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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Fiscal Year:	2007
USDA-ARS Agreement ID:	59-0790-6-068
USDA-ARS Agreement Title:	Starch Degradation by Gibberella zeae and its Role in Fueling Development.
FY07 ARS Award Amount:	$ 59,424

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
HGG	Understanding Vascular Gels as a Resistance Response.	$15,522
PGG	Survival of Fusarium graminearum in Crop Debris and the Role of Protective Antimicrobials.	$ 43,902
	Total Award Amount	**$ 59,424**

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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: *Understanding Vascular Gels as a Resistance Response.*

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

Resources for scab resistance are quite limited. We observed that about one third of the Norm plants we inoculated in the greenhouse had limited spread (Type 2 resistance) due to the presence of pectic gels in the xylem. We performed a progeny test on those plants that showed the resistance. The same percentage of progeny had the reaction as in the parental line. This shows that the reaction is a consistent trait within the population, suggesting this is not due to heterozygosity in the parent line for this trait. The reaction is likely to be an induced response, perhaps the frequency is due to the rapidity of the response in some individuals. We are now working with Janet Lewis, testing this response in other varieties. We see it in resistant varieties in a higher frequency. It is important to note that this response does not kill the upper half of the wheat head. It appears to act just on the floret which is infected.

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 have shown that the pectic gels formed consistently in the progeny of Norm, indicating this form of resistance may be uniformly expressed in Norm.

Impact: Types of resistance to scab are limited in wheat. If this resistance mechanism can be bred into lines, and enhanced, it may be very effective in limiting disease spread.

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?:
We have identified a novel resistance mechanism that may be useful for breeding into lines of wheat.

Project 2: *Survival of Fusarium graminearum in Crop Debris and the Role of Protective Antimicrobials.*

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

We have been investigating the formation of inoculum that arises out of the crop debris. We investigated the role of relative humidity in the formation of perithecia on crop debris (we used colonized stems that had been inoculated at the wheat head). We show that exposure to less that 70% humidity for 5 days in stems harvested at grain maturity minimized mycelium growth and maximized perithecium production when humidity subsequently rose to above 70%. On the other hand, exposure to 100% humidity with no exposure to lower humidity resulted in massive mycelial growth and perithecium production. The data suggest that when optimal conditions for harvest (low humidity) are present during grain harvesting, that the mycelia in the wheat tissue is also primed for directing all of its resources into perithecia (inoculum) production. When high humidity is present, some of these resources will be spent on mycelium production. We are currently testing whether high humidity at harvest results in reduced inoculum the following growing season. We have investigated the physiology of these processes using Affymetrix expression arrays. We have identified a gene we believe may regulate the mycelium/no mycelium switch. We are pursuing the analysis of this gene.

We investigated whether polyketides produced by *F. graminearum* are important for protecting the debris from invasion from other pathogens. We examined a set of mutants for each of the 15 polyketide synthase genes. We found some small effects of protection for 3 of the 15 polyketides. However, there was a much larger effect on the ability of these mutants to colonize the stems. Previous work showed that several PKS genes were expressed during stem colonization. The mutants of 2 of these no longer colonize stems, although they cause head blight disease.

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 have determined that relative humidity during harvest is likely to have a strong impact on ascospore production for the following year.
We have also determined that secondary metabolites other than DON may affect the ability of the fungus to colonize wheat stems, resulting in inoculum the following year.

Impact: The data on conditions for perithecium production vs. relative humidity at harvest is aimed at developing a component of forecasting systems which would take into consideration the amount of inoculum likely to be present.

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?:
We have identified conditions which may greatly affect inoculum development in the fungus in the following season. In addition, if shown to hold in the field, a link between harvest conditions and inoculum development the following year would be readily incorporated into a forecasting system.

Identification of a gene which regulates the switch between mycelia vs. perithecium production could be a target for genetically engineered resistance. Similarly, a gene which is important to colonization of stem tissue would also provide a target for reduction of inoculum production.

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.

Presentations (from 2007-present)

Understanding the impact of amylase production on the life cycle of *Fusarium graminearum.* American Oil and Analytic Chemists International. Meeting Bozeman, MT, June 2008.

Form and function in sexual development of *Fusarium graminearum.* Program for the Biology of Filamentous Fungi. 17th annual symposium. Texas A and M, April 2008.

Spore cannons and chemical warfare: The life cycle of a wheat pathogen. Presented to the Horticulture/ Crop and Soil Sciences joint departmental seminar series MSU. February 2008.

Spore cannons and chemical warfare: The life cycle of *Fusarium graminearum* on wheat. Presented to the Department of Plant Biology at MSU. January 2008.

Life cycle and survival of *Fusarium graminearum*- a revision. Presented to the Fusarium Head Blight Forum. Kansas City, Mo. December 2007.

Integration of polyketides into the life cycle of *Fusarium graminearum*. 40th Annual Meeting of the Society for Invertebrate Pathology, August, Quebec City, Quebec 2007.

Identification of genes involved in sexual development in *Gibberella zeae* by expression analysis. Mycological Society of America Meeting, Baton Rouge, LA. Invited talk 2007.

Weaving a life story: Studies on the disease cycle of *Fusarium graminearum* on wheat. Robert Gilmer Memorial Seminar. Plant Pathology Department, Cornell University 2007.

Perithecium development and ascus function in *Gibberella zeae*. Invited talk. Fungal Genetics Conference, Asilomar, CA 2007.

Related presentation:

Spore cannons: Elucidating the function of asci. Gordon Conference on Cellular and Molecular Mycology. Plymouth New Hampshire, July 2008.

Related papers (from 2007 to present) all of these papers were generated from preliminary studies that were funded by USWBSI that were used to obtain subsequent federal funding from other programs:

Hallen, H., and F. Trail. 2008. The L-type calcium ion channel, Cch1, affects ascospore discharge and mycelial growth in the filamentous fungus *Gibberella zeae* (anamorph *Fusarium graminearum*). Eukaryotic Cell. 7:415-424.

C Cuomo, U Güldener, JR Xu, F Trail, BG Turgeon, A Di Pietro, JD Walton, L-J Ma, S Baker, M Rep, G Adam, J Antoniw, T Baldwin, S Calvo, Y-L Chang, D DeCaprio, LR. Gale, S Gnerre, RS Goswami, K Hammond-Kosack, LJ Harris, K Hilburn, JC Kennell, S Kroken, JK Magnuson, G Mannhaupt, E Mauceli, H-W Mewes, R Mitterbauer, G Muehlbauer, M Münsterkötter, D Nelson, K O'Donnell, T Ouellet, W Qi, H Quesneville, MI Roncero, K-Y Seong, IV Tetko, M Urban, C Waalwijk, TJ Ward, J Yao, BW Birren, HC Kistler. 2007. The *Fusarium graminearum* genome reveals a link between localized polymorphism and pathogen specialization. Science 317: 1400-1402.

Hallen, H., Huebner, M., Shiu, S.-H., Guldener, U., and F. Trail. 2007. Gene expression shifts during perithecium development in *Gibberella zeae* (anamorph *Fusarium graminearum*), with particular emphasis on ion transport proteins. Fungal Genetics and Biology 44: 1146-1156.

Trail, F. 2007. Fungal cannons: Explosive spore discharge in the Ascomycota. FEMS Microbiology Letters 276:12-18.