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

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Fiscal Year:	FY12
USDA-ARS Agreement ID:	59-0206-2-088
USDA-ARS Agreement Title:	Alien Chromosome Engineering and the Deployment of Novel Sources of Resistance to Fusarium Head Blight in Wheat.
FY12 USDA-ARS Award Amount:	$ 29,962[*]

USWBSI Individual Project(s)

USWBSI Research Category[**]	Project Title	ARS Award Amount
HWW-CP	New Sources of Resistance to FHB and DON.	$ 29,962
	Total ARS Award Amount	**$ 29,962**

Principal Investigator Date

[*] Partial funding for this research is under ARS agreement # 59-0206-2-087

[**] 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: *New Sources of Resistance to FHB and DON.*

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

We are working on identifying and transferring new sources of resistance to FHB and DON from the perennial species *Leymus racemosus* and *Elymus tsukushiensis* using chromosome engineering, molecular marker analysis, genomic in situ hybridization analysis, and conventional breeding.

1) We have identified a novel source of FHB resistance, *Fhb3*, derived from *L. racemosus* (T7AL·7Lr#1S), which has been transferred to a Jagger background and was evaluated for FHB resistance and DON accumulation in the greenhouse and field.
2) We have identified a second source of FHB resistance derived from *Leymus tsukushiensis* and have obtained one distal (TWL·WS-1E^{ts}#1S) and one interstitial (TiWL·WS-1E^{ts}#1S-WS) recombinant, which were evaluated for their FHB resistance in the greenhouse and field. We presently are evaluating their DON accumulation.

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):

Accomplishments:

1) Ten lines homozygous for *Fhb3*, present on the wheat–*L. racemosus* Robertsonian translocation chromosome T7AL·7Lr#1S, were evaluated for FHB resistance in a field nursery in Manhattan, KS, by Dr. W.W. Bockus in the 2009–10 growing season. Two lines in the Jagger background, 08-191 and 08-193, flowered about the same time as Jagger and had FHB ratings (% infected spikelets) of 28.7% and 37.2%, respectively, compared to 36.8% for Jagger. DON accumulation of these lines ranged from 7.0 ppm to 13.5 ppm compared to 12.5 ppm for Jagger.
2) We used induced homoeologous recombination to produce two distal (T7AL·7AS-7Lr#1S, rec679 and rec989) and one proximal (T7AL·7Lr#1S-7AS, rec124) recombinants. The FHB ratings for these lines were 27.6% (rec124), 38.1% (rec679), and 48.8% (rec989), with DON accumulations of 10.8 ppm (rec124), 13.8 ppm (rec679), and 14.0 ppm (rec989), indicting that the *Fhb3* gene is located proximally.
3) The Robertsonian translocation present in lines 08-191 and 08-193 as well as the proximal recombinant T7AL·7Lr#1S-7AS (rec124) have been crossed three times with Fuller, and we presently are selecting homozygous RobTs and recombinants in an 88% Fuller background that will be evaluated for their FHB resistance and DON accumulation in greenhouse and field tests.
4) A second source of FHB resistance is derived from *E. tsukushiensis* and was transferred to wheat in the form of a disomic addition (DA1E^{ts}#1), a ditelosomic addition for the short arm (DtA1E^{ts}#1S) and a disomic addition/translocation stock (TWL·1E^{ts}#1S). Greenhouse testing in 2010 revealed that DA1E^{ts}#1 had an FHB rating of 10.0%,

