

Washington Grain Commission
Wheat and Barley Research Annual Progress Reports and Final Reports
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(Begin 1 page limit)

Project #: 3061-3548

Progress Report Year: 3 of 3 (*maximum of 3 year funding cycle*)

Title: Fusarium Crown Rot on Wheat: Prebreeding and Development of Tools for Genetic Disease Management

Investigators: M. Pumphrey, K. Garland-Campbell, and T. Paulitz

Cooperators: R. Smiley, Yvonne Manning

Executive summary:

- We have taken the data from the *Fusarium* field surveys funded by the previous grant, and did an extensive analysis and modeling to look at relationships of species with climatic and cropping factors in the dryland area of PNW. Isolates of *Fusarium* spp. were obtained from 99% of 105 fields sampled in 2008 and 97% of fields in 2009. Results of the factor analysis showed that the distribution of *F. pseudograminearum* occurred in a greater frequency in areas of the PNW at lower elevations with lower moisture and higher temperatures, whereas *F. culmorum* occurred in greater frequency from areas at higher elevations with moderate to high moisture and cooler temperatures.
- We have screened 293 adapted spring and winter wheat lines in greenhouse trials for resistance to *F. culmorum*. In each nursery screened, we were able to identify 4-5 lines with better resistance than others. The lines with the best resistance in these trials included spring wheat lines Nick, WB-1035CL, WA8193, WA8195, LNR10-0551, WA8163, UC1742, and Louise, and winter wheat lines SY Ovation, OR2070870, and ARS010302-5C. These results will have to be confirmed with additional trials, due to the variable nature of the disease.
- A mini-core collection was developed for the Spring wheat germplasm of the National Small Grains collection. These lines were increased are being evaluated for Fusarium resistance in the greenhouse screening in 2014/2015. Genotype data is available for this collection.
- Synthetic wheat lines from CIMMYT were screened and three of them were identified as resistant. These lines have been crossed to adapted spring wheat germplasm.
- We evaluated 90 Spring breeding lines and cultivars from the Washington State spring wheat Extension Trials and the Western Regional Spring wheat nurseries for resistance to *F. culmorum* in the field and Lind. The disease pressure was lower than optimal, likely due to the drought, but we were able to discern some lines with better resistance than others, including LCS-Buck Pronto, and Otis, Patwin515, Scarlet, Tarra 2002, WA8219. WB-1035CL. WB-Fusion, and Zak. These results need to be confirmed in trials with heavier disease pressure and results need to be correlated to the greenhouse trials.

Impact:

- Fusarium crown rot is widely distributed throughout all cropping zones, in levels causing economic loss. Different zones however, have a predominance of one species. This is important information for deployment of resistance/tolerance genes in the future.
- The variability of this disease is such that multiple replications and experiments are needed to accurately rate resistance. With the further refinement of our screening systems, we are able to rate several hundred lines in greenhouse and field screening sites on a routine basis. New sources of resistance have been identified.
- Development of resistant varieties will reduce losses from Fusarium crown rot and improve the economic and environmental sustainability for Washington growers.
- Methods for field screening are essential to accurately evaluate response to root disease. We have developed a method that is working to evaluate varieties at Lind, and collaborated with others to expand the number of testing locations. With these field trials, plus our more rapid greenhouse trials, we have identified some breeding lines and cultivars with better than average resistance. These can be intercrossed to accumulate resistance genes with minor effects.

WGC project number: 3061-3548
WGC project title: **Fusarium Crown Rot on Wheat: Prebreeding and Development of Tools for Genetic Disease Management**
Project PI(s): **M. Pumphrey, K. Garland-Campbell, and T. Paulitz**
Project initiation date: **7/1/2012**
Project year: **Year 3**

Objective	Deliverable	Progress	Timeline	Communication
Objective 1. Objective 1. Confirm resistance of 3B QTL against <i>Fusarium culmorum</i>.	Verification of resistance with the same gene.	Fusarium screens were conducted at the WSU Plant Growth Facility using <i>Fusarium culmorum</i> . The nurseries screened were the WSU wheat variety trials as well as the Western Regional Nurseries. We have identified approximately 40 lines with better resistance, but this disease is highly variable. We need to repeat these trials under heavier infection pressure in order to confirm resistance.	Will be completed after year 3	Articles in Wheat Life, grower presentations, abstracts, conference proceedings, refereed scientific articles. See attached page for 2013 communications.
Objective 2. Optimize field inoculation techniques (millet seed vs seed coating) and develop natural disease nurseries. Test advanced lines and PNW winter and spring wheat varieties for tolerance and resistance in inoculated field nurseries. Use the field screening sites to evaluate and select germplasm resources from other regions of the US, from the USDA-small grains germplasm bank, and from international nurseries.	Efficient screening system that mimics real life farmer experiences with Fusarium.	Inoculated field screening trials were planted at Lind. The winter wheat trial at Pullman was complicated by infection of eyepot making it difficult to rate the entries so that site was not used for Fusarium. The spring wheat trial at Lind had good infection but the disease pressure was low, likely due to the drought. For the future, we will conduct field screening for Fusarium resistance at Lind using irrigation and higher inoculum rates. We were able to distinguish some differences among varieties.	Development of screening systems will be completed after year 3 Variety testing will be ongoing.	Articles in Wheat Life, grower presentations, abstracts, conference proceedings, refereed scientific articles. See attached page for 2013 communications.
Objective 3. Validate the 3B QTL in additional segregating populations with Sunco as a parent and prebreeding development of germplasm using germplasm resources from international CIMMYT nurseries introgressed into the best locally adapted winter and spring wheat cultivars.	New breeding lines with moderate resistance to Fusarium that are derived from combinations of Australian and US germplasm.	Segregating populations have been planted in the greenhouse for inoculation and screening this spring. A mini-core representing 1/100 of the National Small Grains Spring wheat collection was identified. Seed was increased and screening for Fusarium resistance is currently being conducted in the GH. The data obtained from evaluation of the spring mini-core will be used with existing genotype data to conduct association mapping for Fusarium resistance, to identify new sources of resistance.	Will be completed after year 3.	Articles in Wheat Life, grower presentations, abstracts, conference proceedings, refereed scientific articles. See attached page for 2013 communications.

