

**Washington Grain Commission
Wheat and Barley Research Annual Progress Reports and Final Reports**

Project #: 5195
Progress Report Year: 1 of 3
Title: Use of biotechnology for wheat improvement
Investigator/Cooperators: AH Carter, KG Campbell, D See, M Pumphrey

Executive summary: In 2015 we continued our effort to advance breeding lines as quickly and efficiently as possible by employing both molecular marker analysis and doubled-haploid technology. The traits of main focus for marker-assisted selection are foot rot resistance, stripe rust resistance, herbicide tolerance, and end-use quality. These are our primary focus due to very good markers having been developed and the importance of these traits in Washington. Additional traits include aluminum tolerance, SBWMV, dwarfing genes, photoperiod sensitivity, and nematode resistance. Over 1,500 lines were tested to confirm presence of desired genes based on marker profiling. These have been advanced to field testing to confirm presence of the selected genes. Markers were also used to screen all advanced breeding lines to identify presence of known genes. This information was used for selection and advancement purposes (in conjunction with field data) as well as for selecting lines which should be cross-hybridized to create future populations. The process of marker-assisted selection is an ongoing process, and at any given point we either have lines planted for analysis, in the laboratory undergoing marker profiling, or on increase in the greenhouse after selection to advance seed into field evaluations. Our genomic selection efforts are proceeding and we have completed our third year of phenotypic evaluations in the field. We submitted the 2015 and 2016 breeding lines for GBS analysis. Genomic selection models have been developed and will be updated as new data becomes available.

In the greenhouse, we made approximately 1,100 crosses consisting mainly of soft white, hard white, and hard red germplasm. These are being advanced to the F2 generation. We planted 200 DH plants in the field in 2015 for evaluation. The remaining DH lines are undergoing increase in the greenhouse and nearly 2,500 lines will be ready for yield evaluation in 2016. 100 additional crosses have been submitted for DH production.

Impact: This project covers all market classes and rainfall zones in the state of Washington, with about 70% of the effort on soft white crosses. This work will improve end-use quality, genetic resistance to pests and diseases, and agronomic adaptability and stability of released cultivars. All cultivars released have benefited through this project by incorporation of disease and end-use quality genes. These lines have gained popularity and are growing in demand in part due to the gene combinations they were selected for. Continued success will be measured by increases in acreage of these lines as well as enhanced cultivar release through DH production and marker-assisted and genomic selection.

WGC project number: 5195
WGC project title: Use of biotechnology for wheat improvement
Project PI(s): AH Carter
Project initiation date: July 1, 2012
Project year: 1 of 3

Objective	Deliverable	Progress	Timeline	Communication
Marker-assisted selection				Results are presented through annual progress reports, the research review, field tours, and grower meetings
	Foot rot resistant lines	In 2015, 61 populations were screened for the Pch1 gene for foot rot resistance. Of these, lines with the gene were advanced in the greenhouse and field selection will occur this coming year.	Each year new crosses are made to Pch1 containing lines. These are subsequently developed, screened, and advanced to state-wide yield trials. At any given time, lines are in every stage of development	
	Stripe rust resistant lines	In 2015, 26 populations for Yr5 and Yr15 were screened for and selected upon for upcoming field testing. An additional 63 populations were screened for various other rust genes of interest.	Each year new crosses are made to stripe rust resistant lines. These are subsequently developed, screened, and advanced to state-wide yield trials. At any given time, lines are in every stage of development	
	End-use quality lines	In 2015, 48 F2 populations were screened for the genes Gpc-B1 and Bx7oe. Multiple F4 populations were selected in the field for these two genes as a result of previous marker efforts. These lines are now in yield testing to determine agronomic adaptability. Additional lines were screened for GBSS genes (waxy) and the glutenin genes.	Each year new crosses are made to lines containing unique end-use quality genes. These are subsequently developed, screened, and advanced to state-wide yield trials. At any given time, lines are in every stage of development	
	Reduced height lines	In 2015, 14 populations were screened for incorporation of various Rht genes. Previous populations were planted at Lind to be screened for emergence potential.	Each year new crosses are being made to incorporate different Rht genes into the breeding program. We also verify presence of dwarfing genes in all material to assist with selection of lines with enhanced emergence potential.	

	Genomic selection	With the assistance of Dr. Zhang, we have begun genomic prediction model building in 2015. Lines from the 2015 and 2016 breeding program will be genotyped and added to the model development. We have moved away from using training panels for model development and will now use the breeding program material.	Each year we will continue to phenotype the training panel, add more lines to the training panel (and genotype them), and refine the prediction model	Results are presented through annual progress reports, the research review, field tours, and grower meetings
Genotyping advanced breeding lines	Provide useful information regarding genetic diversity and gene profiles to better estimate crossing potential	In 2015, the advanced germplasm was screened with DNA markers for about 20 traits of interest. This information was used to enhance selection of field tested material, as well as assist in parent cross-combinations to develop populations with desired traits of interest.	This is done annually	Results are presented through annual progress reports, with the outcomes of this research being realized in new cultivars
Greenhouse				Results are presented through annual progress reports, with the outcomes of this research being realized in new cultivars
	Hybridization and propagation	In 2015 we made approximately 1100 crosses which were targeted for herbicide resistance, low rainfall and high rainfall production, and specific gene introgressions. These crosses were advanced to the F2 stage.	This is done annually, with the number of crosses/populations varying	
	Single-seed descent	10 SSD populations were started and are being advanced for herbicide resistance.	This is done annually, with the number of crosses/populations varying	
	Doubled haploid	In 2015 we submitted 100 crosses for DH production. We are advancing roughly 3,000 DH lines in the greenhouse to get enough seed to plant in yield plots in the fall of 2016. We have another 2,000 which are being increased for the first time. More crosses will be submitted in 2016 for DH production.	This is done annually, with the number of crosses/populations varying	
	Trait Introgression	We made crosses to germplasm containing resistance to snow mold, stem rust, stripe rust, end use quality, foot rot resistance, preharvest sprouting, Al tolerance, Ceph Stripe, SBWMV, vernalization duration, and certain herbicides. The populations are being increased in the greenhouse for field selection. Currently there are no markers for many of these genes, although some are in development. The idea was either to select based on field conditions or have populations ready once the markers were identified. These will be planted in 2015 as rows at various locations and stages of development, depending on the trait of interest.	This is done annually, with the number of crosses/populations varying	
Trait assessment				Results are presented through annual progress reports, with the outcomes of this research being realized in new cultivars

	Coleoptile length	All advanced breeding lines are screened and selected for coleoptile length (funded by the Amen Foundation)	Screening and selection will be completed in 2015. Superior lines will be planted in the field and crossed back into the breeding program.	
	Foot rot	Advanced populations are being screened for foot rot resistance. Resistant lines will be used in the breeding program to incorporate this trait through a diversity of backgrounds	Screening and selection will be completed in 2015. Superior lines will be planted in the field and crossed back into the breeding program.	
	Cold Tolerance	All advanced breeding lines are screened for cold tolerance through the USDA funded WGC grant.	Screening and selection will be completed in 2015. Superior lines will be planted in the field and crossed back into the breeding program.	
	Stripe rust	An advanced population was screened for stripe rust resistance and that analysis is now complete. We identified over 20 QTL in PNW germplasm, about half of which appear to be novel. These lines are now being crossed to additional breeding lines and cultivars, and selection will be done with the recently identified markers to incorporate this resistance through a diversity of backgrounds.	Screening and selection will be completed in 2015. Superior lines will be planted in the field and crossed back into the breeding program.	

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