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

Project #: GR00012238

Progress Report Year: *3 of* 3

Title: Field Breeding Soft White Winter Wheat

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

Executive summary: Production of soft white winter wheat is an important commodity in Washington to meet the growing demand. High and consistent production with good end-use quality is needed to keep wheat an economical option. This project aims to develop soft white winter wheat cultivars with high and stable agronomic performance, tolerance to biotic and abiotic stresses, and meet consumer demand for end-use quality attributes. Field testing in many diverse locations allows us to evaluate performance and make selections for these traits. This project has developed many soft white wheat cultivars which have helped support production in Washington. Most notable of those in current production are Piranha CL+, Stingray CL+, and Sockeye CL+.

Introduction: There are many production constraints to growing wheat in the state of Washington. Diverse climactic regions alter cropping system approaches and enhance abiotic stresses. These regions also vary for their prevalent diseases, which continue to spread throughout the state and chance race structure. New diseases are always on the threat of being introduced into the region. Annual climate variations can take growers from the best production year to the worst production year in a matter of months. Given all these difficulties, developing cultivars which can mitigate production concerns is an effective way to maintain high economic returns on wheat.

Approach: Due to the diversity of production constraints in Washington, the breeding program is set up to evaluate breeding lines in multiple locations for multiple traits. Efforts of other funded projects create diverse breeding populations containing the traits needed for Washington production. These lines are evaluated at over 18 locations in Washington to evaluate their agronomic performance. Furthermore, locations are used to screen to diseases such as snow mold, stripe rust, and foot rot. Additional screening locations are present for low pH soil tolerance. Other traits are screened for either in the greenhouse or through marker selection. Focus is put on broadening the germplasm base, by continuing to select more lines for traits such as SBWMV, Hessian fly tolerance, and Cephalosporium stripe. Agronomic traits are selected in a diverse set of locations to evaluate high and stable grain yield, crop maturity, and emergence from deep planting, among many other traits. All this data culminates into the selection of breeding lines for advancement in the program and ultimately released as new cultivars.

Results: The year 2023 provided many opportunities in the program to evaluate materials under diverse climactic regions throughout Washington. The continued advantage of evaluation of lines in contrasting years allowed us to view material under very different climatic conditions

and identify varieties that continue to perform well under this variation. Genomic selection has helped improve selection ability of field tested material. Many lines in the program able to perform well under diverse climate conditions were advanced in the breeding program. Several of these lines were also prepared for Breeder seed production in Othello. Nova AX, a soft white winter wheat carrying the AXigen trait used in the CoAXium system was released in 2023 and all Foundation seed was sold. We continue to evaluate Clearfield and CoAXium lines in the program, with an increased focus on improving tolerance, improving disease resistance, and improving agronomic traits and diversity. The breeding programs continues to maintain a high number of lines within testing at all levels of the program. Breeding populations are produced under single-seed descent, and then transferred to single row field testing for further selection. We continue to have multiple locations where yield testing occurs, along with numerous sites dedicated to testing stress resistance such as snow mold, stripe rust, and low pH soils. A long winter in Douglas county produced good snow mold ratings, although at one location is was so severe the trial needed to be abandoned. In 2023 two new soft white wheat lines were approved for release, Rollie and Windust. These recent releases all have high grain yield, good disease resistance, and good end-use quality. We anticipate additional releases in 2024 of lines which performed well over the past years of testing and continue to fit into multiple cropping systems in Washington. Existing releases continue to be commercially produced and we work closely with growers and seed companies to identify new traits needed in upcoming lines to meet production demands.

Figure 1 Nova AX in Foundation Seed production near Pasco, WA.

Impact: Traditionally, over 85% of the wheat crop in Washington is soft white wheat. Even very small reductions of required grower input and/or increases in productivity can mean millions of dollars to the growers, grain trade, and allied industries. By providing genetic resistance to diseases and increasing agronomic adaptability, input costs will be reduced and grain yield increased. WSU soft white cultivars are grown on approximately 34% of the acres in 2023. These include Piranha CL+, Stingray CL+, Sockeye CL+, Curiosity CL+, Devote, Otto, Resilience CL+, and Pritchett, along with the collaboratively released cultivar Castella. Many of these lines were again planted for production in 2024. Newly released Nova AX was in high demand and all Foundation seed of the variety was sold upon release. Nova AX combines broad adaptability, high grain yield, excellent end-use quality, and is approved for use in the CoAXium wheat production system.

