Annual Report

Project #: 4674

Progress Report Year: 3 of 3

Title: Control of Strawbreaker Foot Rot (Eyespot) and Cephalosporium Stripe in Winter Wheat

Cooperators: T. D. Murray, Plant Pathologist
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Executive summary: In 2015, data on the resistance of 40 and 45 winter wheat varieties and advanced breeding lines to eyespot and Cephalosporium stripe, respectively, was determined under field conditions. This brings the total number of lines tested for resistance to these diseases during this project to 120. This is the only program where new varieties and advanced selections from all PNW wheat breeding programs, public and private, are compared head-to-head against these diseases. Summaries of these experiments are provided to all breeders who contribute entries and made available through the WSU Wheat and Small Grains Extension website (smallgrains.wsu.edu), and the data generated from these plots is used to provide relative disease ratings in the Washington State Crop Improvement Association Seed Buyers Guide, which is revised annually.

A total of three field studies (2 in 2015 and 1 in 2013) were conducted to determine the effectiveness of registered fungicides for eyespot control. During the past 5 years, two new products were registered for eyespot control and it's important to collect data under a range of field conditions to determine their effectiveness.

Work to transfer four new eyespot resistance genes identified in a wheat relative was begun during this project, but not completed. These genes must be transferred into a PNW-adapted wheat background and field tested to determine how effective and useful they will be in variety development. This is a long term objective and limited progress was made in transferring the genes because of personnel changes and other objectives that were considered a higher priority.

A postdoctoral scientist was hired to extend previous research on genetic variation in the Cephalosporium stripe pathogen and specifically to identify useful molecular markers. After some initial studies, we decided the most cost-effective approach was to sequence the entire genome of *C. gramineum*, which has been completed. Data analysis is in progress now to identify useful molecular markers. A set of molecular markers was identified for the eyespot fungus *O.*

yallundae that will be useful in studies of genetic variation. Work is underway to identify similar markers in the other eyespot fungus, *O. acuformis*.

Impact:

The most significant and measurable impacts this project has had during this funding cycle is the evaluation of over 120 advanced selections and new varieties for their resistance to eyespot and Cephalosporium stripe. Data on variety performance under disease pressure is critical to farmers and field consultants in making decisions about which varieties to grow, and to breeders in making decisions about which selections to advance or discard. The information collected in these studies is used in the Crop Improvement Seed Buyer's Guide, which is distributed widely. Although eyespot and Cephalosporium stripe are targets in all winter wheat breeding programs in the PNW, this is the only opportunity for varieties developed for production in Washington to be evaluated and compared head-to-head. Another measurable impact during this project has been evaluation of foliar fungicides for efficacy in controlling eyespot. Although fungicide use for eyespot control has decreased over the years, there is still a substantial acreage that is treated each year. No other program in the PNW is testing foliar fungicides for control of eyespot. Such information is useful to growers and field consultants in deciding which fungicides to use.

Currently, the gene present in Madsen is the primary source of resistance in all other eyespot-resistant varieties. The new genes identified for eyespot resistance have potential to further reduce losses to this disease and broaden the genetic base of resistance available to breeders. Developing a better understanding of genetic variation in the eyespot and Cephalosporium stripe pathogens is a long-term goal that will help insure resistance genes remain stable and effective.

Results of all studies generated in this project are communicated to farmers and field consultants directly at field days and other meetings, publications such as Wheat Life and the Wheat and WSU Small Grains extension website, and to other scientists directly and through publication in appropriate journals.

WGC project number: 4674
WGC project title: Control of Strawbreaker Foot Rot (Eyespot) and Cephalosporium Stripe in Winter Wheat
Project PI(s): T. Murray, S. Hulbert, A. Carter, K. Garland-Campbell
Project initiation date: July 2013
Project year: 3 of 3

