance have been released and are being grown on a large scale replacing the most susceptible cultivars. However, most of these cultivars trace their resistances to the Chinese sources, particularly Sumai 3. However, Glenn does not show the presence of the closest markers to the main FHB resistance gene *Fhb1* from Sumai 3. This has raised a major question among us, breeders involved in this project: *Does Glenn have a new combination of FHB resistant genes from its diverse pedigree tracing to Chinese, US, and wild type wheat origin?* or *have breeders at NDSU who developed this cultivar broken the linkage between Fhb1 and the new flanking markers?*. To confirm either case, more research is needed to elucidate this assumption. Similarly, among the most popular grown cultivar developed by NDSU, **Parshall** was grown on significant acreages in the spring wheat region for many years because it has showed consistently good tolerance to FHB. Parshall's parentage does not trace to any exotic origin such as Chinese germplasm. **MN00261-4** is a U of MN released line that has been licensed and is being grown in the spring wheat region. Its pedigree is MN95286/MN94155//Verde which likewise contains no Chinese germplasm or other identified source that may be responsible for its moderate resistance (4 on our 1-9 scale). We believe Parshall and MN00261-4 have indigenous sources of resistance that may of great interest to wheat breeders. To address both topics indicated above and to clarify the genetics of FHB resistance of both Glenn and Parshall, several Recombinant Inbred Lines

(RILs) populations involving these two sources and susceptible parents were developed. My role in this project is to provide field-based FHB data on two of these populations: Glenn/MN00261-4 and Parshall/Reeder.

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:
In summer 2010, RILs of Glenn/MN00261-4 (111 lines, 2 reps) and Parshall/Reeder (109 lines, 2 reps) populations, parents, and checks were evaluated in our Crookston FHB nursery. Data was collected on field severity, 30 spike seed weight, test weight, and visually scabby kernels. Samples will be submitted for DON analysis.

Impact:
The potential impact of this research on the breeding for FHB resistance is high given the prevalence of these lines as crossing parents in recent years. If we can prove that the strong resistance of Glenn to FHB is not based on the *Fhb1* gene, this would be a breakthrough for all wheat breeding programs dealing with FHB as a major threat for wheat. Similarly, new genes for resistance to FHB in wheat are warranted as the arsenal of genes available to breeders is very limited. MN00261-4 and Parshall can be a good source of novel FHB resistance genes that could be mined by breeders.

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.

'Rollag' hard red spring wheat was released in January 2011. Rollag has our best rating (3 on 1-9 scale) for FHB resistance of all currently grown cultivars. Only 'Brick' and 'Glenn' have a rating this high.

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.

Anderson, J.A., J.J. Wiersma, G. Linkert, S. Reynolds, and C. Springer. 2010. Hard Red Spring Wheat. In Minnesota Varietal Trials Results, University of Minnesota Extension Service.