Progress Report

Project #: 3674

Progress Report Year: 3 of 3

Title: Enhancing Resistance to Snow Mold Diseases in Winter Wheat

Cooperators: T. Murray, Plant Pathologist, WSU
A. Carter, Crop & Soil Sciences, WSU
D. Skinner, USDA-ARS, Pullman, WA
J. Marshall, PSES, University of Idaho

Executive summary: Development of snow mold in field plots is not predictable and doesn't occur every year in Washington. Consequently, we expanded the number of locations in Washington and began collaborating with Dr. Juliet Marshall, plant pathologist with the University of Idaho at Idaho Falls, to begin field testing at the Tetonia Research Center in southeastern Idaho. In 2013, field plots were established at three locations, two in WA near Waterville and Mansfield, and another in ID near Tetonia, to test populations from the cross Münstertaler (highly resistant) x Xerpha (susceptible) and Finch x Eltan for resistance to snow mold. A third site in Douglas County, WA was added in 2014, and both populations were planted at all locations. Three QTL and associated makers were identified in the Finch x Eltan population, and data from the Münstertaler x Xerpha population is being analyzed.

Three new doubled-haploid populations were developed between a new source of resistance, PI 173438, and PNW-adapted lines to expand the diversity of resistance genes. These populations will be field-tested beginning in 2016.

Several experiments were conducted to scale-up growth chamber testing for snow mold resistance so it can be used to screen large numbers of plants for resistance in controlled environment conditions, but results were disappointing. Consequently, graduate student Erika Kruse was recruited to work on this project. The focus of her project is both genetic and physiological, and specifically to identify QTL associated with cold-hardening and snow mold resistance, and to understand the role of fructan (a carbohydrate) metabolism in snow mold resistance. Field plots were established on Spillman farm in 2014 and 2015 to collect wheat samples and analyze them for fructan content. Studies are in progress and information gained from them will be used to improve growth chamber screening for resistance. Although we don't expect controlled environment testing to replace field testing, it will allow us to make progress on genetic studies throughout the year and eliminate very susceptible lines from field testing.

Impact:

One of the most significant and measurable impacts during this funding cycle has been the expansion of field testing within Douglas County, to three sites, and in Tetonia, ID. Snow mold developed in at least one location each year, which resulted in us being able to complete testing the Finch x Eltan and Münstertaler x Xerpha populations for snow mold resistance. New QTL and molecular markers were identified in the Finch x Eltan population, which should be useful to breeding programs.

Another measurable impact is the development of three new genetic populations with a new source of snow mold resistance with PNW-adapted lines that have potential for new resistant varieties and introduction of a new source of snow mold resistance.

Successful completion of these objectives will provide growers with a greater selection of adapted, high-yielding snow mold-resistant varieties from which to choose and the development cycle will be shorter compared to the conventional methods now used. In addition, data on variety performance under snow mold conditions is useful to farmers and field consultants in making decisions about which varieties to grow. Results generated in this project are communicated to farmers and field consultants at field days, other meetings, and publications such as Wheat Life. Results are communicated to other scientists directly and through publication in appropriate journals.

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WGC project title: Enhancing Resistance to Snow Mold Diseases in Winter Wheat
Project PI(s): T.D. Murray
Project initiation date: 2013
Project year: 2 of 3