Objective	Deliverable	Progress	Timeline	Communication
To evaluate effectiveness of resistance to eyespot and Cephalosporium in advanced breeding lines and varieties in field plots.	Develop a better understanding of how existing and potential new varieties respond to each of these diseases and provide a direct comparison of variety performance under disease pressure. Provide an unbiased comparison of existing and new varieties relative to their reaction to these diseases.	**2015:** Two field studies with 40 and 45 entries were were conducted on research farms near Pullman for evaluation of resistance to eyespot and Cephalosporium stripe respectively. Emergence in both plots was very good and disease and yield data were collected on both plots. Field plots for 2015-16 were planted; emergence was also very good and both plots were inoculated in fall 2015. Data will be collected, summarized and published in 2016. **2014:** Two field studies with 40 entries each were conducted on research farms near Pullman. Emergence of the eyespot trial in fall 2013 was uneven and therefore only data on disease severity were collected; both disease and yield data were collected from the Cephalosporium plot. Field plots for 2014-15 were planted and inoculated in Fall 2014. Emergence for both plots was good and both were inoculated in Fall 2015. Data will be collected, summarized and published in 2015. **2013:** Two field studies with about 40 entries each were conducted on research farms near Pullman. Data on disease severity and yield were collected from eyespot and Cephalosporium plots in summer 2013, summarized and analyzed. Field plots for 2013-14 were planted and inoculated in	This work will be completed each year of the project. First and second year plots have been completed and third year plots have been planted and inoculated.	Results of these plots were presented at field days and other talks to grower and industry groups. Two technical reports were published and will be posted on the WSU Wheat and Small Grains website. **Presentations**: **2015:** Outlook for eyespot, Cephalosporium stripe, stripe rust and other diseases in small grains. WSU Extension, Northern Lincoln County Field Tour, Creston, June 23, Fairfield, June 16, Dusty, June 4, Ritzville, June 3, and Dayton May 20, 2015. Biology and control of eyespot disease. WSU Weed Science Tour, Pullman, WA, June 17, 2015. **2014:** Resistance to eyespot in wheat and its wild relatives. University of Minnesota, Dept. of Plant Pathology seminar, April 18, 2014. Outlook for stripe rust and other diseases in small grains. WSU Extension, Variety Testing Field Tour, Farmington, St. John, and Lamont, WA, July 16, 2014. Diagnosis and control of eyespot and Cephalosporium stripe of winter wheat. WSU Extension, Crop Diagnostic Clinic, Pullman, WA, June 26, 2014.

		Fall 2013. Emergence for the Cephalosporium plot was good, but variable for the eyespot plot due to heavy rain after seeding. Data will be collected, summarized and published in 2014.		Outlook for stripe rust and other diseases in small grains. WSU Extension, Variety Testing Field Tour, Walla Walla, WA, June 25, 2014. **Technical publications**: **2015:** Wetzel III, H.C. and T.D. Murray. 2015. Reaction of winter wheat cultivars and breeding lines to Cephalosporium stripe, 2014. Plant Disease Management Reports 9:CF013. **2014:** Wetzel III, H.C. and T.D. Murray. 2014. Reaction of winter wheat cultivars and breeding lines to Cephalosporium stripe, 2013. Plant Disease Management Reports 8:CF002. Wetzel III, H.C. and T.D. Murray. 2014. Reaction of winter wheat cultivars and breeding lines to eyespot, 2013. Plant Disease Management Reports 8:CF010. **2013:** Wetzel III, H.C. and T.D. Murray. 2013. Reaction of winter wheat cultivars and breeding lines to Cephalosporium stripe, 2012. Plant Disease Management Report 7:CF021. Wetzel III, H.C. and T.D. Murray. 2013. Reaction of winter wheat cultivars and breeding lines to eyespot, 2012. Plant Disease Management Report 7:CF004.
	Prepare an article for Wheat Life during the three-year project summarizing results to date.	**2015:** No progress **2014:** None to date	An article will be submitted in late 2015 or 2016.	
To transfer genes for eyespot and Cephalosporium stripe resistance from wild relatives to new varieties by identifying molecular markers for these genes.	Increase the number of resistance genes available to breeding programs with the ultimate goal of improving the effectiveness of resistance to these diseases.	**2015:** This objective was put on hold in favor of other priorities (seed transmission). **2014:** The student who conducted this work has returned to the lab as lab manager and is in the process of restarting the work; consequently, little progress was made toward this objective in 2014. **2013:** Crosses were made in the greenhouse beginning in 2012 to transfer newly identified eyespot resistance QTL to PNW-adapted winter wheat varieties. Progeny were being developed and advanced until the work was interupted in 2013 when the postdoctoral scientist left for another position.	This is a long-term goal that will be ongoing during this project.	Although there was no new activity on this objective in 2015, results of previous work were discussed at field days and other talks to grower and industry groups. **Journal articles published:** **2015:** Sheng, H., K. Klos, Z. Sexton and T.D. Murray. 2015. High-throughput single seed detection of *Cephalosporium gramineum* in wheat. Phytopathology [IN PRESS]. **2014:** Sheng, H., D.R. See, and T.D. Murray. 2014. Mapping resistance genes for *Oculimacula acuformis* in *Aegilops longissima* . Theoretical and Applied Genetics 127:2085-2093. **2013:** Sheng, H. and T.D. Murray. 2013. Identifying new sources of resistance to eyespot of wheat in Aegilops longissima. Plant Disease 97:346-353, doi: 10.1094/PDIS-12-11-1048-RE. Esvelt Klos, K., H. Wetzel III, and T.D. Murray. 2013. Resistance to *Oculimacula yallundae* and *Oculimacula acuformis* is conferred by *Pch2* in wheat. Plant Pathology, 63:400-404.

