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

PI:	John F. Leslie
Institution:	Kansas State University
Address:	Department of Plant Pathology 4024 Throckmorton Hall Manhattan, KS 66506-5502
E-mail:	jfl@ksu.edu
Phone:	785-532-1363
Fax:	785-532-2414
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USDA-ARS Agreement Title:	Genetic Diversity and Genetic Mapping of Gibberella zeae.
FY06 ARS Award Amount:	$ 49,812

USWBSI Individual Project(s)

USWBSI Research Area*	**Project Title**	**ARS Award Amount**
PGG	Genetic Diversity and Genetic Mapping of Gibberella zeae.	$ 49,812
	Total Award Amount	**$ 49,812**

_________________________________ 16 July 2007
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

(Form – FPR06)

Project 1: *Genetic Diversity and Genetic Mapping of Gibberella zeae.*

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

Recently it has been proposed that the nine lineages described within the species *G. zeae* should actually be elevated to distinct species. While considerable genetic diversity in gene sequence does exist between the lineages, the lineages are not reproductively isolated under laboratory conditions suggesting that the lineages are not distinct species under the biological species concept.

We have been characterizing the genetic diversity in 472 isolates of *G. zeae* that had been collected from around South America from (wheat and sorghum). How does genetic variability compare among and within lineages of *G. zeae*? Is there any evidence in this population for naturally occurring "hybrids" between the lineages? We also have been working with smaller populations from Korea. The populations in both locations differ from those found in the United States in that strains from multiple lineages occur in these locations, and only one lineage, lineage 7, is known from the United States.

2. List the most important accomplishment and its impact (how is it being used?). Complete all three sections (repeat sections for each major accomplishment):

<u>Accomplishment:</u>

Amplified Fragment Length Polymorphisms (AFLPs) were used to initially assign each of the 472 isolates from South America to one of the nine lineages. Portions of four genes proposed as diagnostics for the various lineages were sequenced - Mating Type (*MAT*), *TRI-101*, Reductase (*RED*), and β-tubulin (*TUB2*)]. In addition to the previously identified alleles we found new alleles at each locus, with some alleles more frequent than others. Lineages that had been separated by multiple differences in a sequence often need not be separated by more than a single base change. In some lineages there is a greater genetic distance within a single lineage than there is between that lineage and all of the other lineages. A number of alleles are not clearly assignable to a lineage as they lack definitive SNPs or possess a mixture of SNPs that prevents their clear identification.

Haplotype networks assembled from the sequence data for all four loci are not homologous with regards to the association of the lineages. Some of these patterns are better explained by recombination than the bifurcating branching usually associated with speciation. This lack of concordance between gene genealogies is consistent with a hypothesis that these lineages are distinct but that all form a part of a single species and should not yet be accorded species status. The polytomies that characterize these genealogies also are consistent with all nine lineages being members of the same species rather than members of a number of different species.

Korean data are similar in nature to the South American data, but not as detailed, as there are fewer strains and only a single gene sequence. In Korea, hybrids may be occurring between lineages 3 and 7, based on AFLP data, but there is insufficient sequencing data to either support or reject this hypothesis.

<u>Impact:</u>

Taxonomic status of *G. zeae*/*F. graminearum* is of critical importance for plant quarantine and trade measures. If there are a number of species then each must be treated separately and the presence/absence of a particular species can be used as a non-tariff trade barrier. Our results strongly suggest that while isolated populations of *F. graminearum* exist, these populations are not reproductively isolated and should be recognized as portions of a single, large, diverse species rather than as nine discrete entities. Such recognition would not materially impact the plant quarantine regulations currently in place, nor alter the application/implementation of current trade practices. The similarities between Korea and South America indicate that the difficulties with the use of the SNPs is not limited to a single location.

<u>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?</u>

The question of naming different strains of *F. graminearum* is controversial. Previously this controversy has been interpreted as a difference in species definition, *i.e.* morphology or cross-fertility vs. phylogenetics. Using morphology and cross-fertility as measures, the nine lineages are not resolvable. DNA markers (AFLPS) and DNA sequences can group the isolates, but these groups do not appear to be tight. There are two critical questions: (1) How much sequence variation is present in the United States? and whether this variation can discriminate between the two different DON-associated genotypes? (2) Are there traits of economic importance within the various lineages and how frequently are these traits transferred between lineages.

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.

