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

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Fiscal Year:	FY10
USDA-ARS Agreement ID:	59-0790-6-068
USDA-ARS Agreement Title:	Starch Degradation by *Gibberella zeae* and Its Role in Fueling Development.
FY10 USDA-ARS Award Amount:	$ 74,215

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
PBG	Use of Airulent Strains for Protection against Head Scab and for Increased Yield.	$ 37,073
BAR-CP	Understanding Colonization Leading to DON Accumulation in Barley.	$ 37,142
	Total ARS Award Amount	**$ 74,215**

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: *Use of Airulent Strains for Protection against Head Scab and for Increased Yield.*

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

We are exploring ways to reduce toxin levels and reduce the presence of Fusarium in kernels.
Use of 3 genetically engineered F. graminearum strains and 2 collected natural endophytes (from grasses) tested on 3 cultivars of Spring wheat (2 susceptible, 1 resistant (Alsen)) showed that there are different interactions between cultivars and specific strains. Interestingly, strains survived and colonized best in the resistant line. A lot of recent work on natural endophytes indicates they are important in protection of native plants from disease and environmental stress and that they are the rule, rather than the exception in ecosystems. In this light, it is interesting that the resistant line is most tolerant of the presence of an endophyte. Perhaps part of the resistance mechanism is the ability to sustain protective endophytes.

This year we also completed a study of DON accumulation and DON gene expression in Alsen vs. a susceptible cultivar that we initiated in the previous funding cycle. Our data showed expression of Tri5 in hyphae occurred over a much longer period of time than previously documented. This suggests the ability of the fungus to rapidly resume toxin biosynthesis in dried infected grain, or grain infected late, and is a possible mechanism for high DON levels in asymptomatic grain. In addition, we found some indication that Alsen may have the ability to cure grain infection early in development. See recent manuscript by Hallen et al., 2011.

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):

Accomplishment:
Our work has enhanced our understanding of the infection and the resistant response of cultivar Alsen. Alsen can maintain endophytic relationships better than 2 susceptible cultivars. In addition, Alsen has some unique properties for purging hyphae as the grain matures.

Impact: Alsen maintains endophytes more readily than 2 susceptible cultivars. This will be a strength for developing durable resistance incorporating a number of mechanisms/approaches. We conclude that a lot more work will be needed to fully develop the endophytes angle for scab control. We recommend that this would be better accomplished by waiting for further development in other systems. However, in the future, this looks like it might be one part of a multi-facted disease protection program.

We are investigating further the elimination of hyphae from Alsen as a resistance response. Such a mechanism would help to reduce DON accumulation during later stages of grain development and during storage.

3. Project 2: *Understanding Colonization Leading to DON Accumulation in Barley.*

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

We are examining the colonization and DON accumulation in heads of barley using susceptible and resistant (Quest) cultivars. Although some work has been done in this area, many questions still remain as to how F. graminearum gets into developing grain and when and where DON biosynthesis occurs. Most of our work this year has focused on the infection process. We are just beginning to work on following DON biosynthesis.

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):

Accomplishment: We have documented a new infection route for F. graminearum into barley. We have found that germination hyphae from conidia differentiate and then penetrate between trichomes and the adjacent epidermal cell. These trichomes are located along the vascular bundles of the palea. This infection route leads right to the vascular bundles, which can advance rapid spread of the hyphae into the grain (Figure 1).

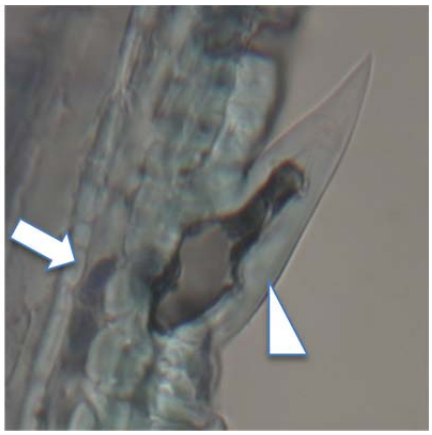

Figure 1. Colonization of a trichome (arrowhead) by *F. graminearum* and subsequent penetration of the vascular tissue (arrow). Hyphae stained with chorazol black.

Impact: This information identifies a clear penetration route of *F. graminearum* into barley. It also identifies specific cell types and locations which are targets for genetic engineering for disease resistance.

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.

Recent Related articles:

Hallen-Adams, H.E., Wenner, N., Kuldau, G.A., and F. Trail. 2011. Deoxynivalenol biosynthesis-related gene expression during wheat kernel colonization by *Fusarium graminearum.* Phytopathology, *In Press.* COVER

Hallen-Adams, H.E., Cavinder, B.L. and Trail, F. *Fusarium graminearum* from expression analysis to functional assays. *In:* Fungal Genomics: Methods and Protocols. J.-R. Xu and B.H. Bluhm, eds. Methods in Microbiology Vol. 722. 2011. Humana Press, pp79-1022.

Cavinder, B., Hamam, A., Lew, R.R. and F. Trail. 2011. Mid1, a mechanosensitive calcium ion channel, affects growth, development, and ascospore discharge in the filamentous fungus *Gibberella zeae*. Eukaryotic Cell 10: 832-841. COVER.

Min, K., Lee, J., Kim, J.-C., Kim, S. G., Kim, Y. H., Vogel, S., Trail*, F., Lee*, Y.-W. 2010. A novel gene, ROA, is required for proper morphogenesis and discharge of ascospores in *Gibberella zeae.* Eukaryotic Cell, 9:1495-1503.

Baldwin, T., I. Gaffoor, J. Antoniw, C. Andries, J. Guenther, M. Urban, K. Hammond-Kosack, F. Trail. 2010. A partial chromosomal deletion caused by random plasmid integration resulted in a reduced virulence phenotype in *Fusarium graminearum.* Molecular Plant-Microbe Interactions, 23:1083-1096. COVER.

Recent Presentations:

Hallen-Adams, H., Trail., F. 2010. DON biosynthesis in wheat by *Fusarium graminearum.* Poster presented at the Fusarium Forum. Dec 6 Milwaukee, WI.

Cavinder, B., Hallen-Adams, H., Trail., F. 2010. Calcium signaling in ascospore discharge. Gordon Research Conference on Cellular and Molecular Mycology. New Hampshire, June.

Hallen-Adams, H., Guenther, J., Trail, F. The role of lipids in successful overwintering and subsequent perithecium production by *Fusarium graminearum.* Mycological Society Meeting, Lexington, KY. July 2010.