USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY12 Final Performance Report
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Cover Page

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USDA-ARS Agreement ID:	59-0206-9-062 (PI: Richard Horsley)
FY12 USDA-ARS Award Amount:	$ 21,442

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
HWW-CP	Transfer of FHB Resistance to NDSU Hard Red Winter Wheat Breeding Material.	$ 21,442
	Total ARS Award Amount	**$ 21,442**

06-27-2013

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: *Transfer of FHB Resistance to NDSU Hard Red Winter Wheat Breeding Material.*

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

A new breeding population and breeding program is being developed. This necessitates the acquisition, development and utilization of parental stock that will enable breeding of new varieties with adequate disease resistance, a high level of winter-hardiness, adaptation to North Dakota growing conditions and good processing properties. The available germplasm have low levels of resistance to predominant diseases, in particular against FHB. In North Dakota, winter-hardiness and FHB resistance are primary breeding objectives. Reduced tilling improves winter survival and also has financial and ecological advantages, yet accentuates damage from FHB as the pathogen survives better in these conditions. FHB resistance is only partial and its expression is strongly influenced by the environment making it difficult to select for. Additive resistance effects can be attained by pyramiding different resistance genes. Winter-hardiness is similarly a complex, polygenic trait that is difficult to select for. Combining adequate levels of winter-hardiness, disease resistance, yield and quality in new varieties is therefore a formidable challenge.

Development of an appropriate breeding population requires diverse winter-hardy wheat parents carrying different FHB resistance genes. The available FHB resistance genes occur primarily in spring wheat genotypes which made it necessary *to speedily develop and select bridging genotypes (parents) that combine the winter habit with FHB resistance and at least an intermediate level of cold-hardiness*. Such genotypes will be better suited for the integration of FHB resistance into a broad array of elite winter wheat germplasm.

Spring wheat genotypes carrying *Fhb1, Fhb2* and *Qfhs.ifa-5A* from Sumai 3; a gene on chromosome 3A of Frontana and 5AS plus 5AL QTL ex spring wheat accession PI277012 were crossed with Norstar, Jerry and Peregrine (winter-hardy winter wheat). F_1 and segregating populations were used to derive random F_3, doubled haploid (DH) and single seed descent (SSD) inbred lines for evaluation as potential bridge parents. Where possible (and affordable), marker-assisted identification was used to enrich the populations with the target genes.

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>

A large number of segregating populations and inbred lines were established from which bridging genotypes will be identified for final transfer of FHB resistance to a broad range of winter wheat germplasm. These include (Table 1):

a. Eighty F_3 bulk rows planted at Carrington, ND for artificial FHB inoculation and single plant selection during 2013 with the aim to identify resistant plants for use as parents in 2014.
b. 583 DHs of which roughly 291 are expected to be winter types.
c. 559 SSD lines, most of which are expected to be winter types.
d. The DH and SSD selections will be planted at Carrington in the fall of 2013, artificially inoculated in 2014 and selected for FHB resistance. The best lines will be used as parents in the 2015 crossing blocks.

Table 1. Material developed by the project during 2012 and 2013.

Cross number	Pedigree	F_3 rows	DH lines	F_4-derived F_5 SDS lines
11M213	ND2710 (*Fhb1, Fhb2*)/Norstar		149	
11K407	RCATL33 (*Fhb* ex Frontana & Sumai 3)/Jerry		30	
11K431	RCATL33 (*Fhb* ex Frontana & Sumai 3)/Norstar		50	
11M225	RWG10 (*Fhb1*)/Jerry	27	82	132
11M237	RWG28 (*Fhb1*)/Norstar	12	145	74
11M221	CM82036 (*Fhb1*, *Qfhs.ifa-5A*)/Jerry	9	127	172
11M219	5602HR (*Fhb?*)/Peregrine	4		11
11M217	Alsen (*Fhb1*)/Norstar	18		80
11M223	Frontana (*Fhb* type 1/3)/Peregrine	5		36
11M228	RWG21 (5AS, 5AL QTL ex PI277012)/Jerry	5		54
	Total number	**80**	**583**	**559**

During field evaluation, only winter habit plants with a reasonable level of cold tolerance are expected to survive the winter. The relevant DH and SSD populations will have been pre-screened with markers for the presence of *Fhb1* and *Qfhs.ifa-5A* and the resistance confirmed following artificial inoculation. For genes that cannot be detected with markers the diseased phenotypes will be used as basis for selection.

Impact:

a. Bridge genotypes for the transfer of FHB resistance genes from spring wheat have been developed. The agronomically superior lines/plants will be used as cross parents (2014 and 2015) in combination with a cohort of 25-35 (per season) winter-hardy winter wheat parents. The F_1 from each year will subsequently be used extensively in three-way and double crosses in order to widely disperse and establish the resistance genes within the breeding population.
b. The most promising inbred lines will continue to be evaluated for possible commercial use.

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.

None

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.

Poster presentations

(a) Davey Cookman and Francois Marais, 2012. Use of generation acceleration to enhance the transfer of Fusarium head blight resistance into hard red winter wheat. The 22nd International Triticeae Mapping Initiative and 4th National Wheat Genomics Committee Joint Workshop, June 24-29, 2012. Ramada Plaza Suites & Conference Center, Fargo, ND, USA

(b) Francois Marais, David Cookman, Bradley Bisek and Tyler Larson, 2012. Pre-breeding through recurrent mass selection. National Fusarium Head Blight Forum, Dec 4-6, 2012. Wyndham Orlando Resort, Orlando, FL USA.