Communications for Washington Wheat Commission Grant 2012-2014

Refereed Publications, Popular Press Articles (partially supported with Wheat Commission funding):

2012

G. J. Poole, G. J., Smiley, R. W., **Paulitz, T. C.** Walker, C.A., Carter, A. H., See, D. R., and **Garland-Campbell, K.** 2012. Identification of quantitative trait loci (QTL) for resistance to Fusarium crown rot (*Fusarium pseudograminearum*) in multiple assay environments in the Pacific Northwestern US. Theoretical and Applied Genetics. 91-107.

2013

Poole, G., Smiley, R., Walker, C., Huggins, D., Rupp, R., Abatzoglou, J. **Campbell, K.** and **Paulitz, T. C.** 2013. Effect of climate on the distribution of *Fusarium* species causing crown rot of wheat in the Pacific Northwest of the US. Phytopathology 103:1130-1140.

Paulitz, T. C. 2013. Fusarium Crown Rot: What's known, what's new? Wheat Life, June, 2013.

Presentations and Reports:

2012

Paulitz, T. C., Cook, R. J., **Campbell, K.G.** and Poole, G. 2012. Fusarium crown rot research in the Pacific Northwest of the United States: A half a century of discoveries. Pg. 11. Proceedings of the First International Crown Rot Workshop for Wheat Improvement, Oct. 22-23, 2012. Narrabri, New South Wales, Australia.

Poole, G. J., Smiley, R. W., Walker, C. A., **Campbell, K. G.**, and **Paulitz, T. C.** 2012. Distribution of *Fusarium* spp. causing crown rot in the Pacific Northwest. Pg. 22. Proceedings of the First International Crown Rot Workshop for Wheat Improvement, Oct. 22-23, 2012. Narrabri, New South Wales, Australia.

Poole, G. J., Erginbas, G., Smiley, R. W., **Campbell, K. G.** and **Paulitz, T. C.** 2012. Inoculation methods to assay wheat seedlings for resistance to Fusarium crown rot in a controlled environment. Pg. 39. Proceedings of the First International Crown Rot Workshop for Wheat Improvement, Oct. 22-23, 2012. Narrabri, New South Wales, Australia.

Poole, G. J., Smiley, R. W., **Paulitz, T. C.**, and **Campbell, K. G.** 2012. Identifying QTL for Fusarium crown resistance (*F. pseudograminearum*) in field, terrace, and

growthroom screen environments. Pg. 49. Proceedings of the First International Crown Rot Workshop for Wheat Improvement, Oct. 22-23, 2012. Narrabri, New South Wales, Australia.

Paulitz, T.C. 2011. Soilborne Pathogens in Wheat- Fusarium, Rhizoctonia, and Cereal Cyst Nematode. Nez Perce County Grower Workshop, Lewiston, ID, Oct. 18, 2011.

Paulitz, T.C. Root Disease Research at ARS Pullman-What's New? Spokane Farm Forum, Ag Expo, Feb. 7, 2012

2013

Paulitz, T. C. 2013. "Root Disease Research at ARS Pullman-What's New?" Spokane Farm Forum, Ag Expo, Feb. 5, 2013.

Paulitz, T. C. 2013. Distribution of Fusarium Crown Rot in the Pacific Northwest: Relationships with Climatic Factors". REACCH Annual Conference: Regional Approaches to Climate Change. Portland, OR, Feb. 13, 2013.

Schroeder, K. L 2013. Overview of soilborne pathogens: Rhizoctonia, Fusarium and take-all. Montana State University Extension Ag Tour, Pullman, WA. June 6, 2013.

Schroeder, K. L. 2013. Temporal shifts in soilborne pathogen populations in dryland wheat cropping systems. Conference on Soilborne Plant Pathogens, Corvallis, OR. March 27, 2013.

2014

Paulitz, T. C. 2014. Updates in Wheat Disease Research, Garfield Grange, Colfax, Washington, January 25, 2014

Paulitz, T. C. 2014. Research at USDA-ARS in Pullman, What's New? Spokane Farm Forum, Ag Expo, Spokane, Washington, February 4, 2014.

Paulitz, T. C. 2014. Fusarium Diseases. Crop Diagnostic Clinic, Spillman Farm, Pullman, Washington, June 26, 2014