

Washington Grain Commission
2023 Wheat and Barley Research Annual Progress Reports and Final Reports
Project #: 3163

Progress Report Year: __2__ of __3__ (*maximum of 3 year funding cycle*)

Title: ***Greenhouse and laboratory efforts for spring wheat variety development***

Cooperators Mike Pumphrey, Josh DeMacon, Sheri Rynearson, Wycliffe Nyongesa, Vadim Jitkov

Executive summary Spring wheat varieties with high yields, good grain traits, complex stripe rust resistance, Hessian fly resistance, aluminum tolerance, superior end-use quality, and broad adaptation benefit Washington wheat producers by adding millions of dollars to annual returns. This project supports core efforts of the WSU Spring Wheat Breeding program by providing funding to make crosses and develop breeding populations in the greenhouse, staff support for management and selection of breeding materials in the field and greenhouse, and supports/enables the most effective end-use quality selection procedures for development of superior Washington spring wheat varieties. In addition to routine early-generation grain quality selection carried out through this project, we apply DNA marker technology to elite breeding materials, and conduct research projects and germplasm development of direct relevance to our breeding efforts. This project also supports our two-gene Clearfield and AXigen breeding efforts, Fusarium head blight resistance gene introgression, Hessian fly resistance gene introgression, and expanded irrigated hard red spring wheat breeding efforts. Our progress in each of these areas is consistent, and these outputs continue to shape our overall breeding efforts and directly contribute to variety release and on-farm profitability.

Introduction Our release of top-yielding spring wheat varieties continues to be of substantial economic benefit to growers in Washington. The consistency, broad adaptation, disease and pest resistances, aluminum tolerance, sound grain traits, most desirable end-use quality, good falling numbers, and overall performance of these varieties reflect the outputs of comprehensive wheat breeding and genetics research efforts. Each new WSU variety released under Pumphrey's leadership has most desirable quality, is top yielding, pest and disease resistant, and has been accepted and adopted by seed dealers and farmers. Two new releases/Foundation seed increases were advanced in 2023. The first is a top-performing club spring wheat variety that is the first spring club to have

Hessian fly resistance: ‘Roger’. ‘Hale’ is a broadly adapted hard red spring wheat with excellent yield, disease resistance, Hessian fly resistance, quality, and slightly higher protein than our current top-end yielding dryland varieties. Hale has the highest two and three-year average yields across all precip zones and was a top performer in 2023.

Approach

- 1) Conduct greenhouse operations required for variety development, including crossing, doubled haploid development, generation advancement, and seedling assays such as herbicide screening, and stripe rust screening.
- 2) Apply genome-wide DNA markers for genomic selection and enrich specific breeding lines by marker-assisted selection with stripe rust resistance, Hessian fly resistance, high end-use quality, aluminum tolerance, and Clearfield™ and Axigen herbicide tolerance as well as other traits when desirable.
- 3) Select early-generation breeding lines with good end-use quality potential by eliminating inferior breeding lines prior to expensive and capacity-limited yield tests.

Impact

In 2023, 97% of all Washington soft white spring wheat acres were planted to varieties from the WSU Spring Wheat Breeding Program, and 80% of all spring wheat acres. Continued genetic gain and regular variety replacement of this important rotation crop are key to supporting farm economics, efficient use of resources, and maintaining and expanding wheat markets.

WGC project number: 3163
WGC project title: Greenhouse and laboratory efforts for spring wheat variety development
Project PI(s): Mike Pumphrey
Project initiation date: 1-Jul-22
Project year (X of 3-yr cycle): 3 of 3 year cycle

Objective	Deliverable	Progress	Timeline	Communication
Apply genome-wide and specific DNA markers to select breeding lines for numerous quantitative and qualitative traits.	Elite variety candidates will result, in part, due to these molecular selection activities. These breeding populations will be ideal for marker optimization, new genetic mapping studies, and potentially the basis of new competitively funded projects.	Axigen trait introgression continued, and we have made BC4 and BC5-derived doubled haploid breeding lines with this new herbicide tolerance to date. We have developed new DNA markers for a previously undocumented Hessian fly resistance locus that allow us to track resistance in most of our germplasm for the first time. KASP assays have been developed. One new variety was fast-tracked for variety release consideration in 2024 based on marker-assisted selection and other selection efforts through this project.	Activities are cyclical and occur annually throughout the normal breeding cycles.	Pumphrey will attend/present at numerous WSU field days, workshops/meetings, PNW wheat Quality Council, WSCIA Annual Meeting, WSCIA Board Meetings, WA Grain Commission meetings, industry tours.
Select early-generation breeding lines with good end-use quality potential by eliminating inferior breeding lines prior to expensive and capacity-limited yield tests.	Elimination of lines with inferior end-use quality. This ensures only lines with acceptable end-use quality are tested in the field and maximizes efficiency in field operations. Current analyses include: NIR-protein, NIR-hardness, SKCS-hardness, SDS micro-sedimentation, PPO, and micro-milling.	Another year of selection was successfully completed in 2023, with approximately 3000 lines evaluated through the various quality tests. Additional DNA markers for priority traits including test weight were tested and validated for use in our breeding materials. Approximately 1500 lines per year are being genotyped with genome-wide markers for genomic selection.	Return on investment is realized each year, since lines with poor end-use quality are not tested in expensive and capacity-limited field tests. This allows for additional yield testing of lines with good end-use quality and more efficient variety development.	
Conduct greenhouse operations required for variety development, including crossing, doubled haploid development, generation advancement, and seedling assays such as herbicide screening, and stripe rust screening.	Lines for field testing that contain desirable and novel characteristics. This is where new varieties are born. Greenhouse operations also allow more rapid breeding cycles by advancing F1 and F5 generations every year as part of our routine breeding efforts. Seedling evaluation of stripe rust resistance and herbicide tolerance screening are also major greenhouse activities.	We continued to use the expanded greenhouse space to our advantage to increase breeding and research materials, make crosses, and conduct experiments.	Greenhouse multiplication and crossing is completed annually, including two large crossing blocks and thousands of breeding lines advanced.	