Activity 7

High Quality Canadian Western Red Spring (CWRS) Wheat Germplasm Development to Mitigate Climate Change Risks and Promote Clean Environment

Lead Researchers
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→ **This research focuses on four key objectives to develop field ready cultivars for Western Canada:**

- Improving genetic tolerance to Fusarium head blight (FHB)
- Greater resistance to wheat stem sawfly through solid stem wheat
- The development of earlier maturing wheat varieties
- Improving water and nitrogen-use efficiency (NUE) content

Both research centres have well-established and world-renowned wheat breeding programs, each equipped with several full-time employees, field disease nurseries, greenhouses and laboratories.

This research builds on previous Canadian National Wheat Cluster projects under the Growing Forward 1 (2008–2013), Growing Forward 2 (2013–2018), and Canadian Agricultural Partnership (2018–2023) initiatives. Several CWRS varieties were released from the Brandon-RDC and Swift Current-RDC programs in the previous Wheat Cluster (2018 to 2023) including AAC Starbuck, AAC Wheatland, AAC Broadacres, AAC Warman, AAC Magnet, AAC LeRoy, AAC Hockley, AAC Redstar and AAC Hodge. The programs used marker assisted selection and haplotype-based breeding, which accelerated the genetic gains for disease tolerances, agronomic traits and quality attributes in the CWRS germplasm. The goals of this activity through the Sustainable Canadian Agricultural Partnership builds on the previous findings in order to improve economic growth with enhanced food safety and security by developing farming scale climate resilient germplasm. This will reduce greenhouse gas (GHG) emissions and promote a clean environment for the Canadian public.

This research activity aims to develop high-quality wheat adapted to a changed and changing climate in Western Canada. The new germplasm development will focus on plant health from a “One Health” perspective. Traits will be developed for Fusarium head blight (FHB) resistance and mycotoxin reduction while pyramiding new sources of resistances to diseases such as leaf rust, stem rust, stripe rust, leaf diseases such as leaf spots, common bunt, and insect pests namely wheat stem sawfly.

Climate resilience will be improved by combining early maturity and high yield by maximizing photosynthetic harvest under abiotic stresses. The germplasm developed by pyramiding nutrient-use efficiencies and water-use efficiencies in the early maturing cultivars will generate superior yield to protein ratio under recommended fertilizer inputs and natural precipitation.

The rising global temperature due to GHGs is reducing wheat yields, but improving nitrogen-use efficiency (NUE) can mitigate GHG concerns without the need for additional chemical inputs. The programs use a selection of germplasm uniquely but separately suited to the Eastern and Western Prairies environmental pressures. These germplasm are hybridized to develop new and improved germplasm adapted to Eastern and Western Prairie region specific temperature, moisture and disease

Dr. Santosh Kumar explaining the development process of new wheat varieties and demonstrating new wheat varieties.
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One of the yield plot experiments for wheat variety development from Dr. Santosh Kumar's program. PHOTO CREDIT: DAVE BOSS

conditions for optimal NUE. This leads to selection of regionally adapted varieties to provide suitable choices to farmers. Advanced generation tests are conducted throughout Western Canada, and successful Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT) supported lines will be registered with the Canadian Food Inspection Agency and released as varieties for the Western Canadian market.

The germplasm is developed through strategic parent crossing and selected through extensive field trials and genetic testing. Over 300 wheat crosses have been made in greenhouse facilities since this research activity began. Crossing parents are chosen based on their field performance and genetic composition. The goal of crossing is to produce wheat with enhanced desirable traits from the combination of the parents without losing any of the characteristics of a high performing CWRS wheat line. Each summer, approximately 600,000 individual second generation plants are grown in the disease nurseries and are selected for optimal disease resistance, height, lodging tolerance, time to maturity and plant type.

Early generation germplasm is sent to breeding nurseries near Christchurch, New Zealand each winter where it is grown as single plants, rows, and yield plots for increasing seed and making further selection of wheat lines that fit the researcher's goals. The chosen wheat lines from the New Zealand nurseries are shipped back in early spring, where grain samples will then be grown at numerous trial locations. Growing early generation material in New Zealand ensures that two generations of wheat are advanced each year, which shortens the overall length of time for varieties to be developed.

The breeding material is tested in over 15 locations across Western Canada each summer, where research scientists, wheat breeders, independent owners, and team members contribute to this research. The disease assessment is conducted in artificially inoculated nurseries to test for leaf rust, stem rust, stripe rust, FHB, bunt and loose smut. Insect resistance is assessed from field samples and through genetic testing.

The best wheat lines are then selected based on yield and other agronomic traits. Seed protein concentration and pre-harvest sprouting resistance are measured and advanced wheat lines are tested for important seed quality traits including general milling performance, dough properties, and baking quality. Seven new CWRS wheat varieties have been released since the beginning of this research activity: AAC Walker, AAC Spike, AAC Craven, AAC Walsh, AAC Westking, AAC Stoughton and AAC Oakman.

These research programs conduct fundamental research alongside their breeding objectives. The results of this fundamental research are communicated through publications and a wide audience benefits from the findings. For example, certain Doubled Haploid (DH) populations that are used for variety development are also used for research projects. Recent DH populations have been used for quantitative trait loci (QTL) analysis looking for new sources of FHB resistance and increased yield. Fundamental research may be conducted in conjunction with other researchers to benefit from collaborative knowledge and resources. The results from this research are incorporated into wheat breeding strategies.

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