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WGC project title: Field Breeding Soft White Winter Wheat
Project PI(s): AH Carter
Project initiation date: July 1, 2021
Project year: 3 of 3

Objective	Deliverable	Progress	Timeline	Communication
Develop soft white winter wheat cultivars	New cultivars released for production in WA	We released the soft white lines Otto, Jasper, Puma, Purl, Stingray CL+, Devote, Piranha CL+, Sockeye CL+, Jameson, Inspire, Rollie, Windust, and Nova AX. Collaborative releases include Curiosity CL+, Mela CL+, Resilience CL+, Pritchett, ARS-Castella, and ARS-Cameo. Our CL+ lines have shown excellent grain yield over multiple years and are widely grown. Newly released Nova AX has has interest from growers and all the Foundation seed has been sold. We have multiple breeding lines in statewide testing for consideration of release, many of which had excellent performance in 2022 and 2023. We have over 20,000 plots and 30,000 rows of soft white material under evaluation at various stages of the breeding process.	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 will be reported through field days, grower meetings, commission reports, annual progress reports, Wheat Life articles, and peer-reviewed manuscripts
	Agronomic traits	We have 18 locations across the state representing diverse climatic zones in which advanced breeding lines are evaluated for agronomic characteristics. An additional six have been added through collaborative testing. Early generation material is selected for in Lind and Pullman. This year we moved all DH and SSD production to initial 4-row selections due to the ability to screen for important traits such as emergence and stripe rust, along with our snow mold screening in Waterville.	Evaluation is done annually at multiple locations across the state.	In 2023 we communicated results of this project through the following venues: 8 peer-reviewed publications; 2 field day abstracts; various field days and grower interactions; 2 poster presentations; 3 popular press interviews; 1 podcasts; 1 grower meeting presentations; and 4 seed dealer presentations;
	Disease resistance	Disease resistance is recorded on our 18 breeding locations when disease is present, with certain locations being selected specifically for disease pressure (Waterville for snow mold, Pullman for stripe rust, etc.). Additional locations are planted in cooperation with plant pathologists to screen other diseases of importance in WA.	Evaluation is done annually at multiple locations across the state.	

	End-use quality	All SSD/DH and greater material is subjected to end-use quality screens to evaluate performance. Lines with poor quality are discarded from the breeding program and from selection in 2023.	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	Multiple soft white lines have been developed for herbicide resistance and are being evaluated under replicated trials across the state. We have multiple Clearfield lines, advanced lines in testing for the CoAXium system, and novel traits are being incorporated into germplasm and field tested through collaboration with Dr. Ian Burke.	Evaluation is done annually at multiple locations across the state.	
Introgress novel genes for essential traits	Incorporation of novel genes into adapted germplasm for evaluation under WA environments			Progress will be reported through field days, grower meetings, commission reports, annual progress reports, and peer-reviewed manuscripts
	Rht and photoperiod genes	Crosses have been made to include non-traditional Rht and photoperiod genes into our soft white winter wheat germplasm for testing under PNW conditions.	Crosses made through the project GR00012235 will be evaluated under field conditions upon MAS.	
	Stripe rust genes	We constantly have material coming out of the MAS program for stripe rust. In 2023 we evaluated multiple populations in both early and preliminary yield trials, with very good screening conditions. Focus is on pyramiding all-stage and adult-plant resistance	Crosses made through the project GR00012235 will be evaluated under field conditions upon MAS.	
	Foot rot genes	We have many populations being screened for foot rot resistance. Both Phc1 and Pch2 are being evaluated. Field evaluations of these selections are done in collaboration with Dr. Campbell.	Crosses made through the project GR00012235 will be evaluated under field conditions upon MAS.	
	Cephalosporium	No markers are currently being used for this introgression. All selection is being done under field conditions. We recently made many crosses to resistant material and are now field screening them for selection of resistant material.	Evaluation were done in field locations in WA in 2023	
	Aluminum tolerance	Field screening of breeding lines for aluminum tolerance is being conducted under field conditions. We recently made many crosses with material that was aluminum tolerant. Genes for aluminum tolerance are being backcrossed into multiple backgrounds.	Evaluation were done in field locations in WA in 2023	

	Hessian Fly	Populations with new sources of resistance to Hessian Fly were screened in yield trials field conditions. Selections made had previously been confirmed resistant to Hessian fly. Many lines were selected for good agronomic features and are being further evaluated under field conditions at additional locations.	Populations were advanced in 2023 under yield trials. Additional field screening at more locations will be conducted in 2024.	
	Nematodes	Nematode screening has been done in collaboration with Dr. Paulitz and Dr. Campbell.	Lines with resistance continue to be advanced in the breeding program.	
	Other traits	Genes of interest to production regions in the PNW are being introgressed into soft white winter backgrounds. Upon completion, lines are tested for performance in Washington to being developing adapated germplasm in the SWW market class for production in Washington	Evaluation is completed once lines are produced from project GR00012235	
	End-use quality	Lines are continually screened for end-use quality. We submitted an additional 10 lines for statewide testing to begin generating quality scores prior to release decisions.	Validated genomic prediction models were available for selection in 2022.	

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