Objective	Deliverable	Progress	Timeline	Communication
1. Complete field screening of a population with new snow mold resistance genes transferred from the variety Münstertaler into Xerpha.	Test mapping populations, advanced breeding lines, and varieties under field conditions to determine their resistance to snow mold diseases.	**2015:** Field plots were planted near Mansfield and Waterville, WA and Tetonia, ID. Snowmold developed in Tetonia and in one of the Douglas County plots, which allowed us to complete field screening of the Münstertaler x Xerpha population with new snow mold resistance genes. Data analysis is in progress to identify the genes and associated molecular markers. We attempted to find another location for field testing near McCall, ID in conjunction with University of Idaho Extension personnel, but were unsuccessful. **2014:** Field plots were planted near Waterville and Mansfield, WA and Tetonia, ID in fall 2013. Not enough snow mold developed near Waterville for useful data; although snow mold was not severe near Tetonia, enough disease developed to be useful. Three field plots were planted Douglas County, two near Mansfield and one near Waterville, and one in Tetoniain fall 2014 with the same and new material for evaluation in 2015. We identified a potential farmer cooperator near McCall, ID, but were not able to establish a plot in fall 2014; we will try again in 2015. **2013:** Field plots were planted near Waterville, WA and Tetonia, ID in fall 2012. Snow mold developed at both locations and survival notes were taken in spring 2013. The data have been	Field testing will be conducted in each year of this proposal with the goal to identify another location for field testing in fall 2015.	Results of this work was presented at field days, other grower and industry talks, and on the WSU Wheat and Small Grains website. **Presentations:** **2014:** Eyespot, snow mold, stripe rust, and stem rust diseases of wheat. Wilbur-Ellis Growers Meeting, Odessa, WA, January 17, 2014. **Field Day abstracts**: **2015:** Murray, T., H. Sheng, Z. Sexton, and S. Koberstein. 2015. Eyespot, Cephalosporium Stripe, Snow Mold, and Soilborne Wheat Mosaic Diseases of Winter Wheat. Washington State University, Dept. of Crop and Soil Sciences Technical Report 15-1, p. 52. **2014:** Murray, T., H. Wetzel III, H. Sheng, D. Vera, and S. Koberstein. 2014. Eyespot, Cephalosporium Stripe, Snow Mold, and Soilborne Wheat Mosaic Diseases of Winter Wheat. Washington State University, Dept. of Crop and Soil Sciences Technical Report 14-1. **2013:** Murray, T., H. Wetzel III, and D. Vera. 2013. Eyespot, Cephalosporium Stripe, Snow Mold, and Soilborne Wheat Mosaic Diseases of Winter Wheat. Washington State University, Dept. of Crop and Soil Sciences Technical Report 13-1.
		summarized and are being analyzed now. Field plots were planted again near these locations with the same and new material for evaluation in 2014.		
2. Identify molecular markers associated with snowmold resistance from Eltan using the Finch x Eltan mapping population.	Molecular markers that can be used in marker-assisted-selection to transfer snow mold resistance genes.	**2015:** Three QTL for snow mold resistance resistance and associated molecular markers were identified in a Finch x Eltan population . **2014:** Data from the Tetonia field plot were analyzed and used to confirm the location of QTL in the Finch x Eltan population. Growth chamber testing was planned for 2015, but a useful test is needed (see below). **2013:** Crosses were made and populations developed in the greenhouse. Plants were field-tested once with no useful results and planted again in 2012 at two locations.	Growth chamber testing of these populations will occur during 2014-15.	Results will be published in appropriate journals and communicated directly to breeders.

	Prepare an article for Wheat Life during the three-year project summarizing results to date.	**2015:** Article was published in the March issue of Wheat Life **2014:** Article is in preparation now.	An article will be submitted in February 2015	Murray, T.D. 2015. Speeding up snow mold research. Wheat Life 58(03):66-69.
3. Identify markers from PI 173438 using "Genotyping by Sequencing" and transfer this resistance into new varieties.	Molecular markers that can be used in marker-assisted-selection to transfer snow mold resistance genes.	**2015:** Three doubled-haploid populations were developed between a new source of snow mold resistance (PI 173438) and lines adapted to Washington production (WA8315, WA8137, and Farnum). Seed increase is underway in anticipation of planting these populations in the field in August 2016. **2014:** Development of doubled-haploid populations continued in the greenhouse and will be available in 2015 for genotyping, and field and greenhouse testing. **2013:** Initial crosses were made in the greenhouse and development of the doubled-haploid plants is in progress.	Doubled-haploid plants will be produced during 2013-14 and GBS will be conducted during 2015. Field and greenhouse screening will be conducted in 2015. Marker associations will be analyzed once phenotyping is completed.	Results of this work are presented at field days, and other grower and industry talks. When completed, results will be published in Wheat Life, scientific journals, and the WSU Wheat and Small Grains website.
4. Establish protocols for screening large numbers of breeding lines for snow mold resistance under controlled environment conditions.	Methods of screening for snow mold resistance in growth chambers. Data on variety reaction.	**2015**: This objective was put on hold in favor of objective 5 in an effort to develop a better understanding of cold-hardening. Experiments are planned for early 2016 to correlate field accumulation of fructans with accumulation under growth chamber conditions. **2014:** Three experiment were conducted to optimize large-scale testing of germplasm for snow mold resistance in the growth chamber. Results have been disappointing and we are reassessing how to proceed with this objective. **2013:** Four experiments were conducted to identify the best methods for testing large numbers of plants for resistance to snow mold in growth chambers based on previous research. Unfortunately, growth chamber space was not available	Growth chamber testing will occur during each year of this project.	Results of this work are presented at field days, and other grower and industry talks. When completed, results will be published in Wheat Life, scientific journals, and the WSU Wheat and Small Grains website.
5. Measure fructan concentrations in breeding populations and identify genes involved in its production to determine its association with resistance.	Methods and data that can be used to screen breeding populations efficiently and determine whether fructan accumulation can be used to indirectly select for resistance to snow mold diseases.	**2015:** Initial field collections were sampled for fructan analysis. Methods are being standardized to complete this analysis. Once methods are established, fructan concentrations will continue to be evaluated in 2016 from both field and greenhouse screening. **2014:** A graduate student was recruited to join the program with the goal of examing carbohydrate accumulation in relation to snow mold resistance. She is becoming familiar with the disease and has established field plots on Spillman farm to collect winter wheat plant samples during cold-hardening on which fructan accumulation will be measured.	This research will continue for the duration of the project.	Results of this work are presented at field days, and other grower and industry talks. When completed, results will be published in Wheat Life, scientific journals, and the WSU Wheat and Small Grains website.