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

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0790-7-074
USDA-ARS Agreement Title:	Heterogeneity & Toxigenic Potential of U.S. *Fusarium Graminearum.*
FY10 USDA-ARS Award Amount:	$ 31,220

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
PBG	Traits of Biological Relevance in U.S. Populations of *Fusarium graminearum.*	$ 31,220
	Total ARS Award Amount	**$ 31,220**

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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: *Traits of Biological Relevance in U.S. Populations of Fusarium graminearum.*

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

Our long term objectives are to identify, and differentiate among, genetically coherent populations and species of Fusarium Head Blight (HB) pathogens in small grain cereals producing areas with special focus on the U.S., to elucidate their genetic structure and molecular characteristics, to determine their distribution and prevalence in space and time, to determine their phenotypic characteristics, with special focus on aggressiveness and toxigenic potential, and to determine the impact and interaction of the various populations and species on host genotypes (both, deployed and in development), fungicides and other agricultural practices. Our USWBSI-funded research established that U.S. isolates of *Fusarium graminearum* do not belong simply in a single population as has been previously assumed, but that the pathogen population composition in the U.S. is complex and in flux. In addition to a widespread and predominant U.S. *F. graminearum* population (Midwestern (MW) 15ADON population), we have identified, molecularly and phenotypically characterized, and geographically and temporally mapped *F. graminearum* populations that are genetically distinct from the MW15ADON population. Genetically distinct populations have been previously identified in MN, ND, and more recently in SD [emergent (E) 3ADON and E15ADON populations] and in LA [Southern Louisiana population (mainly NIV type, Gulf Coast population (mainly 3ADON and NIV types)]. A newly detected population with MN being the possible geographic origin, includes isolates that do not produce NIV, DON or their acetylated derivatives. We also detected a *Fusarium asiaticum* population (NIV type) to be present in Louisiana. Isolates can be placed into distinct populations by first using molecular markers to generate isolate-specific genotypes and then by analyzing the genotypic data by a Bayesian model-based clustering method.

We also determined that differences between populations are also present at a phenotypic level, affecting traits that are agriculturally and economically important, including aggressiveness, types of toxins produced and toxigenic potential. The recent identification and emergence of genetically distinct populations raises important questions for FHB management strategies. Greenhouse and field experiments fortunately have not observed host genotype by pathogen strain interaction for FHB.

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 1:</u>
Further analysis of the newly detected Northland population of *F. graminearum* determined that this population until recently existed in the non-agricultural northern areas of MN and just over the past 10 years has moved into agricultural areas. This population is still predominantly found in MN (77%), but has also been detected in commercial fields in ND and SD. Many isolates in this population (ca. 30%) do not produce NIV or DON, while remaining pathogenic. Collaborative efforts with chemists indicate that these isolates produce a novel trichothecen toxin. The structure is currently being determined.

Impact 1:
Our data indicates that the Northland population is becoming more frequent and that it is expanding its geographic range. The new trichothecene toxin this population produces needs to be identified and studied, especially its toxicity for consumer protection.

Accomplishment 2:
A large collection of ca. 1,500 strains has been established from diseased wheat originating from 29 counties in Arkansas provided to us by our collaborator D. Gene Milus, University of Arkansas. This collection has been analyzed using PCR-RFLP markers and was assessed for trichothecene type: 79.6% were of the 15ADON type, 16.6% were 3ADON and 3.8% NIV. Preliminary analysis indicates that 1. The pathogen population consists of a large clonal component, whereby many genotypes are found at various spatial levels (within fields, between fields within a county, between counties). About 30% of isolates within a county have a genotype that is also found in other counties. In Arkansas, a novel population has also been identified, the Arkansas population that is predominantly of a 3ADON trichothecene type. Greenhouse experiments tested 25 Arkansas with a 3ADON type for their aggressiveness and toxigenic potential with PH-1 and three 3ADON isolates from the emergent populations in the Upper Midwest for comparison. While the Arkansas population 3ADON isolates produced DON at lower levels than the three emergent population 3ADON isolates, 713.1ppm DON vs. 873ppm, respectively, they produced on average more than 50% more DON than PH-1, the standard control strain and member of the MW15ADON population that produced 467.5ppm on average.

Impact 2:
Arkansas harbors the most diverse pathogen populations of *F. graminearum* in the U.S. Significantly, AR isolates that belong to the MW15ADON population, are diverse for trichothecene type (NIV, 3ADON and 15ADON). We currently examine the hypothesis that Arkansas may be the center of origin for *F. graminearum sensu stricto*. To understand the diversity found in Arkansas is important as genotypes with different phenotypes may move further north or south, especially if environmental or agronomic conditions change in future.

Accomplishment 2:
Baseline studies have been completed to determine fungicide sensitivity in isolates from different populations for seven fungicides (Topguard, Folicur, Caramba, Proline, Multiva, Prosaro and Tilt). The data still needs to be analyzed.

Impact 3:
Information on whether differences in fungicide sensitivities between isolates or between populations exist is pertinent for agronomists and farmers alike.

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.

Peer-reviewed

Sarver, A. J., Ward, T. J., Gale, L. R., Broz, K., Kistler, H. C., Aoki, T., Nicholson, P., Carter, J., and O'Donnell, K. 201x. Novel Fusarium head blight pathogens from Nepal and Louisiana revealed by multilocus genealogical concordance. Fungal Genetics & Biology. Submitted.

Gale, L. R., Harrison, S. A., Ward, T. J., O'Donnell, K., Milus, E. A., Gale, S. W., and Kistler, H. C. 2011. Nivalenol-producing *Fusarium graminearum* and *F. asiaticum* are prevalent on wheat in Southern Louisiana. *Phytopathology* 101:124-134.

Horevaj, P., Gale, L. R., and Milus, E. A. 2011. Resistance in winter wheat lines to initial infection and spread within spikes by deoxynvalenol and nivalenol chemotypes of *Fusarium graminearum*. *Plant Disease*: 95:31-37.

Presentations/ Research Abstracts

2011. Co-Author with various collaborators. "Systematics, phylogeny and trichothecene mycotoxin potential of Fusarium head blight cereal pathogens". IUMS 2011, Sapporo, Japan.

2010. "*Fusarium graminearum* in the U.S.: heterogeneous and in flux". State University of Maringá, Dept. of Agronomy, Maringá, Brazil.

2010. "*Fusarium graminearum* in the U.S.: heterogeneous and in flux". VI Brazilian Mycological Congress, Brasilia, Brazil.

2010. "A subset of the newly discovered Northland population of *Fusarium graminearum* from the U.S. does not produce the B-type trichothecenes DON, 15ADON, 3ADON or NIV". Page 48 in: *2010 National Fusarium Head Blight Forum Proceedings*.

2010. Co-Author with various collaborators. "Preinoculation of wheat heads with a nontoxigenic *Fusarium* isolate inhibits deoxynivalenol production by a toxigenic pathogen". Page 57 in: *2010 National Fusarium Head Blight Forum Proceedings*.