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

Project #:	**3163**
Progress Report Year:	___3_ 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.

Impact:

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. Over the past six years Ryan, Seahawk, Tekoa, Melba, Hedge CL+, Net CL+, Alum, Chet, and Glee have been widely multiplied and/or grown across Washington. Each variety has most desirable quality, is top yielding, pest and disease resistant, and has been accepted and adopted by seed dealers and farmers. Our wheat varieties occupied 80% of total Washington spring wheat acres in 2021 and our soft white spring wheat releases were planted on 95% of acres in this dominant class. All soft white, club, and hard red spring wheat varieties released by the program under Pumphrey's leadership are rated as "Most Desirable" quality. Thus, at least 80% of 2021 spring wheat acres in Washington were most desirable.

Two new releases/Foundation seed increases were advanced in 2021. The first is a top-performing club spring wheat variety that is the first spring club to have Hessian fly resistance:

WA8325 (‘Roger’). Roger two-year average yields in 12-16, 16-20, and >20 inch precipitation areas is comparable to the highest yielding soft white spring wheat varieties. ‘Hale’ (WA8315) 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 locations and was a top performer in the highly stressful 2021 trials.

Outputs and Outcomes: File attached

WGC project number: 3019 3163
WGC project title:Greenhouse and laboratory efforts for spring wheat variety development
Project PI(s): Mike Pumphrey
Project initiation date: 2019
Project year: 3 of 3

Objective	Deliverable	Progress	Timeline	Communication
Develop DNA markers and select breeding lines by marker-assisted selection with stripe rust resistance, Hessian fly resistance, and two-gene Clearfield™ herbicide tolerance as well as other traits when desirable.	Elite variety candidates will result, in part, due to these molecular selection activities. Many of these 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 materials 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. Two new varieties were released based on marker-assisted selection and other selection efforts through this project.	Activities are cyclical and occur annually throughout the normal breeding cycles. 2021 work was completed on schedule.	Pumphrey attended/presented at numerous virtual WSU field days, workshops/meetings, PNW wheat Quality Council, WSCIA Board Meetings, WA Grain Commission meetings, industry tours. A Wheat Life article was written/contributed in 2021.
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 succesfully completed in 2021, with approximtaely 3000 lines evaluated through the various quality tests. Markers for PPO and waxy alleles were validated and applied to breeding materials.	Return on investment is realized each year, since lines with poor end-use quality are not tested in expensive and capacity-limited yield tests. This allows for additional yield testing of lines with good end-use quality and more efficient variety development.	PNW preferred varieties brochure lists all releases as Most Desirable Quality.
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 characterisitcs. 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 of our routine breeding efforts. Seedling evaluation of stripe rust resistance and herbicide tolerance screening are also major greenhouse activities.	We continue to use the expanded greeenhouse space to our advantage to increase breeding and research materials, make crosses, and conduct experiments. COVID-19 has some, but minor impact on our ability to conduct this day to day work.	Annual greenhouse multiplication and crossing completed in 2021, including two large crossing blocks and backcrossing and MAS for Hessian fly, herbicide tolerance, and numerous other markers	Several greenhouse tours led in 2021.