USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
One-Year No Cost Extension (NCE) through FY12
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Cover Page

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Fiscal Year:	FY11 (NCE for FY12)
USDA-ARS Agreement ID:	59-0206-9-065
USDA-ARS Agreement Title:	Combining Resistance Sources to Produce FHB Resistant Specialty Spring Wheat Varieties.
FY11 USDA-ARS Award Amount:	$ 28,054

USWBSI Individual Project(s)

USWBSI Research Category*	**Project Title**	**ARS Award Amount**
VDHR-SPR	Development of Spring White and Specialty Wheat Cultivars Resistant Scab Disease.	$ 28,054
	Total ARS Award Amount	**$ 28,054**

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 Spring White and Specialty Wheat Cultivars Resistant Scab Disease.*

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

Scab also known as Fusarium head blight (FHB) is a major threat to wheat production in many parts of the world, particularly in the Northern Central plains of the USA. This disease causes significant losses in wheat grain yield and its quality due to the accumulation of fungal mycotoxins, such as deoxynivalenol (DON). In the US spring wheat region, the losses due to FHB have been estimated to billions of dollars afflicted to wheat growers, industry, and export market. Hard white and specialty spring wheat (HWSW) genotypes resistant to FHB are needed by regional producers to remain competitive in domestic and international markets. A successful wheat breeding approach has been to combine different sources of host FHB resistance, including Types I and II resistances, into a single genotype. This has been done successfully in the hard red spring wheat (HRSW) breeding program and should be implemented in our HWSW breeding program as well.

The HWSW breeding program at NDSU has been addressing this problem by initiating/ reinforcing the development of elite and adapted genotypes/ lines/cultivars and breeding populations that incorporate genetic resistance with desired agronomic and quality traits. The strategy used is based on importing/incorporating/pyramiding several types of genetic resistance to FHB, particularly from our adapted HRSW sources. These include Glenn, Alsen, Faller, Prosper, Steele-ND, and some elite lines. These genes are being incorporated into adapted HWSW lines using classical breeding methods and appropriate novel technologies such as selected molecular markers. Based on our experience, we strongly believe that genetic resistance is/will provides a strategic long-term, economically, and environmentally sound solution to the problem. In 2012-2013 cycles, with these additional funding from the USWBSI, we have included more HWSW germplasm in our evaluations for FHB under both artificial and natural infection conditions. However, given the situation of hard white wheat and its limited acreages in the region, it was decided that the funding of this project will be terminated in 2013-14. Therefore, focus was made on only screening existing populations involving parents with FHB resistance but not generating new ones. We have also included some HWSW lines from advanced generations in our trials. Our goal is to develop elite HWSW germplasm that are adapted to ND in particular, and spring wheat region, in general.

Using funds provided by the USWBSI in the past, we could evaluate the function of types I resistance genes. This was accomplished by a graduate student; Mr. Dalitso Yabwalo whoe was hired in 2008 to conduct this research. Reciprocal backcross monosomic lines developed by hybridizing FHB resistant spring wheat 'Frontana' to a set of 'Chris' spring wheat monosomics, which are susceptible to FHB were used in Mr. Dalitso Yabwalo study. This work has been completed in 2010 and the results were published in Plant Breeding journal in 2011.

1. **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 USWBSI funds allocated to this project have allowed NDSU HWSW breeding program to develop several elite spring wheat lines including NDSW0714 and NDSW0715 which contained one and two QTL for FHB resistance, respectively. Similarly, other USWBSI funds to our hard red spring wheat (HRSW) breeding program resulted in many HRSW cultivars developed in the last decades with excellent agronomic and quality performance and good levels of FHB resistance. These include Glenn, Faller, Steele-ND, Howard, Barlow, Prosper, and recently released cultivars such as Elgin-ND and other in the pipeline of our HRSW breeding program. These genotypes have been used extensively in generating more than hundreds of crosses and segregating populations in past years. This material from these germpasm was selected for FHB and is being advanced in the HWSW breeding pipeline.

