Project #: GR000010090. AWD 004416

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

Title: *Club wheat Breeding*

Cooperators: *Arron Carter, Michael Pumphrey*

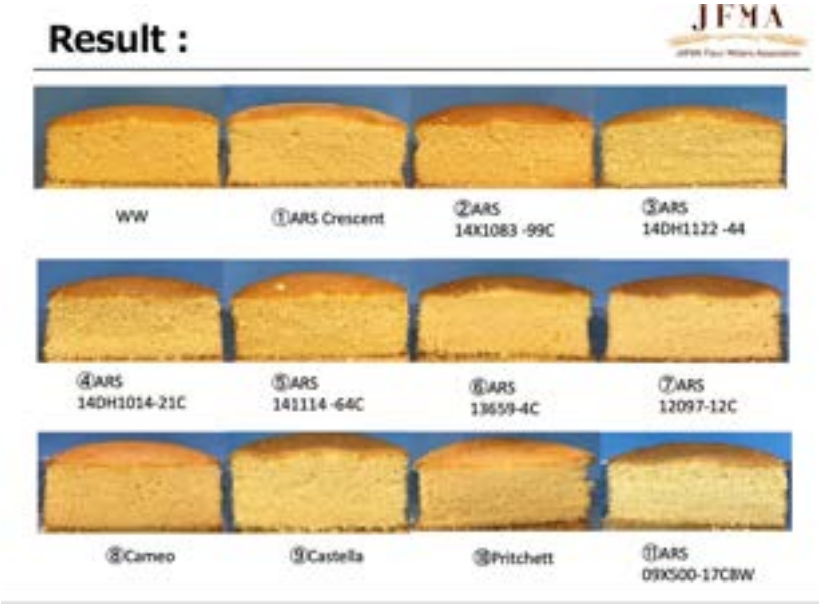
Executive summary: Registered seed of Cameo club wheat was harvested in 2023. Cameo is targeted to the higher rainfall production region with better agronomic performance than other clubs in trials on the Palouse, better stripe rust resistance than ARS Crescent, and tolerance to eyespot, soilborne wheat mosaic virus, acid soils and Hessian fly. In addition, a club-COAX trial was planted at Hartline WA with breeding lines that were created by the WSU Winter wheat program. In the fall of 2023, we expanded our testing in the traditional club wheat growing area with new yield trials at Hartline with cooperator Ryan Poe and Almira with Highline Grain. We now have trials at 12 locations in Washington, Idaho, and Oregon.

Introduction: Club wheat is a superior quality product with an established demand that is uniquely grown commercially in the Pacific Northwest (PNW) of the US. Club wheat has a market in Japan and other countries in Asia. A premium is often required for the product because of the limited supply. In the market, club wheat is mixed in a 10-20% blend with PNW soft white wheat and sold as Western White. Club wheat has been selected to have soft textured flour with high flour milling extraction and clean separation from the bran, desired for fine-textured baked projects. Club wheat is remarkable for its consistent functionality, achieved by few other wheat classes, because most cultivars are developed from a single breeding program, the USDA-ARS program based in Pullman. This project is critical to meet the demand for new club wheat varieties that are agronomically competitive with alternatives market classes.

Approach: Each year approximately 300 crosses are made at the WSU plant growth facility for club wheat improvement. The best lines in the USDA club wheat program are intercrossed to combine traits and crosses are also made to lax soft wheat from the PNW and other regions for genetic diversity. Initial generations are advanced to the F4 using 'mini-bulks' in the PGF which enables us to select for club head type. Field selection in head rows is conducted for plant type and disease resistance. Marker assisted selection and selection for end use quality is initiated at this stage. The best 10% of those selections are entered in yield plots at Pullman and Lind and then at multiple locations. Genomic selection is incorporated in decisions at this point. In 2023 we expanded our testing footprint in the traditional club growing area of central WA. We now evaluate elite trials, comprising 96 entries, at 12 locations.