compared to 32.0% for Chinese Spring and 5.3% for Sumai 3. Directed chromosome engineering using molecular marker and genomic in situ hybridization analyses of 488 progenies homozygous for *ph1b* and heterozygous for 1D and TWL·1E^{ts}#1S identified one distal (TWL·WS-1E^{ts}#1S) and one interstitial (TiWL·WS-1E^{ts}#1S-WS) recombinant, and homozygous recombinant stocks were obtained after self pollination. We evaluated the FHB resistance of the *E. tsukushiensis* recombinants in the greenhouse during the 2011–12 growing season after point inoculation of about 40 spikes per entry. Whereas Everest and Karl92 had FHB ratings of 27.7% and 32.7%, respectively, the susceptible check Overly and Chinese Spring had FHB ratings of 54.4% and 35.1%, respectively. The interstitial recombinant TiWL·WS-1E^{ts}#1S-WS had an average FHB rating of 13.5% and the distal recombinant TWL·WS-1E^{ts}#1S had a average rating of 8.8% compared to 12.5% for DA1E^{ts}#1 and 6.2% for TWL·1E^{ts}#1S. Both recombinant chromosomes have been crossed once with Fuller and twice with Everest, and we presently are selecting homozygous recombinants. Cytogenetic analysis revealed that the interstitial recombinant is highly rearranged and of the noncompensating type. We are focusing our efforts on the distal recombinant. During the 2012–13 growing season, we selected FHB-resistant plants with acceptable plant type in Dr. Bockus' scab nursery. The FHB resistance of these plants will be verified in greenhouse and field tests in the next growing season, and these plants also will be evaluated for their DON accumulation.

5) During the 2012–13 growing season, field observations revealed that the germ plasm release KS93WGRC28 with *Pm20* resistance located on the wheat–rye translocation chromosome T6BS·6RL had a high level of type-2 FHB resistance. We will determine the DON accumulation in this line and verify these results in the next growing season.

Impact:

Two novel sources of FHB resistance derived from *L. racemosus* and *E. tsukushiensis* have been identified and transferred to adapted winter wheat backgrounds. Advanced *Fhb3* lines with wheat–*L. racemosus* Robertsonian translocations and recombinants with improved FHB resistance and DON accumulation were developed that can be exploited in wheat improvement.

A second new, and so far unnamed, source of FHB resistance derived from *E. tsukushiensis* has been identified and homozygous distal and interstitial recombinants were obtained and evaluated in greenhouse and field tests for their FHB resistance. This resistance also is being transferred into adapted winter wheat cultivars.

The identification and transfer to wheat of these alien sources of resistance will broaden the genetic base for FHB resistance and DON accumulation.

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.

Bockus WW, Friebe B, and Gill BS. 2010. Reaction of winter wheat accessions containing *Fhb3* and selected cultivars for Fusarium head blight. 2009 Plant Dis Management Rep CCFO12:1-2

Friebe B, Cainong JC, Qi LL, Chen PD, Bockus WW, and Gill BS. 2010. Chromosome engineering and transfer of alien sources for Fusarium head blight resistance in hard red winter wheat. In: Proc 2010 Natl Fusarium Head Blight Forum, 7-9 December 2010, Milwaukee, WI.

Friebe B, Cainong JC, Chen PD, Bockus WW, and Gill BS. 2011. Utilizing alien sources of resistance to Fusarium Head Blight for wheat improvement. In: Proc 2011 Natl Fusarium Head Blight Forum, 4-6 December 2011, St Louis, MO.

Friebe B, Cainong J, Chen PD, Bockus WW, Gill BS. 2012. A novel source of Fusarium head blight resistance derived from *Elymus tsukushiensis*. In: Proc 2012 Natl Fusarium Head Blight Forum, 2-4 December 2012, Orlando, Florida.

Qi LL, Friebe B, Pumphrey MO, Chen Q, Chen PD, and Gill BS. 2008. Shortening of the *Leymus racemosous* segment in the *Fhb3* transfer using *ph1b*-induced homoeologous recombination. In: Proc 2008 Natl Fusarium Head Blight Forum, 2-4 December, 2008, Indianapolis IN, p 194.

Qi LL, Pumphrey MO, Friebe B, Chen PD, and Gill BS. 2008. Molecular cytogenetic characterization of alien introgressions with gene *Fhb3* for resistance to Fusarium head blight disease of wheat. Theor Appl Genet 117:1155-1166.