To insure effective fungicides for eyespot remain available by evaluating new fungicides in field plots.	Develop data that will help bring new, more effective fungicides into the marketplace by testing fungicides registered in Europe and experimental fungicides for their effectiveness in controlling eyespot in field plots.	**2015:** Foliar fungicide studies were conducted in field plots near Ralston and Dayton, WA. Each plot included the three registered fungicide treatments and a control. Priaxor, the most recently registered material, provided significantly better disease control but not a corresponding yield increase. **2014:** Fungicide studies were not conducted in 2014 due to lack of industry interest. **2013:** A field study was conducted with six treatments including the currently registered product and three other non-registered products in an inoculated plot on the plant pathology farm. One product, Priaxor,	Testing will be completed during each year of the project given industry interest and support.	Results of studies conducted in 2015 were presented in talks to grower and industry groups. **Technical article**: **2014:** Wetzel III, H.C. and T.D. Murray. 2014. Evaluation of fungicides to control eyespot in winter wheat in Washington, 2013. Plant Disease Management Reports 8:CF009. **2013:** Wetzel III, H.C. and T.D. Murray. 2013. Evaluation of fungicides to control eyespot in winter wheat, 2012. Plant Disease Management Reports 7:CF003.
To insure resistance genes for eyespot and Cephalosporium stripe remain effective by evaluating pathogen populations for pathogenic specialization.	Increase knowledge about genetic variation in these pathogens and their potential to overcome resistance genes by evaluating pathogen isolates collected from commercial fields in the PNW for genetic variation using molecular and microbiological methods.	**2015:** The genomes of *C. gramineum* and *Oculimacula yallundae* were sequenced and are being annotated. Data from the *O. yallundae* genome was mined to identify microsattelite markers that will be used in population genetic studies. Additional molecular analyses were conducted on *C. gramineum* to determine the amount of genetic variation present and the mating system. Data from the *C. gramineum* genome is being used to develop molecular markers for population genetic studies. **2014:** A postdoctoral scientist was hired and began work in April 2014. She has conducted studies examining genetic variation in three different genomic regions and found limited variation. We are currently preparing to have the genome sequenced to develop a dataset reflective of the entire genome that can be mined for useful molecular markers to advance these studies. **2013:** A study of genetic diversity in the Cephalsporium stripe pathogen based on cultural characteristics and molecular markers was completed and a paper written. Additional work is needed to fully understand genetic variation in this pathogen, but the postdoctoral scientist working on this project left to take another position. Another person has been hired	This research will be ongoing throughout the project.	Results of this work will be presented to grower, industry, and scientific audiences, published in appropriate scientific, popular and industry journals and posted on the WSU Wheat and Small Grains website. **Poster presentation:** **2014:** Klos, K.E., J.G. Evans and T.D. Murray. 2014. Genetic and phenotypic variation among, *Cephalosporium gramineum* isolates collected in the Pacific Northwest United States. Phytopathology 104(11S):S3.38. **Article in preparation:** **2015:** Esvelt Klos, D. Wafai Baaj, J.G.Evans, and T.D. Murray. 2016. Genetic and phenotypic variation among *Cephalosporium gramineum* isolates collected in the Pacific Northwest region of the United States. Phytopathology
		for this project and will begin working in April 2014.		