USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY10 Final Performance Report
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Cover Page

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0790-8-068
USDA-ARS Agreement Title:	Characterization of Resistance to Fusarium Head Blight in Wheat and its Realives.
FY10 USDA-ARS Award Amount:	$ 73,699

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
DUR-CP	Introgression of Fusarium Head Blight Resistance from Hexaploid Wheat to Durum.	$ 38,823
VDHR-SPR	Enhancing Resistance of Spring Wheat to FHB Using Alien Species.	$ 34,876
	Total ARS Award Amount	**$ 73,699**

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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: *Introgression of Fusarium Head Blight Resistance from Hexaploid Wheat to Durum.*

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

An effective FHB resistance source, which is readily usable for variety development, has not been found in durum wheat. We initiated this research project to incorporate FHB resistance from hexaploid bread wheat into tetraploid durum wheat in May 2010. We developed and collected over 10 hexaploid wheat lines (2n=42, genome AABBDD) with different sources of FHB resistance. Some of these hexaploid lines contain alien chromatin. These resistant hexaploid wheat lines were crossed to different durum cultivars/lines, including Alkabo, Grenora, Mountrail, Lebsock, D00095, Divide, Dilse, Plaza, Maier, Monroe, Kyle, Renville, and Munich. Tissue culture was performed to rescue immature hybrid embryos from these wide crosses. One or two backcrosses with respective durum parents have been made to recover durum genetic background and to eliminate D-genome chromosomes. Recently we have obtained about 60 additional hexaploid wheat lines with various levels of FHB resistance derived from wild relatives of wheat. They are being grown in the FHB nursery at Fargo, ND to verify their resistance. Genotyping analyses suggested that over 50% of the lines do not contain the Sumai 3-derived *fhb1* allele. The hexaploid wheat lines with non-*fhb1* resistance will be crossed to durum for FHB introgression.

To date, we have selected about 500 durum segregants with improved FHB resistance from the crosses between the resistant hexaploid wheat lines and durum varieties/lines in the greenhouse. Also, selection for FHB-resistant individuals has been performed with the segregating materials at early generations (F_2, F_3, and BC_1F_2) in the field at Jianyang, China and Fargo, ND. About 200 durum segregants with improved resistance were selected from the FHB nursery at Jianyang, China spring 2011. In addition, we have observed that FHB resistance QTL exhibit less effectiveness of resistance in durum than hexaploid wheat. Previous studies indicated that tetraploid wheat contained the suppressor gene for the expression of FHB resistance QTL. Moreover, preliminary results suggest that D genome of hexaploid wheat might contain the gene with the capacity to enhance the effectiveness of FHB resistance QTL. Preliminary experiments have showed variation in FHB resistance among the disomic durum "Langdon"-D genome substitution lines. Further evaluation of FHB resistance will be performed for the complete set of disomic durum "Langdon"-D genome substitution lines in the greenhouse.

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>

- Made over 100 crosses between different hexaploid resistance sources and durum varieties/lines and ensured the production of the F_1 hybrids by embryo rescue.
- Developed about 500 durum segregants (BC_1F_3, BC_2F_2) with a FHB severity of 15% or less in the greenhouse.
- Genotyped the hexaploid resistance sources and used molecular markers to assist selection of resistant segregants.

Impact:

- Durum germplasm with improved FHB resistance will potentially be developed from the durum segregants with FHB resistance. This will facilitate the development of durum varieties with improved FHB resistance.
- We anticipate that resistant durum germplasm developed in this project would be breeder-friendly for variety development.

Project 2: *Enhancing Resistance of Spring Wheat to FHB Using Alien Species.*

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

Sumai 3 and its derived lines are still the major source of FHB resistance used for the development of common wheat varieties. Recently, more emphasis has been placed on the research of diversifying and enhancing FHB resistance in common wheat. We have been continually identifying, characterizing, and introgressing FHB resistance from relatives of wheat and wheat-alien species derivatives into spring wheat. To date, 25 spring wheat germplasm lines with FHB resistance and various agronomic traits, which have been evaluated at multiple field locations, have been provided to the wheat breeding programs for variety development. Three of the 25 germplasm lines exhibited lower DON accumulation than their resistant wheat parents.

Recently, we have identified and developed additional 60 hexaploid wheat-alien species lines with FHB resistance. More than half of them do not contain the Sumai 3-derived *fhb1* allele. We have been verifying FHB resistance for some of these lines in the FHB nursery at Fargo, ND. Meanwhile, we have been characterizing those non-*fhb1* resistance sources and incorporating novel sources of resistance into adapted spring wheat backgrounds. To date, we have developed over 400 BC_1F_3 and BC_1F_4 individuals/lines with a FHB severity of 10% or less derived from the non-*fhb1* sources in the greenhouse. Advanced lines will be evaluated for FHB resistance and agronomic performance under field conditions. Further chromosome manipulation, if necessary, will be performed to reduce linkage drag associated with alien chromatin.

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:

- Developed 25 spring wheat germplasm lines with FHB resistance. Three of them showed lower DON accumulation than their resistant wheat parents. In addition, most of the germplasm lines exhibited favorable agronomic performance, including yield, test weight, and maturity.

- Identified 60 additional hexaploid wheat-alien species lines with non-*fhb1* resistance to FHB.
- Developed over 400 new introgression individuals/lines with a FHB severity of 10% or less derived from the non-*fhb1* sources in the greenhouse.

Impact:

- Provided wheat breeders elite germplasm for the development of superior wheat varieties with FHB resistance and reduced DON accumulation.
- Germplasm with non-*fhb1* resistance derived from wild relatives of wheat will diversify and enhance FHB resistance of spring wheat.

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.

We have provided the spring wheat germplasm lines with FHB resistance to several wheat breeding programs for use in the development of wheat varieties. Most of them exhibited a FHB severity of 9-15% in the field at Langdon, ND and Jianyang, China. Several of the germplasm lines showed a DON level of 0.38-1.00 ppm.

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.

Cai, X., McArthur, R.I., Zhang, Q., Oliver, R.E., Zhong, S., Chao, S., Hareland, G.A., Berzonsky,W., Mergoum, M., Hanson, B., Dong, Y., and Xu, S.S. 2010. Development of advanced spring wheat lines with FHB resistance through alien introgression [abstract]. In Proc. 2010 National Fusarium Head Blight Forum, Milwaukee, WI, December 7-9, 2010. p. 136.

Xu, S.S., Chu, C., Friesen, T.L., Chao, S., Zhong, S., Halley, S., Cai, X., and Elias, E. 2010. Introgression of two major FHB-resistance QTLs into durum and hard red spring wheat [abstract]. In Proc. 2010 National Fusarium Head Blight Forum, Milwaukee, WI, December 7-9, 2010. p. 172.