

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

**PROJECT No.: 30109-6601**

**Progress report year:** *1 of 3 (maximum of 3 year funding cycle)*

**Title: CLUB WHEAT BREEDING**

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**Executive summary:** The new club wheat cultivar, Pritchett, jointly developed by the USDA-ARS and WSU winter wheat breeding programs, was released in 2015, because of its superior agronomic productivity in the targeted region, and superior end use quality combined with resistance to multiple diseases and abiotic stress. Breeder seed of this cultivar was produced in Moses Lake in 2016.

The USDA-ARS Wheat breeding program managed field testing locations at Central Ferry, Lind, Harrington, Pullman, and Farmington WA and at Pendleton OR and Genesee ID. We also evaluated breeding lines at Walla Walla, St. Andrews, Mansfield, Ritzville, and Kahlotus, WA and Corvallis OR in collaboration with the WSU Winter Breeding program, the WSU Cereal Variety Testing Program, OSU-CBARC, the OSU Wheat Breeding program, the University of Idaho and Syngenta. The overall goal of this project has been to remove the agronomic constraints that make club wheat less attractive to growers than soft white wheat.

We focused club wheat development on two major goals: 1) Development of competitive club wheat cultivars for the < 15 inch rainfall zone with excellent resistance to snow mold, eyespot, stripe rust, sprouting and good emergence and winter hardiness and 2) Development of competitive early maturing club wheat for the > 15 inch rainfall zone with excellent resistance to eyespot, cephalosporium stripe, stripe rust, aluminum toxicity and good straw strength, and excellent test weight.

The club wheat ARS Crescent is a complement to Pritchett in the higher rainfall regions. In the 2016 WSU Cereal Variety Trials, ARS Crescent was the second highest released cultivar in the >20 in. precipitation region. ARS Crescent yielded 107%, 97%, 103% and 99% of the trial averages in the >20, 16-20, 12-16, and <12 inch rainfall zones, respected. ARS Crescent maintained acceptable falling numbers in almost all environments in 2016 and has achieved stable high performance across rainfall zones over multiple years. New club wheat breeding lines have been highly competitive with soft white wheat cultivars in multiple rainfall zones during the past three harvest seasons. The breeding line ARS20060123-31C, is being purified in head rows for possible release in 2018 targeted as an early maturing club wheat with good performance, stripe rust resistance, aluminum tolerance and tolerance to low falling numbers.

For the 2017 WA State Extension trials for the dry rainfall zones, we entered two lines: ARS20060123-31C (was in the 2015-16 trials) is derived from a cross between NY89066-7131/B980696//CHUKAR; a tall, early maturing, awnless club that has been very resistant to

stripe rust in USDAARS trials;

ARSDH08028-111C, is a new entry for 2017 derived from a cross between Cara/Xerpha, an awned club that has performed well, where Xerpha is adapted but with better adult plant resistance to stripe rust and excellent milling quality.

For the 2017 WA State Extension trials for the high rainfall zones, we entered two lines: ARSDH08028-44C is an awnless club and new entry for 2017 derived from the Cara/Xerpha cross with excellent stripe rust resistance and moderately early maturity that has performed well in early maturing and higher rainfall regions.

ARS20040150-2C is also a new entry for 2017 derived from a cross between Chukar/Cayuga/2\*Chukar. Cayuga is a source of preharvest sprouting resistance from NY. This entry was selected to have that resistance. We still need further testing to confirm but the line has performed well on the Palouse with good stripe rust resistance and maturity similar to Chukar.

These club breeding lines are all products of crossing with soft wheat from the Eastern US as additional sources of resistance to rusts, Hessian Fly and BYDV. We have added an additional head row purification and selection step to the breeding program in order to provide Washington Foundation Seed with quality Breeder seed in a timely manner.

We have greatly expanded our use of genotyping and are in the process of genotyping all our the entries in all of our yield trials using the genotyping by sequencing (GBS) procedure in the USDA Western Small Grains Genotyping laboratory. We are implementing genomic selection for end use quality and cold tolerance. Marker assisted selection using KASP and SSR markers was used to select for resistance to Preharvest sprouting, BYDV, eyespot, stripe rust and for dough strength.

We evaluated several hundred doubled haploid lines in disease nurseries and unreplicated trials and have advanced several to our Elite replicated trials. Early generation quality testing using the Micro-mill, the polyphenol oxidase assay, and solvent retention capacity tests was performed on all early generation selections in order to continue to maintain and improve club wheat milling quality. Coleoptile testing and survival from freezing was assayed on all breeding lines. All breeding lines were selected for resistance to stripe rust, eyespot, cephalosporium stripe, and Fusarium in inoculated nurseries.

### **Impact**

Club wheat acreage represents a small but significant part of the total WA wheat market. The excellent disease resistance of the club wheat is a built-in premium for growers because the reduced need for fungicides. Because of their disease resistance, club wheat cultivars have been used to incorporate stripe rust resistance and eyespot resistance into other wheat classes. The combination of excellent end use quality, disease resistance, and cold tolerance of new club wheat cultivars allows growers to make planting decisions based on market demands and to maximize choice in marketing strategy. The club wheat breeding program works collaboratively with several other WGC funded projects including the Winter and spring wheat breeding

projects, the disease resistance and quality projects, and the drought and preharvest sprouting projects to integrate their results and methods into production of quality cultivars for PNW growers.

