USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY06 Final Performance Report (approx. May 06 – April 07)
July 16, 2007

Cover Page

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Fiscal Year:	2006
USDA-ARS Agreement ID:	59-0790-3-081
USDA-ARS Agreement Title:	Genetic Mechanisms to Control Head Scab.
FY06 ARS Award Amount:	$ 23,497

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Award Amount
PGG	Role of Dioxygenases in Fusarium graminearum Sporulation and Toxic Production.	$ 23,497
	Total Award Amount	**$ 23,497**

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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
PGG – Pathogen Genetics & Genomics
VDUN – Variety Development & Uniform Nurseries

Project 1: *Role of Dioxygenases in Fusarium graminearum Sporulation and Toxic Production.*

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

One of the most severe mycotoxin problems in the U.S. is trichothecene contamination of small grains by *Gibberella zeae* (anamorph *Fusarium graminearum*) in a disease called scab or Fusarium head blight (FHB). Our lab is attempting to find genes and gene products important in either *Gibberella zeae* sporulation or toxin production. Such genes and gene products would provide needed knowledge of virulence factors in the fungus and possibly provide insight into control strategies.

In this project, we proposed to disrupt four *F. graminearum* genes (*ppo1, ppo2, ppo3* and *lox*) involved in oxylipin production. Oxylipins, oxygenated fatty acids produced by oxygenases (both dioxygenases and lipoxygenases), are conserved ligands proposed to regulate sporulation and secondary metabolism (e.g. mycotoxins) in all filamentous fungi. Evidence to support this comes from studies in *F. sporotrichioides* and *Aspergillus* spp. where disruption of oxygenases (*ppo* and *lox* genes) producing oxylipins yields mutants with altered sporulation abilities, decrease in mycotoxin production and pathogenicity. As plant hosts produce similar oxylipins, we propose that both fungal and plant oxylipins are involved in fungal/seed Cross Kingdom communication. This latter hypothesis was recently supported by a manuscript from the Kolomiets lab where disruption of a maize lipoxygenase (*lox)* resulted in decreased ability of *F. verticilliodes* to colonize the seed and produce fumonisin.

Gao X, Shim WB, Göbel C, Kunze S, Feussner I, Meeley R, Balint-Kurti P, Kolomiets M. 2007. Disruption of a maize 9-lipoxygenase results in increased resistance to fungal pathogens and reduced levels of contamination with the mycotoxin fumonisin. Molecular Plant Microbe Interactions (in press).

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: We found out that Drs. Willi Shaefer and Ivo Fuessner (Germany) had already started to disrupt all of the *ppo* genes in *F. graminearum* so there was no need for us to repeat the work. We take their work as a form of flattery as they based it on our previous *Aspergillus* findings. Instead, we agreed to collaborate on this topic. Considering that the *ppo* genes were taken care of, we focused on disrupting the *F. graminearum lox* gene. We have succeeded in doing so. In collaboration with Dr. Robert Butchko (USDA, Peoria), we have created *lox* disruption strains and have complemented these strains. The mutants did not show any difference in pathogenicity or trichothecene formation or spore production. We are currently examining them for pathogenicity on Arabidopsis and wheat. We will collaborate with German labs to make *lox/ppo* double, triple and quadruple mutants to assess the role of these oxygenases on sporulation, toxin formation and pathogenicity.

Impact: This is the first identification of *F. graminearum* oxygenases, a topic that has become of interest in international laboratories. While it is yet too early to assess the role of all four

genes on sporulation, toxin formation and pathogenicity, we expect there to be a significant role of these genes and their oxylipins on fungal development. The participation of other labs has brought additional funding into the study of oxylipins and their role in *F. graminearum* biology as a disease agent.

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 important contribution of this work is a vision of the importance of cross kingdom signaling between fungi and their host plants. Interest in this work has led to collaborations with the German group and Dr. Kolomiets (Texas A&M University) specifically on oxylipin signaling of *Fusarium* spp. Gene sequences and *F. graminearum lox* mutants are now available to the public.

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.

Tsitsigiannis D I, Keller NP (2007) Oxylipins as developmental and host-fungal communication signals. Trends in Microbiology Mar;15(3):109-18.

Brodhagen M, Keller NP (2006) Signaling pathways connecting mycotoxin production and sporulation. Molecular Plant Pathology 7:285-301.

McDonald T, Devi T, Shimizu K, Sim S-C, Keller NP (2004) Signaling events connecting mycotoxin biosynthesis and sporulation in *Aspergillus* and *Fusarium spp.* In New Horizon of Mycotoxicology for Assuring Food Safety, Proceedings of the International Symposium of Mycotoxicology (Editor: Takumi Yoshizawa) pp 139-147.