USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
July 13, 2012

Cover Page

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Fiscal Year:	FY11
USDA-ARS Agreement ID:	59-0206-9-052
USDA-ARS Agreement Title:	Spring Wheat Breeding Scab Resistance in South Dakota.
FY11 USDA-ARS Award Amount:	$ 77,437

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-SPR	Spring Wheat Breeding for Scab Resistance in South Dakota.	$ 72,366
VDHR-SPR	Genetic Characterization of Fusarium Head Blight Resistance in Two Elite Spring Wheat Cultivars.	$ 5,071
	Total ARS Award Amount	**$ 77,437**

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: *Spring Wheat Breeding for Scab Resistance in South Dakota.*

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

Fusarium head blight (FHB) is a serious wheat disease that continues to pose a threat to production within South Dakota as well as the North Central region of the USA. In an attempt to alleviate this threat, development of resistant cultivars has became a high priority within the spring wheat breeding program at South Dakota State University. An aggressive program was initiated to speed development of spring wheat cultivars with improved FHB resistance and desirable agronomic traits. Established off-season nurseries and mist-irrigated greenhouse and field screening nurseries are utilized to accelerate breeding efforts to improve resistance along with desirable agronomic characteristics. Three early generations of breeding materials are evaluated for resistance each year: two generations in the greenhouse and one in the field. Approximately 8,000 individual hills are evaluated in the greenhouse nurseries and 3,000 head-rows are screened in the field nursery. Both the field and greenhouse nurseries are inoculated with infested corn and conidial suspensions. A mist-irrigation system is used to provide a favorable environment for infection and disease development. Each year we make approximately 400 crosses to introduce new resistance genes and create new resistance gene combinations. Sources of resistance used in the crosses include material from the Uniform Regional Scab Nursery (URSN) for spring wheat parents, (a cooperative regional effort to identify and utilize sources of scab resistance) newly identified germplasm provided through introduction and evaluation efforts, other introduced sources, as well as both cultivars and advanced breeding lines with various levels of resistance. The off-season nursery aids in the simultaneous selection for resistance and desirable agronomic characteristics.

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):

<u>Accomplishment:</u>

Our program has provided elevated levels of resistance to FHB in the form of Hard Red Spring Wheat (HRSW) cultivars and germplasm made available to regional growers and other breeders to utilize. Within the past several years, five cultivars have been released to growers by our program. Over five years of simultaneous testing, the FHB disease index ratings recorded for ‘Briggs’, ‘Granger’, ‘Traverse’, ‘Brick’, and ‘Select’ were 31.2, 33.7, 28.8, 17.8, and 25.2, respectively, compared to ‘Alsen’, (26.9) the resistant check. Additionally, germplasm provided to the Uniform Regional Scab Nursery by this program in 2010 and 2011 were ranked as first, second, and third most resistant when averaged over testing locations.

Impact:

Elevated resistance levels in released cultivars are immediately utilized by the most apparent beneficiaries of our work; HRSW producers. Through utilizing cultivars with elevated resistance levels, growers are more able to protect themselves from suffering devastation of fields in the presence of a severe FHB epidemic. Elevated resistance levels in germplasm is also quite often utilized by a less immediately apparent group; HRSW breeders. Through utilizing both germplasm and released cultivars, other breeding programs strive to further increase FHB resistance among germplasm pools that will eventually result in the release of continually improved cultivars.

Project 2: *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?

Decades of breeding of 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, particularly, NDSU cultivars, replacing the most susceptible cultivars. Most of these cultivars trace their resistances to the Chinese sources, particularly Sumai3. This is true for cultivars such as Alsen and supposedly **Glenn**, both NDSU releases that have dominated the spring wheat area since 2002. However, recently we have collected some data showing that Glenn does not show the presence of the closest markers to the main FHB resistance gene Fhb1 from Sumai 3. These results have been confirmed by many labs including U of MN (USDA-ARS, Fargo,…etc). All these results show that haplotyping Glenn is consistent with our data that Glenn may not have *Fhb1* markers as we previously believed based on Glenn pedigree. This has raised a major question among us, breeders involved in this project. *Does Glenn have a new combination of FHB resistant genes from it diverse pedigree tracing to Chinese, US, and wild type wheat origin?* or *have breeders at NDSU who developed this cultivar have broken the linkage between the 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 parentage do not trace to any exotic origin such as Chinese germplasm. We believe Parshall has an indigenous source of resistance that may of great interest to the 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 or resistances and susceptible parents from MN (MN00261-4), SD (SD3870), and ND (Reeder) were developed. In this study we will use a couple RIL populations with Glenn and Parshall to map the FHB resistance and use other RIL populations for validating our results.