#### **D. Communication**

##### **Presentations:**

- a. Report of Progress: Washington Grains Commission Research Review, “Club Wheat Breeding”, Pullman WA, Feb. 2016.
- b. Plot and field day tours speaking to approximately 15-30 growers and industry representatives per tour during June, 2015: Reardan WA.
- c. Invited by Planning Committee, Edgar Mcfadden Symposium to speak on, "Learning from the Daleks and the Silurians to Control Stripe Rust in the Great Plains" at Joint Edgar McFadden Symposium-Hard Winter Wheat Workers Workshop, April 19, 2016. San Antonio TX

##### **Refereed manuscripts with applications to this project.**

1. **Garland-Campbell, K.**, Carter, A.H., Jones, S.S., Chen, X.M., DeMacon, P., Higginbotham, R., Engle, D., Guy, S.O., Mundt, C.C., Murray, T.D., Morris, C.F., See, D., 2017. Registration of “Pritchett” Soft White Winter Club Wheat. In press
2. *Gizaw, S.A., Garland-Campbell, K.*, Carter, A.H., 2016. Evaluation of agronomic traits and spectral reflectance in Pacific Northwest winter wheat under rain-fed and irrigated conditions. *Field Crops Res.* <http://dx.doi.org/10.1016/j.fcr.2016.06.018>
3. *Gizaw, S.A., Garland-Campbell, K.*, Carter, A.H. 2016. Use of spectral reflectance for indirect selection of yield potential and stability in Pacific Northwest winter wheat. *Field Crops Res.* Available online 21 July 2016. <http://www.sciencedirect.com/science/article/pii/S0378429016302088>
4. **Garland-Campbell, K.**, 2016. Errors in Statistical Decision Making. Chapter 2, In Glaz, B and K. M. Yeater, (eds). *Applied Statistics in Agricultural, Biological and Environmental Sciences.* American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. Madison, WI. Peer reviewed, invited chapter, IN PRESS

##### **Popular Press:**

**WGC project number:** 3019-6601  
**WGC project title:** Club wheat breeding  
**Project PI(s):** Kimberly Garland-Campbell and Arron Carter  
**Project initiation date:** 7/1/16  
**Project year:** 1

Objective	Deliverable	Progress	Timeline	Communication
1. Develop agronomically competitive club wheat cultivars targeted to the diversity of rainfall and production zones of the PNW. These cultivars will possess the excellent end use quality characteristic of club wheat. They will also possess excellent resistance to stripe rust. Specific other characteristics will be targeted to individual rainfall regions.	Club cultivar releases	The club wheat cultivar Pritchett is on increases as Foundation seed. The breeding line ARS20060123-31C is being purified in head rows for possible release in 2018.	Sept 2016-June 2019. Cultivar releases are targeted as one every three years per rainfall zone.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.
2. Develop club breeding lines for the <15 inch rainfall zone with improved resistance to snow mold and fusarium crown rot , improved emergence and winter survival	Germplasm identified with resistance, used to introgress new resistance genes into existing club wheat germplasm. Better combination of traits in club wheat targeted to the <15 in rainfall zone	ARS20060123-31C and ARSDH08028-111C were entered into the 2017 Washington variety trials targeted to the < 15 inch rainfall zone.	Sept 2016-June 2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.
3. Develop club breeding lines for the > 15 inch rainfall zone with improved resistance to eyespot, cephalosporium stripe, aluminum toxicity, and cereal cyst nematodes.	Germplasm identified with resistance, used to introgress new resistance genes into existing club wheat germplasm. Better combination of traits in club wheat targeted to the >15 in rainfall zone	ARSDH08028-44C and ARS20040150-2C were entered into the 2017 Washington variety trials targeted to the > 15 inch rainfall zone	Sept 2016-June 2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.

4. Release a club wheat cultivar with early maturity targeted to SE Washington and NE Oregon.	Club wheat cultivar with early maturity (2-5d earlier than Pritchett) combined with excellent stripe rust resistance.	Head rows were planted in Pendleton in the fall of 2016 so that early generation selections can be made in that environment.	Sept 2016-June 2019. Our next club wheat release after Pritchett will be targeted to this growing environment	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.
5. Release germplasm with improved resistance to preharvest sprouting	Club wheat Breeding lines with stable falling numbers above 300 in all but extreme environments.	ARS Crescent has improved resistance to low falling numbe. ARS20040150-2C was selected for improved resistance to preharvest sprouting.	Sept 2016-June 2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.
6. Identify an early generation method to assess cake baking quality	Early generation prediction equation for cake baking quality, the key trait for club wheat.	Association mapping and genomic selection for improved baking quality is underway.	Sept 2016-June 2019.	Presentation at grower meetings, Wheat commission meetings, field days, plot tours, Wheat Life and Research Review.