USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY05 Final Performance Report (approx. May 05 – April 06)
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Cover Page

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Fiscal Year:	**2005**
FY05 ARS Agreement ID:	**NA**
Agreement Title:	**Global Surveillance of FHB Species, Mycotoxin and Population Diversity.**
FY05 ARS Award Amount:	**$ 55,000**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
EDM	Global Surveillance of FHB Species, Mycotoxin and Population Diversity.	$ 55,000
	Total Award Amount	**$ 55,000**

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Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

Project 1: *Global Surveillance of FHB Species, Mycotoxin and Population Diversity.*

1. What major problem or issue is being resolved and how are you resolving it?

Our long-term molecular surveillance of *Fusarium* head blight (FHB) has shown that only a small fraction of the FHB pathogen and trichothecene toxin chemotype diversity is currently represented within North America. Detailed knowledge of FHB pathogen diversity in North America and worldwide at the species, chemotype, and population genetic level is critical to understanding what FHB pathogens/trichothecene toxin chemotypes are responsible for this disease here and abroad. The improved understanding of the ecology, epidemiology, and population dynamics of FHB pathogens provided by our USWBSI-funded studies is critical to disease control and surveillance, the formulation of informed regulatory policy, and the development of cereal cultivars with broad-based resistance to trichothecene-producing fusaria. Our molecular surveillance program, based on multi-locus DNA sequence-based molecular phylogenetics and a novel Luminex microsphere array, has provided the most detailed information to date on what FHB pathogens and toxin chemotypes are currently represented within North America and how they compare to FHB globally. Our research directly addresses the goals of PGG (research priority: Characterize FHB pathogen diversity, phylogenetics, or taxonomy) by providing greater understanding of pathogen diversity and taxonomy which may inform grain crop breeding strategies and phytosanitary issues; and by providing an increased understanding of pathogen biology, this research will benefit other USWBSI program areas which could lead to the identification of novel control strategies.

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:

The overall goal of our research was to understand *Fusarium* head blight (FHB) pathogen diversity in North America at the species and toxin chemotype level. Molecular surveillance conducted as part this USWBSI-funded project identified an East-West chemotype cline in Canada and evidence that *F. graminearum* isolates that produce 3-acetyldeoxynivalenol as the primary acetylated derivative of deoxynivalenol (3ADON chemotype) may be displacing those that produce primarily 15-acetyldeoxynivalenol and deoxynivalenol (15ADON chemotype). In addition, through collaborations with H. C. Kistler and L. R. Gale (Cereal Disease Laboratory), we have identified for the first time the presence of *F. asiaticum* and nivalenol-producing (NIV chemotype) *F. graminearum* in the Southern U.S. In addition to their importance to plant pathology, disease control efforts and plant breeding programs, these findings have significant implications for animal health and food safety as the 3ADON and NIV chemotypes appear to have greater vertebrate toxicity than the 15ADON chemotypes that have been predominant in North America. We have also identified a novel species (*F. gerlachii*) from the Northern Plains, and a divergent group of *F. graminearum* from the Gulf Coast. The recent discovery of this unprecedented variation and the geographical partitioning evidenced in our preliminary analyses suggests that FHB pathogen variation in the U.S. may have increased recently due to introductions of foreign pathogens or novel chemotypes. Our active molecular surveillance program on FHB has provided a

baseline so that changes in pathogen and toxin chemotype diversity can be monitored over time. Moreover, the dramatic increase in 3ADON producing FHB pathogens, which appears to be over twice as toxic as the resident 15ADON population within North America, provides critical information necessary to develop informed crop breeding strategies and formulate phytosanitary issues. Lastly, providing an increased understanding of pathogen biology represents a critical first step towards identifying novel control strategies.

Impact:

Our studies are have facilitated a greater understanding of the ecology, epidemiology and population dynamics of the FHB pathogens by demonstrating for the first time that: 1) the primary etiological agent of FHB, *Fusarium graminearum*, actually comprises 11 phylogenetically distinct species; 2) over half of these species are segregating for trichothecene toxin chemotype; 3) several putatively foreign FHB pathogens appear to have been introduced into the U.S. recently, and 4) a foreign and more toxigenic 3ADON population of *F. graminearum* appears to be displacing the resident 15ADON population of *F. graminearum* in North America. These findings provide plant disease specialists, quarantine officials and plant breeders with the most detailed information to date on the great genetic diversity and toxin potential of the FHB pathogens.

