USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY09 Final Performance Report
July 15, 2010

Cover Page

PI:	Michael Lawton
Institution:	Rutgers
Address:	Biotech Center - Cook College 59 Dudley Road New Brunswick, NJ 08901-8520
E-mail:	lawton@aesop.rutgers.edu
Phone:	732-932-8165 ext. 223
Fax:	732-932-6535
Fiscal Year:	2009
USDA-ARS Agreement ID:	59-0790-6-063
USDA-ARS Agreement Title:	A Rapid Assay System for Transgenes that Confer Resistance to DON and FHB.
FY09- USDA-ARS Award Amount:	$ 48,202

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
GDER	A Rapid Assay System for Trangenes that Confer Resistance to DON and FHB.	$ 48,202
	Total Award Amount	**$ 48,202**

July 12th 2010

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 Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *A Rapid Assay System for Trangenes that Confer Resistance to DON and FHB.*

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

In spite of exhaustive testing, only limited germplasm resources are available to breeders and crop improvement specialists to enhance resistance against FHB and prevent accumulation of the mycotoxin DON. Genes present in plants other than wheat or barley have the potential to enhance FHB resistance when introduced into grain plants. Since transformation of wheat and barley is time- and resource-consuming, it is not possible to directly screen large numbers of transgenes genes for activity against FHB in these crop plants. To address this problem, we have developed a rapid and efficient gene assay system based on the recombinogenic plant *Physcomitrella patens*, which allows gene function to be readily assessed through the creation of gene knockout or overexpression lines. By exploiting this model plant as a rapid assay system, we have been able to identify a number of genes that confer resistance to DON and to FHB. Genes that are effective in Physcomitrella provide the raw material for assessment against FHB in wheat or barley. These activities constitute a research and development pipeline for gene discovery and for the deployment of novel anti-FHB genes in wheat.

This project addresses Goal #1 of the Gene Discovery and Engineering Resistance (GDER) research area (RA) for "*increased efficiency of identification of candidate genes for resistance against FHB and reduced DON accumulation…* (through) …*high-throughput functional screening assays to identify genes that confer increased FHB resistance and/or lower accumulation of DON.*"

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 a number of effective anti-FHB genes using the model system *Physcomitrella patens.* These systems are currently being used to identify the efficacy of the corresponding wheat genes against FHB and towards the reduction of DON. These include genes that are involved in the expression of FHB resistance as well as those that are important for disease susceptibility (in accord with the recommendations to focus on the identification of both types of genes, as per the Action Plan of the GDER RA).

We have used the *Physcomitrella* functional assay system to determine which wheat homologs of anti-FHB genes (specifically, those encoding activities against reactive oxygen species as well as a set of nucleases) are most effective against FHB. This provides an early indicator of success of wheat genes in transgenic wheat and allows the most promising candidate genes to be put in the front of the pipeline for delivery into crop plants. This fulfils the stated need that "priority will be given to resistance strategies that can be implemented using wheat or barley DNA sequences." Significantly, where these genes exist as gene families in crop plants, not all homologs are equally effective against FHB. This points to the importance of having relatively simple and rapid functional assay systems that can be used to select the best performing genes for introduction into wheat and barley.

Impact:
These developments constitute a research and development pipeline for screening genes for DON and FHB resistance. They provide a collection of genes that can be targeted for improvement by molecular or marker-assisted methods or through gene transfer. They also establish the R&D pipeline for the discovery and deployment of additional genes as these are uncovered from ongoing screens. These studies provide a foundation for fulfilling Research Priority #2, to *"develop effective FHB resistance through transgenic strategies."* By focusing on conserved genes, we increase the probability that genes that function in model systems will function similarly in crop plants.

The best performing genes from our studies have been made available to other researchers in the USWBSI community so that their impact on FHB can be evaluated through stable or transient expression in wheat and barley. Should they provide effective, they will provide complementary approaches to improving grain crops through direct gene transfer, through marker assisted breeding or through mutant selection schemes such as TILLING.

Accomplishment:
The use of gene knockouts in Physcomitella also reveals which mechanisms of resistance are important during the interaction with FHB. We analyzed the transcriptional behavior of and created gene knockouts for plant components involved in the perception and signaling of pathogenic derived PAMPs. Our results indicate that these components contribute significantly to the ability of the plant to mount a defense response.

Impact:
By understanding these mechanisms, we can develop new strategies –not necessarily based on transgenes, but also on the use of traditional chemical control –to ameliorate susceptibility to FHB. This approach, in which gene knockouts provide insight into novel targets for FHB and mycotoxins, provides the knowledge base for the development of new types of chemicals for control of FHB in the field. Our results suggest that the ability to mount a defense response is an important component of the interaction with FHB and suggest that its manipulation through genetic or chemical means might provide an alternate and attractive approach to the control of FHB in the field.

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.

Publications

Lawton, M and Saidasan, H. (2009) Physcomitrella Pathogenesis. In The Moss, Physcomitrella, C, Knight, D. Cove and P.-F. Perroud, Eds. Ann. Plant Rev.,Wiley-Blackwell, Oxford.

Lawton, M. and Saidasan, H. Cell wall genomics in the recombinogenic moss Physcomitrella patens. IN: The Routes to Cellulosic Ethanol (M. Buckeridge, Ed.) Springer. NY. *In Press*

Proceedings

Saidasan, H., Uzumcu, Z., McLaughlin, J,, Tumer, N. Lam, E and Lawton, M. "Genetic Manipulation of Susceptibility to Fusarium Head Blight". Proceedings of the 2009 National Fusarium Head Blight Forum (Eds, S. Canty, A. Clark, J. Mundell, E. Walton, D. Ellis and D. Van Sanford) University of Kentucky, Kansas City, MO, p. 196.

Patents

E. Lam, M. Lawton and H.Saidasan Chemical chaperones as antifungal agents for treatment of plants against fungal pathogens –patent disclosure filed 2009.

Presentations

H. Saidasan M. Lawton. Rapid gene assay in Physcomitrella patens reveals multiple mechanisms and approaches for controlling Fusarium Head Blight. Microbiology at Rutgers Third annual mini-symposium. Cultivating traditions, current strength and future frontiers. 2009.

H.Saidasan and M.Lawton. Physcomitrella patens A rapid assay system for transgenes conferring resistance to mycotoxins and FHB. Theobald smith Society, New Jersey branch of American Society of Microbiology. Meeting in Miniature April 2009, Cook Campus Center, Rutgers University.

Lawton, M. and Saidasan, H. "Weapons of Moss Destruction: Fusarium Infection of *Physcomitrella patens*" II Simpósio Brasileiro de Genética Molecular de Plantas March 31st - April, 2009 Búzios, Rio deJaneiro, Brazil. Invited Talk.

Lawton, M. "Manipulating disease susceptibility and resistance in *Physcomitrella patens.*" March, 2010, Texas A&M University, College Station, TX