USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY07 Final Performance Report (approx. May 07 – April 08)
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Cover Page

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USDA-ARS Agreement ID:	59-0790-7-074
USDA-ARS Agreement Title:	Heterogeneity & Toxigenic Potential of U.S. *Fusarium graminearum*.
FY07 ARS Award Amount:	$ 36,219

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
PGG	Heterogeneity and Toxigenic Potential of U.S. *Fusarium* graminearum Population.	$36,219
	Total Award Amount	**$ 36,219**

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Principal Investigator Date

* CBCC – Chemical, Biological & Cultural Control
EEDF – Etiology, Epidemiology & Disease Forecasting
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GET – Genetic Engineering & Transformation
HGR – Host Genetics Resources
HGG – Host Genetics & Genomics
IIR – Integrated/Interdisciplinary Research
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Heterogeneity and Toxigenic Potential of U.S. Fusarium graminearum Population.*

1. What major problem or issue is being resolved and how are you resolving it?
Our long term objectives are to accurately determine the composition of genetically coherent populations of Fusarium Head Blight (FHB) pathogens in economically important wheat producing areas of the world with special focus on the U.S., to determine their genetic structure, to evaluate their potential to change in composition and genetic structure and to determine the effect of such change on deployed host genotypes and/or other agricultural practices. Our USWBSI-funded research established that U.S. isolates of *Fusarium graminearum*, the main causal agent of FHB in small grains, do not belong simply in a single, homogeneous and inter-breeding population as has been previously assumed, but that the pathogen population composition in the U.S. is both complex and in flux. In addition to the widespread *F. graminearum* population (Midwestern 15ADON population) we have identified, molecularly and phenotypically characterized, and geographically and temporally mapped *F. graminearum* populations that are genetically distinct from the MW 15ADON population. Genetically distinct populations have been identified in the Upper Midwestern U.S. (MN, ND, and more recently in SD) and in Louisiana. We also learned that differences between populations are not only present at a molecular level, but also at a phenotypic level, affecting traits that are agriculturally and economically important. Briefly, representatives of emerging populations of *F. graminearum* that have been identified in the Upper Midwestern U.S. have a higher toxigenic potential than the MW 15ADON population as they produce substantially more deoxynivalenol (DON) on wheat in greenhouse experiments than members of the MW15ADON population. Members of *F. graminearum* populations in Louisiana were found to be predominantly nivalenol producers. Nivalenol is believed to be several times more toxic than DON. Prior to our efforts, it was assumed that nivalenol producers of *F. graminearum* in the U.S. are rare or non-existent.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):
Accomplishment #1: We demonstrated that the emergent populations of *F. graminearum* that have a higher toxigenic potential than the common MW15DON population and that were first identified from samples in ND and MN, are moving further south. Population genetic analysis of 1,132 isolates from a 2006 collection found members of the emergent populations in areas were these populations were previously rare or absent.
Impact: For the first time, isolates of *F. graminearum* with a 3ADON trichothecene type were identified in South Dakota. The isolates belong to the highly toxigenic Upper Midwestern (UMW) 3ADON population and were detected in 4 out of 10 counties sampled in South Dakota. Accurate knowledge of the population composition of *F. graminearum* is important for breeders, field pathologists and farmers alike as pathogen variability may affect the reaction of host genotypes that are either deployed or in development and/or the efficacy of other agricultural practices (e.g. chemical control by fungicides).
As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?: An update on the population composition of *F. graminearum* that is both complex and in flux in sampled regions of North Dakota, South Dakota and Minnesota. Evidence that highly toxigenic emergent populations are moving further south.
Accomplishment #2: Previously, we demonstrated that *F. graminearum* isolates from Louisiana are predominantly nivalenol producers. As most isolates from initial collections were sampled

from nurseries, it was not clear whether commercial fields would harbor nivalenol producers as well. We found that isolates of *F. graminearum* from commercial fields in Louisiana are also predominantly (~80%) nivalenol producers. Nivalenol producers of *F. graminearum* were also identified from Arkansas, though examined isolates were from older collections (early 1990s). Development of PCR-RFLP markers and subsequent population genetic analyses further indicated that isolates from Louisiana largely belong to one of three genetically distinct populations. In contrast, the majority of *F. graminearum* isolates from Arkansas could not be grouped into specific populations. This was taken as an indication that Arkansas may constitute a hybrid zone between the Midwestern and southern populations of *F. graminearum*.

Impact: For the first time, significant numbers of *F. graminearum* isolates from commercial fields in Louisiana were examined for their trichothecene type. As previous work predominantly had examined isolates from nurseries, we established a more complete picture of population composition in Louisiana. Some of our characterized isolates were given to collaborator Dr. Gene Milus for further use in greenhouse experiments.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?: Information that nivalenol producers of *F. graminearum* are omnipresent in Southern Louisiana and that nivalenol producers also occur in Arkansas.

Accomplishment #3: We determined in greenhouse experiments that members of the emergent populations have a higher toxigenic potential on popular spring wheat cultivars. For example, members of UMW 3ADON population produced on average 87% (range 40%-128%) more DON on tested cultivars (Alsen, Knudson, Briggs, Oklee, Granite, Freyr) than members of the MW 15ADON population.

Impact: For the first time it was established that the increased toxigenic potential of the emergent populations is also observed for commercially important cultivars.

As a result of that accomplishment, what does your particular clientele, the scientific community, and agriculture as a whole have now that they didn't have before?: A working hypothesis that recent changes in population composition in the Upper Midwest may have resulted to an increase of DON levels in small grains even though the level of disease may not have increased.

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 publications:

Suga, H., Karugia, G. W., Ward, T., **Gale, L. R.**, Tomimura, K., Nakajima, T., Miyasaka, A., Koizumi, S., Kageyama, ' K., and Hyakumachi, M. (2008). Molecular characterization of the *Fusarium graminearum* species complex in Japan. *Phytopathology* 98:159-166.

Gale, L. R., Ward,T. J., Balmas,V., and Kistler, H. C. (2007). Population subdivision of *Fusarium graminearum sensu stricto* in the Upper Midwestern United States. *Phytopathology* 97: 1434-1439.

Starkey, D. E., Ward, T. J., Aoki, T., **Gale, L. R.**, Kistler, H. C., Geiser, D. M., Suga, H., Toth, B., Varga, J. and O'Donnell, K. (2007). Global molecular surveillance reveals novel Fusarium head blight species and trichothecene toxin diversity. *Fungal Genetics and Biology* 44:1191-2004.

Presentations:

Phenotypic and Molecular Diversity of *Fusarium graminearum sensu stricto* from the U.S. National Fusarium Head Blight Forum, Kansas City, MO, 2007.

Non-peer reviewed articles:

Gale, L. R., and Kistler, H. C. (2007). Phenotypic and molecular diversity of *Fusarium graminearum sensu stricto* from the U.S. Page 27 in 2006 National Fusarium Head Blight Forum Proceedings.

Gale, L. R., Harrison, S. A., Milus, E. A., Ochocki, J. E., O'Donnell, K. O., Ward, T. J., and Kistler, H. C. (2007). Diversity in *Fusarium graminearum sensu stricto* from the U.S.: an update. Page 26 in 2006 National Fusarium Head Blight Forum Proceedings.