Results: In 2023, the breeding lines, ARS12097-12C and ARS15X1460-8CBW were entered into the < 16 in. rainfall zone winter wheat variety trials in WA; ARS09X500CBW and ARS14X1114RS-3CBW were entered into the >16 in rainfall zone nurseries. ARS09X500CBW was proposed for release but it was decided to hold it so that our last release 'Cameo' could find its place in the market. We evaluated 79 IMI-resistant breeding lines in yield trials at Lind and Spillman and in sprayed trials at Lind. These lines were derived by crossing our best quality club wheats with Piranha CL+, Stingray CL+ and an Oregon CL+ breeding line and 37 or these

were advanced to our multilocation trials at 12 locations. We evaluated resistance to snowmold, stripe rust, eye spot, and aluminum in dedicated stress trials and evaluated resistance to Cephalosporium stripe in collaboration with Chris Mundt at OSU, Brett Carver at OK State. We rated our upper-level breeding lines for tolerance to alpha amylase using the Phadebas enzyme assay in collaboration with the Steber and Thompson labs. Our mid-level breeding lines were evaluated for cold tolerance using the artificial freeze test. We sent 12 samples to the Japanese Flour Millers Technical Exchange for full mill and bake analysis. These included a sample of Western White and ARS Crescent, Cameo, Castella ad Pritchett as checks. All samples met expectations and several scored better than the ARS Crescent check for Mill score, cake volume, and mouthfeel texture (see figure).



Impact: Club wheat represented 4% of total soft white wheat production in Washington in 2023, comprising 75,373 acres for winter club and 8,890 acres for spring club. Castella was planted on 32,147 acres, and Pritchett on 33,828 acres. ARS Crescent (8,089 acres) and Coda (1,310 acres). All of these lines were released by the USDA breeding program, with the support from this project.The spring clubs are created by the WSU Spring wheat breeding program. Hedge Cl+ was on 3462 acres, JD on 3072, and 'Melba' on 2,357 acres. Club wheat production is sensitive to the carryover and premium. The current premium is between $0.25 and $0.50 per bushel, which is closer to sustainability for club wheat purchases than the premiums over $1.00 that we experienced in 2021. When the premiums are high, the markets shift to other classes. This means that our club wheat crop remains competitive in the field and desired by our primary customers which provides market alternatives for wheat growers in the Pacific Northwest.

Communication:

WGC Research Review, Feb 15, 2023
Plot tour, Pullman June 28, 2023
Japanese Trade Team, Aug 14, 2023
Wheat Academy, Dec 12, 2023

WGC project numb GR000010090 AWD 004416
WGC project title: Club wheat Breeding
Project PI(s): Kim Garland-Campbell, Arron Carter
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Project year (1 of 3-yr cycle): 2

Objective	Deliverable	Progress	Timeline	Communication
Club wheat cultivar development	New populations for club wheat production. Club wheat breeding lines evaluated in nurseries for disease resistance, agronomic performance and end use quality. New club wheat breeding lines tested in regional and state variety nurseries. New club wheat cultivars released.	Four club wheat breeding lines entered into 2023 winter wheat variety trials. IMI-club breeding lines selected for agronomic performance at Spillman and Lind WA and advanced to multi-location testing in 2024. Registered seed of Cameo club wheat produced. The Japanese Flour Millers Association evaluated 10 club wheat samples including advanced breeding lines and found them to be acceptable and of good quality. In 2024, we decided to add two locations in the dryer 'traditional' club wheat growing region, Hartline adn Almira. We discontinued our trails at Walla Walla.	2022-2025	Presentation at grower meetings, Wheat commission meetings, Wheat Life and Research Review. Published on WSU small grains Web-site
Development of high quality club wheat germplasm with resistance to low Falling Number	Club wheat breeding lines evaluated for trait associated with low falling numbers.	Alpha amylase evaluated on Pullman nurseries in 2023 using Phadebas assay. This technology is giving us an early warning for susceptibility to conditions that result in low falling numbers.	2022-2025	Results posted on Falling Numbers web site. Presentation at Wheat Research Review, Included in peer reviewed publications.

Club wheat population improvement	Population improvement condcted for disease resistance, end use quality, nutritional quality.	Head rows for entire breeding program evaluated at Waterville and Mansfield for snow mold resistance an at Lind for emergence. Crosses made with soft breeding lines from PNW and eastern wheat breeding programs. Backcross populations advanced using minibulks. Marker assisted selection used for diseae resistance and end use quality.	2022-2025	Presentation at Research Review. Peer reviewed publications. Shared with regional breeders.