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

Project #: 3193

Progress Report Year: *3 of* 3

Title: Field Breeding Hard White and Red Winter Wheat

Investigator/Cooperators**:** **AH Carter,** KG Campbell, XM Chen, TD Murray

Executive summary: Due to the price of hard red winter wheat being below that of soft white winter wheat, hard red production in the state has been decreasing. Because of this, we have not proposed for release any new hard red cultivars, but instead have let Scorpio begin to gain traction in the state. Scorpio was released in 2019 and commercial seed is available of this line. Scorpio is broadly adapted to many intermediate and high rainfall growing areas of the state, and have very good end-use quality, very good stripe rust resistance, is resistant to Hessian fly, and tolerant of low pH soils. Scorpio was also one of the best performing lines in 2021, indicating the ability to perform even under drought stress conditions. This combination of traits makes it a desirable cultivar for many production areas. We continue to work with seed dealers to make this cultivar available to growers. We will continue to watch the hard red market and in discussion with seed dealers and growers, determine when new cultivars need to be released to enter the market. We have several lines which have been performing well in trials and will continue to evaluate these for release potential. Continued emphasis is placed on selecting breeding lines with superior quality and disease resistance. We also have a strong interest in developing hard lines with excellent emergence capabilities, and continually screen material to this end. Efforts have been initiated and are ongoing to develop hard cultivars with herbicide tolerance (Clearfield and CoAXium systems are our main targets), snow mold tolerance, and aluminum tolerance. We maintain about 10% of the hard material as hard white and apply heavy selection pressure to ensure adapted material is advanced. Some of these hard white lines have been tested under irrigation in Southern Idaho and have performed very well. There is interest to release these lines for production under irrigation in Idaho.

Impact: Sequoia replaced many of the Farnum acres in the state due to its excellent emergence capability and high yield potential under low rainfall and deep planting conditions. Although grown on limited acres, we continue to develop lines with excellent emergence for those regions which need this trait to reduce risk to planting failures under deep planting conditions when moisture is limited. Scorpio is a recent WSU hard red cultivar targeted to high rainfall conditions and will provide growers with a high yielding line with good disease resistance, aluminum tolerance, and Hessian fly tolerance, adapted to PNW growing conditions. Current and future hard red and white lines will continue to lead to a sustainable production of hard wheat in the PNW.

WGC project number: 3193
WGC project title: Development of hard red and white winter wheat
Project PI(s): AH Carter
Project initiation date: July 1, 2009
Project year: 3 of 3

Objective	Deliverable	Progress	Timeline	Communication
Develop hard red and white winter wheat cultivars	New cultivars released for production in WA	In 2019 we released Scorpio, which combines high yield, good protein content, stripe rust resistance, low pH soil tolerance, and Hessian fly tolerance in one line. Seed of Scorpio is being increased by the seed industry and was available in 2021. The line Balance was released in 2020 for production in Montana, as this line shows high yield and very good protein content, and has low pH soil tolerance. Balance is also available to growers in Washington, but testing suggests Scorpio would be the better selection for Washington. No new hard red lines were released in 2021 given the decreased interest in hard red lines due to declining price. We had over 2,000 plots and 8,000 rows of hard material under evaluation at various stages of the breeding process for 2021. Some hard white winter lines have been submitted for testing in Southern Idaho and have had very good performance under irrigated conditions. These continue to be evaluated for release potential. Focus has also been on developing lines with herbicide tolerance.	Each year we evaluate germplasm at each stage of the breeding process. Each year lines are entered into statewide testing for final release consideration. A cultivar is released, on average, every two years.	Progress is reported through field days, grower meetings, commission reports, popular press, and peer-reviewed manuscripts, and through the annual progress reports
	Agronomic traits	Field trials and agronomic data was conducted and collected at 15 locations in 2021. This includes emergence, winter survivability, heading date, test weight, plant height, and grain yield. Our Kahlotus and Ritzville trials gave a very good screen for emergence potential in 2021. Our snow mold locations gave a good rating of snow mold tolerance. All other locations had very good stand establishment and we are looking forward to a good year of screening the germplasm.	Evaluation is done annually at multiple locations across the state.	In 2021 we communicated results of this project through the following venues: 21 peer-reviewed publications; 1 virtual field day recordings; 4 field day abstracts; various field days and grower interactions; 8 poster presentations; 1 popular press interviews; 1 podcasts; 2 grower meeting presentations; and 4 seed dealer presentations;
	Biotic and Abiotic stress resistance	Lines were screened for snow mold, stripe rust, eyespot foot rot, nematodes, Cephalosporium stripe, SBWMV, Hessian fly, and aluminum tolerance.	Evaluation is done annually at multiple locations across the state.	

	End-use quality	All breeding lines with acceptable agronomic performance in plots were submitted to the quality lab. Those with acceptable or better milling characteristics were advanced to baking trials. Data should be back in early-2022. Lines with inferior performance will be discarded from advancement. We screened nearly 500 early generation lines for end-use quality in 2021.	Each year, all head rows are evaluated for end-use quality and lines predicted to have superior quality advanced. Each yield trial is submitted for quality evaluations and those with high performance are advanced in the breeding process.	
	Herbicide resistance	Trials were conducted in Lind, Walla Walla, Prescott, and Pullman for herbicide resistance. The hard red material had a lower priority for development when we started compared to the soft white germplasm, but we now have multiple populations and advanced lines being tested. Crossing has been initiated to incorporate novel herbicide resistance into hard red lines.	Evaluation is done annually at multiple locations across the state	Advanced hard red lines with herbicide tolerance are in final stages of testing for release consideration.
Field test adapted germplasm with novel genes introgressed for essential traits	Incorporation of novel genes into adapter germplasm for evaluation under WA environments			Progress is reported through field days, grower meetings, commission reports, popular press, and peer-reviewed manuscripts, and through the annual progress reports
	Rht genes	Populations have been developed and are under field evaluation for Rht1, 2, and 8.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	
	Stripe rust genes	Multiple different stripe rust resistance genes have been introgressed into our germplasm which are under evaluation in Mount Vernon, Central Ferry, and Pullman. We have also started mapping populations to find markers linked to these genes.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	
	Foot rot genes	Pch1 has been selected for and is under evaluation in field trials in Pullman.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	
	SBWMV	Crosses are initiated and being evaluated for resistance to SBWMV, mainly first through marker analysis and then under field trials in Walla Walla.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	
	Herbicide tolerance	Hard red lines with herbicide tolerance are being developed in both the Clearfield and CoAXium systems. Populations are first screened in the greenhouse, then transitioned to field testing.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	

	Hessian fly tolerance	With the identification that Scorpio was tolerant to Hessian fly, we have been able to go into our crossing block and find crosses and populations with Scorpio as a parent to begin making selection. These lines will be screened at the University of Idaho as part of the Hessian fly proposal. One additional line, WA8368, has been identified as having Hessian Fly tolerance.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS. Screening will be done through project #3674	
	GPC-B1 and Bx7oe	These two genes have been incorporated into many hard breeding lines. These are being tested for agronomic performance in the field. Some lines have already been returned to the breeding program as parents for additional crosses.	Crosses made through the project #5195 will be evaluated under field conditions upon MAS.	

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