Refereed journal articles:

1. Bentley, A. R., M. G. Cromey, M. G., R. Farrokhi-Nejad, **J. F. Leslie**, B. A. Summerell & L. W. Burgess. 2006. *Fusarium* crown and root rot pathogens associated with wheat and grass stem bases on the South Island of New Zealand. *Australasian Plant Pathology* **35:** 495-502.
2. Kerényi, Z., B. Oláh, A. Jeney, L. Hornok & **J. F. Leslie**. 2006. The homologue of *het-C* of *Neurospora crassa* lacks vegetative compatibility function in *Fusarium proliferatum*. *Applied and Environmental Microbiology* **72:** 6527-6532.
3. **Leslie, J. F.** & B. A. Summerell. 2006. *Fusarium* Laboratory Workshops – A recent history. *Mycotoxin Research* **22:** 73-74.
4. Schmale, D. G., **J. F. Leslie**, K. A. Zeller, A. A. Saleh, E. J. Shields & G. C. Bergstrom. 2006. Genetic structure of atmospheric populations of *Gibberella zeae*. *Phytopathology* **96:** 1021-1026.
5. Jeney, A., E. Béki, A. Keszthelyi, **J. F. Leslie** & L. Hornok. 2007. Inactivation of *Fpmtr*, an amino acid transporter gene causes communication disturbances in *Fusarium proliferatum*. *Journal of Basic Microbiology* **47:** 16-24.
6. Bentley, A. R., **J. F. Leslie**, E. C. Y. Liew, L. W. Burgess & B. A. Summerell. 200x. Genetic structure of *Fusarium pseudograminearum* populations from the Australian grain belt. (acepted).
7. Hornok, L., C. Waalwijk & **J. F. Leslie**. 200x. Genetic factors affecting sexual reproduction in toxigenic *Fusarium* species. *International Journal of Food Microbiology* (in press).
8. **Leslie, J. F.**, L. L. Anderson, R. L. Bowden & Y.-W. Lee. 200x. Inter- and intra-specific genetic variation in *Fusarium*. (accepted).
9. Ramirez, M. L., M. M. Reynoso, M. C. Farnochi, J. F. Leslie & S. N. Chulze. 200x. Population genetic structure of *Gibberella zeae* from wheat in Argentina. (accepted).

Abstracts and meeting presentations:

10. Anderson, L. L., Y.-W. Lee, R. L. Bowden & **J. F. Leslie**. 2006. Haplotype networks from *Fusarium graminearum* reveal patterns of evolution. *Proceedings of the 2006 National Fusarium Head Blight Forum* (Research Triangle Park, North Carolina): 136.
11. **Leslie, J. F.** 2006. Genetic diversity in *Fusarium* from sorghum and millet. *Proceedings of the 8th International Mycological Congress (Cairns, Australia)*: 412.
12. Petrovic, T., A. R. Bentley, **J. F. Leslie**, E. C. Y. Liew, B. A. Summerell & L.W. Burgess. 2006. Genetic diversity of *Fusarium thapsinum* isolates from different hosts in Australia. *Proceedings of the 8th International Mycological Congress (Cairns, Australia)*: 305.
13. Schmale, D. G., **J. F. Leslie**, K. A. Zeller, A. A. Saleh, E. J. Shields & G. C. Bergstrom. 2006. Genetic structure of atmospheric populations of *Gibberella zeae*. *Phytopathology* **96:**s104.
14. Anderson, L. L., Y.-W. Lee, R. L. Bowden & **J. F. Leslie**. 2007. Relationships between

alleles at lineage diagnostic loci in *Fusarium graminearum*. *Fungal Genetics Newsletter* **54(Suppl.):** 67.

15. Lee, J., R. L. Bowden & **J. F. Leslie**. 2007. Pheromone functions in *Gibberella zeae*. *Fungal Genetics Newsletter* **54(Suppl.):** 134.

Dates and locations of invited presentations by Dr. Leslie that contained information from this project but for which there is no published abstract:

16. Royal Botanic Gardens, Sydney, Australia – 08/06.
17. St. Paul's College, University of Sydney, Sydney, Australia – 08/06.
18. 8th International Mycological Congress, Cairns, Australia – 08/06.
19. Fungi and Mycotoxins in Food and Indoor Air Symposium, Cairns, Australia – 08/06.
20. Science University of Malaysia, Penang, Malaysia – 08/06.
21. CNR Institute for the Science of Food Production, Bari, Italy – 09/06.
22. Mycoglobe Conference on Mycotoxins and Genomics, Monopoli, Italy – 09/06.
23. Northwest University, Potchefstroom, South Africa – 10/06.
24. FABI, University of Pretoria, Pretoria, South Africa – 11/06.
25. International Institute for Tropical Agriculture, Ibadan, Nigeria – 11/06.
26. OECD meeting on Mycotoxins in Food, Omaha, Nebraska – 11/06.
27. Bioforsk, Ås, Norway – 03/07.
28. 24th Asilomar Fungal Genetics Conference, Pacific Grove, California – 03/07.
29. College of Life Sciences, Dalian Nationalities University, Dalian, China – 04/07.
30. Shenyang Agricultural University, Shenyang, China – 04/07.
31. Faculty of Agricultural & Life Sciences, Seoul National University, Seoul, Korea – 05/07.