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?:

Our studies have provided plant breeders, plant disease specialists, plant quarantine and regulatory officials with the most detailed understanding of FHB pathogen and toxin chemotype diversity within North America and worldwide to date. Most importantly, our research has shown that major changes are taking place in FHB pathogen and toxin chemotype diversity within North America. The recent discovery of this unprecedented variation and the geographical partitioning evidenced in our preliminary analyses suggests that FHB pathogen variation in North America may have increased recently due to introductions of foreign pathogens or novel chemotypes. Lastly, the dramatic increase in the more toxigenic 3ADON FHB population within North America should alert the scientific community that this foreign pathogen could have major deleterious effects on U.S. wheat production and the export trade in the not too distant future.

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.

Clear, R. M., Patrick, S. K., Gaba, D., Roscoe, M., Turkington, T. K., Demeke, T., Pouleur, S., Couture, L., Ward, T. J. and O'Donnell, K. 2006. Trichothecene and zearalenone production in culture by isolates of *Fusarium pseudograminearum* from Western Canada. Can. J. Plant Pathol. 28:131-136.

Gale, L. R., Bryant, J. D., Calvo, S., Giese, H., Katan, T., O'Donnell, K., Suga, H., Taga, M., Usgaard, T. R., Ward, T. J. and Kistler, H. C. 2005. Chromosome complement of the fungal plant pathogen *Fusarium graminearum* based on genetic and physical mapping and cytological observations. Genetics 171:1-17.

Hill, N. S., Schwarz, P., Dahleen, L. S., Neate, S., Horsley, R., Glenn, A. E. and O'Donnell, K. ELISA analysis for *Fusarium* in barley: Development of methodology and field assessment. Crop Science (in press).

Rep, M., Duyvesteijn, R. G. E., Gale, L., Usgaard, T., Cornelissen, B. J. C., Ma, L.-J. and Ward, T. J. 2006. The presence of GC-AG introns in *N. crassa* and other euascomycetes determined from analysis of complete genomes: implications for automated gene prediction. Genomics 87: 338-347.

Rooney, A. P. and Ward, T. J. 2005. Evolution of a large ribosomal RNA multigene family in filamentous fungi: Birth-and-death of a concerted evolution paradigm. Proc. Natl. Acad. Sci. USA 102:5084-5089.

O'Donnell, K. 2005. The Importance of species biology in a genomics era: Examples from *Fusarium.* 23rd Fungal Genetics Conference. March 2005.

O'Donnell, K. 2005. Discordant Evolution of *Fusarium* head blight species and their toxins: Evidence from multigene genealogies. Connecticut Agricultural Experiment Station. Seminar April 2006.

O'Donnell, K. 2006. Evolution of *Fusarium* head blight pathogens and their toxins. University of California-Davis. Department of Plant Pathology, Seminar March 2006.

Ward, T. J. 2005. A Trichothecene Chemotype Cline in Canada and the Changing Nature of FHB in North America. 4th Canadian Workshop on Fusarium Head Blight, Ottawa, Canada, November, 2005.

Ward, T. J. 2005. Evolution and functional significance of trichothecene mycotoxin diversity in plant-pathogenic *Fusarium*. 105th General Meeting of the American Society for Microbiology, Atlanta, Georgia, June, 2005.

Ward, T. J. 2005. A multilocus genotyping assay for identification of *Fusarium* head blight species and trichothecene toxin chemotypes. National Fusarium Head Blight (NFHB) Forum, Milwaukee, WI, December, 2005

Ward, T. J. 2005. FHB species and trichothecene toxin diversity in North America. National Fusarium Head Blight (NFHB) Forum, Milwaukee, WI, December, 2005.

Ward, T. J. 2006. Evolution and biogeography of trichothecene mycotoxin diversity in *Fusarium* head blight pathogens: adaptation via gene loss. Genetics Area Program Seminar Series, University of Missouri, Columbia, Feb. 2006.

"Fighting Fusarium Head Blight". Milling Journal, Fourth Quarter, 2005.

"DNA Test Developed to Study, Combat *Fusarium* Head Blight in Wheat". Agricultural Research. May, 2005.