Breeding for developing HWSW germplasm with FHB resistance started practically in 2009. Past UWSBSI funding, although may affect breeding, was rather for specific projects. This current project consists of extra-funds to support the on-going project that started few years ago but was significantly in 2012. Unfortunately, it is a one year fund. Therefore, it has been used in 2012 basically to test more material that was generated by previous USWBSI grants. Hence, an extra 50 crosses involving HWSW and HRSW parents to generate HWSW germplasm with FHB resistance was done accomplished. Also, emphasis was made on evaluating more of the existing germplasm. Therefore, an extra 100, 650, 400, 200, 35, 30, and 20 F2 population, F3 families, F4, PYT, IYT, AYT, and EYT lines respectively were screened in 2012 filed nurseries including FHB scab. The screening of the above white/specialty wheat genotypes under scab nursery conditions (artificial inoculation and mist irrigation) was continued at three locations in ND in 2012. Based on data from previous years, many genotypes were selected and identified. Field data was supplemented by the molecular markers information from the USDA-ARS Fargo Genotyping Center to make final selection of resistant genotypes that combine different sources of resistance. This material is being advanced for tests in 2013 nurseries.

Previously, a graduate student, Mr Dalitso Yabwalo was funded by the USWBSI. His study on the evaluation of the monosomics lines to determine the function of both type I resistance. These results were published in the Plant Breeding Journal (Yabwalo, D.N., M. Mergoum, and W.A. Berzonsky. 2011. Plant Breeding 130: 521-525.) emphasized further the characterization of the scab resistance of ‘Frontana’ spring wheat and the relationships between resistance mechanisms. The results demonstrated that 3A is a major genomic region for FHB resistance; therefore, mapping and cloning efforts should focus on this chromosome. The results also indicated the involvement of chromosomes 6A and 4D in reducing FHB spread although to a lesser extent than 3A.

Impact:

The developing HWSW cultivars adapted to ND in particular and the spring region in general could be significant impact given that this class of wheat can expand to larger acreages in the spring wheat region. The use of white wheat for producing 'whole wheat' flour is certainly more appealing for end-users than other red wheat. This type of wheat is also very desirable for the export market such as producing noodle in Asia. Therefore the impact of developing HWSW with FHB resistance may be substantial. Substantial revenues could be generated by growing such as cultivars as is in the case of our HRSW developed by NDSU HRSW breeding program. The results of this project added with other support from the USWBSI will allow us to identify white and specialty wheat germplasm with good FHB resistance.

As mentioned before, previous funding of a graduate student by the USWBSI has generated good results that may have significant impact on our breeding program and the other breeding programs dedicated to pyramid FHB resistance genes. The results from Yabwalo et al., 2011 study indicated the importance of the type I FHB resistance from Frontana and its benefits in pyramiding genes for FHB, which is was demonstrated by a decrease in the level of disease severity over time. The study also provides information to breeders on how pyramiding genes can be useful in developing host plant resistance to FHB, and ultimately resulted in the release of a spring wheat germplasm line which combines two different genes for resistance to FHB. These results can be used also to demonstrate if molecular markers can be effectively employed to pyramid different genes, despite these genes expressing a similar Type II phenotypic resistance to FHB.

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.

Yabwalo, D.N**., M. Mergoum**, and W.A. Berzonsky. 2011. Further characterization of the scab resistance of 'Frontana' spring wheat and the relationships between resistance mechanisms. **Plant Breeding 130: 521-525.**

Abstract/Presentations

Dalitso N. Yabwalo, **M. Mergoum**, and W. Berzonsky. 2010. Chromosome Determining Types I and II Resistance to Fusarium Head Blight in Frontana Spring Wheat. In ASA-CSSA-SSSA-CSSS Abstracts 2010 [CD-ROM], Long Beach CA, USA.