USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY11 Final Performance Report
July 13, 2012

Cover Page

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Fiscal Year:	FY11
USDA-ARS Agreement ID:	NA
USDA-ARS Agreement Title:	Functional Dissection of FHB Resistance in Wheat and Barley.
FY11 USDA-ARS Award Amount:	$ 57,000

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	High Efficiency Method for Generating FHB-Resistant Barley: Removing Bottlenecks in the Pipeline for Deploying FHB Resistance Genes.	$ 10,000
GDER	Investigating the Role of PAMP-Triggered Immunity in FHB Resistance.	$ 47,000
	Total ARS Award Amount	**$ 57,000**

Steven R Scofield

July 12, 2012

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: *High Efficiency Method for Generating FHB-Resistant Barley: Removing Bottlenecks in the Pipeline for Deploying FHB Resistance Genes.*

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

This multi-investigator project is designed to accomplish two objectives:

1. To develop improved methods to generate transgenic barley cultivars.

2. Using these improved methods, to introduce transgene constructs that are effective for improving barley's resistance to Fusarium head blight (FHB).

My laboratories work in this project is focused on identifying effective transgene constructs for improving FHB resistance and then transferring these to the laboratory performing the barley transformation research.

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 identified four cereal genes that have a strong prospect for improving FHB resistance. Our work has shown that their expression makes significant contributions to FHB resistance. We have assembled DNA constructs that will express these genes at elevated levels when transformed into barley. These gene constructs have been introduced into barley and when sufficient seed is available, we will assess the efficacy of these transgenes for improving FHB resistance in barley.

Impact:
The known sources of genetic resistance for FHB resistance for barley are quite limited and provide only partial protection against the disease. Resistance provided by these loci can be readily overwhelmed during epidemic conditions; therefore there is a great need to identify other means to provide effective genetic resistance to FHB. The transgenes developed here have strong prospects for improving FHB resistance and should be able to be combined with the best existing resistance loci to provide strong FHB resistance.

Project 2: *Investigating the Role of PAMP-Triggered Immunity in FHB Resistance.*

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

   This project is aimed at identifying wheat genes that make key contributions to Fusarium head blight (FHB) resistance and then to test if engineering wheat to express these genes at elevated levels will confer significantly improved FHB resistance. We employ a novel functional test that silences, or down-regulates candidate genes in wheat that is normally resistant to FHB. We then challenge the silenced plants in FHB assays to see if they remain resistant, or become susceptible. If plants become susceptible when a candidate gene is silenced, this is a strong indication that the gene has a critical function in FHB resistance. This assay has identified a number of wheat genes that hold great promise for engineering improved FHB resistance.

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 functional analysis of genes required for FHB resistance has identified several classes of genes that make significant contributions to FHB resistance in wheat. The gene class for which we have achieved the greatest information are genes required for ethylene (ET) biosynthesis or ethylene-induced signaling. Silencing genes required for ET biosynthesis or ET-induced signaling result in FHB resistant genotypes becoming susceptible and susceptible genotypes becoming even more susceptible. These findings have been confirmed using chemical inhibitors of ET perception, a method that is completely independent from our virus-induced gene silencing (VIGS) assay. More significantly, we have performed experiments in which FHB susceptible wheat is treated with ACC, the chemical precursor to ET. After this treatment the plant converts ACC to ET causing increased ET-signaling and a significant increase in FHB resistance is observed. This finding strongly supports our strategy that overexpression of genes promoting ET-signaling will confer improved FHB resistance.

   It is interesting to note that the study of the response of cereals to Fusarium infection has identified multiple classes of FHB resistance, with type I and II being the modes utilized by breeders. Type I resistance is defined as resistance to initial infection, while type II results in confining the infection to the initially infected spikelet. Our studies with ACC treatments have been performed separately to test the effect on type I and type II FHB resistance, and we have observed that both modes of resistance shown significant increase when ET-signaling is increased, which again bodes well for the efficacy of this approach to improve FHB resistance.

Impact:

This work has very significant impact for researchers working to understand the resistance response of cereals to FHB. In this regard, its impact is particularly high as a publication appeared in 2009 that claims the exact opposite result to what we have observed. Our work, when published soon, will correct this story and hopefully provide new direction to researchers who may have set off on an erroneous path. However, we believe the greatest impact of this work will be in guiding us to effective strategies for engineering improved FHB 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.

Presentations:

Presentation to the International Workshop on Molecular Crop Improvement, New Delhi, India, October 30, 2011.

Presentation during the GDER Session of the 2011 USWBSI National Forum.

Presentation during the Plants Interacting with Pests and Pathogens Workshop at the Plant and Animal Genome Conference, January 14, 2012, San Diego, CA**.**

Presentation to the AEIC Spring Meeting April 19, 2012, Research Triangle Park, NC.

Presentation to the Noble Foundation Virology Symposium, May 5, 2012, Ardmore, OK.

Presentation to the E-COST Virus-induced Gene Silencing Training School, June 24, 2012, Rothamsted Research Centre, Harpenden, England.

Peer-reviewed Publications:

Gillespie, M. Gill, TA and Scofield, SR. Chemicals used to assess the role of hormone signaling in Fusarium head blight resistance may directly affect fungal growth. (submitted).

Gillespie, ME, Brandt, AS and Scofield, SR. Ethylene-signaling is essential for type I and II resistance to Fusarium head blight in wheat. (in preparation).