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:

A graduate student, Mr. Ahmed El Doliefy was hired to work on this project in 2010. He has been conducting research activities related to this project. Particularly, he has been doing field evaluations for FHB reaction of the RILs and their parents along with the checks in ND and lab. Work to map the FHB resistance in Glenn and Parshall will start in Fall 2012. Drs J. Anderson and K. Glover are responsible for field evaluations in MN and SD, respectively. Dr. S. Chao, in the USDA-ARS lab in Fargo, will provide Mr. Ahmed El Doliefy the facilities and guidance in the mapping phase, particularly to saturate the genomic regions of

interest that determined by the Diversity Array Technology (DArT, Australia) data analysis. In 2011, significant results related to FHB field evaluations and DNA samples preparation for DArT analysis were achieved. Following are the achievements in 2011.

Field evaluations:
In summer 2011, the RILs populations, their parents, and appropriate susceptible and most resistant FHB checks were included in four experiments in this project. The experiments were planted in three to four FHB field nurseries located in the three states, ND, MN, and SD in summers of 2011. Data on some agronomic traits including heading height and FHB diseases notes including incidence and severity visually estimated were recorded for each plot approximately 21 days after anthesis. Plots were be harvested to determine DON levels in the lab. However, at Prosper, ND severe floods were have caused some severe effects on many nurseries including FHB nursery.

Lab. Work and DNA extraction:
DNA has been extracted (by Ahmed) from the RILS of all populations, their parents, and checks. This DNA was sent to the DArT for mapping the most known genes on wheat genomes. Therefore, the DNA extraction and its quality should meet the DArT standards. The data generated by DArT was performed in 2011 and is now available to be used by Mr. Ahmed El Doliefy with the help of Dr Chao to (1) generate a basic map and identify important QTL regions, (2) augment the identified QTL regions with microsatellite markers (SSR) that show polymorphism between parents; and (3) subsequently, generate linkage maps. This work will start in Fall 2012 to included phenotypic data that will be generated in this coming 2012 filed FHB nurseries. However, we believe that mapping FHB genes in these populations would be more accurate and useful using SNPs panel that is now available at the USDA-ARS genotyping Center at Fargo. Hence, we are looking for funding (about $15,000) to conduct this additional operation.

Impact:

This research has a substantial potential impact on the breeding for FHB resistance, particularly, if Glenn resistance to FHB is not based on the Fhb1 gene. This would be 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. Parshall can be a good source of novel FHB resistance genes that could be mined by breeders. In both cases, the direct impact on wheat production at the state and regional (northern Great Plains), and national levels is tremendous. In the past years, NDSU HRSW cultivars with FHB resistance have been dominating the spring wheat growing region in the US. Recently released NDSU cultivars Barlow, Faller, Glenn, Steele-ND and Howard are major HRSW cultivars in the US spring wheat region. However, new and novel FHB resistant genes are needed to enhance the resistance of the most common and available cultivars.

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.

Glover K. D., J. C. Rudd, R. N. Devkota, R. G. Hall, Y. Jin, L. E. Osborne, J. A. Ingemansen, J. R. Rickertsen, and G. A. Hareland. 20XX. Registration of Forefront Wheat. Journal of Plant Registrations (in preparation).

Glover K. D., R. G. Hall, L. E. Osborne, J. A. Ingemansen, J. R. Rickertsen, and G. A. Hareland. 20XX. Registration of Advance Wheat. Journal of Plant Registrations (in preparation).

'Advance' and 'Forefront' HRSW cultivars were released in fall 2011. Over four years of simultaneous testing, the FHB disease index ratings recorded for 'Brick', 'Select', 'Forefront', 'Advance', and 'Granger' were 24.3, 28.3, 28.6, 32.4, and 35.9, respectively, compared to 'Alsen', (26.8) the resistant check.

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.

None