

Winter Wheat Breeding at the AAFC Lethbridge Research Centre

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Introduction

Western Canadian farmers grow an average of 9.84 million ha of wheat (including durum) annually, producing 22 M tonnes of grain (1999-2008). Winter wheat has some unique advantages over spring wheat and producers are increasingly taking advantage of these benefits. In 2008, winter wheat was sown on 6.6% of the Western Canadian wheat acreage and (CWRW) is now the third most important wheat class.

Winter wheat has the potential to become one of the best cropping options available to Canadian farmers. Even in the harsh continental climate of western Canada, agronomic practices that encourage early seeding and stable snow cover to insulate the crop from cold air temperatures will permit reliable survival of winter hardy cultivars. The challenge for plant breeders is to make continual improvements to the productivity, sustainability, and marketability of varieties to meet the present and future requirements of the entire industry: from the producer right through to the processor and super-market customer.

Winter Wheat Advantages

Environmental Advantages:

1. Promotion of conservation tillage practices.
2. Reduces wind and water based soil erosion.
3. More favourable moisture utilization pattern.
4. Better competition with annual weeds and reduced herbicide requirements.
5. Lower herbicide use resulting in reduced selection pressure for herbicide resistant weeds.
6. Efficient use of fossil fuel due to fewer field operations.
7. Less disturbance to wildlife.

Economic Advantages:

8. Up to 60% higher yield than spring wheat.
9. Greater diversity reduces production and marketing risks.
10. Lower fuel costs because of fewer field operations.
11. Higher net returns than other cereal crops.
12. Escape from Fusarium head blight due to earlier crop development (normal situation in Western Canada).
13. Asynchrony with emergence of the orange wheat blossom midge (western Canada).
14. Avoidance of seeding problems during late, wet springs
15. Earlier harvest than spring wheat usually results higher grades than spring wheat.
16. Improved cash flow through early marketing calls.
17. Improved utilization of on-farm storage.
18. Displacement of workload allowing longer annual use of farm machinery.

Research Strategy

The winter wheat breeding program at AAFC Lethbridge has an integrated research and development strategy directed towards deploying cost-effective genetic solutions to meet Canadian industry demands for:

- Enhanced agricultural sustainability & production efficiency.
- Safe and nutritious wheat and wheat products.
- Expanded domestic and export market opportunities.

Through collaborations with breeding and research programs within AAFC, as well as with various universities, provincial governments, producer organizations, private companies, and researchers outside of Canada, improvements identified as being important to the industry are being made.

The Challenges

The development of agronomically superior cultivars with desirable end-use quality is the primary objective of any breeding program. However, to fully realize the yield potential of a new cultivar, the impact of disease and insect pests must also be minimized.

The AAFC Lethbridge breeding program works to improve winter wheat in three broad areas.

Productivity Enhancement (Agronomics)

- High yield (greater than the appropriate checks)
- Superior winter hardiness
 - Minimum = AC Bellatrix, CDC Falcon Target = Norstar
- Moderate to short, strong straw
 - Range = CDC Falcon to AC Readymade
- Range in maturity
 - Range = CDC Falcon to AC® Radiant & AC Readymade
- High test weight and large seed size
 - Equal to AC Bellatrix & AC® Radiant
- Drought tolerance
 - Target = AC Bellatrix
- Resistance to shattering

Maintenance of Food Safety & Productivity

Minimizing the effects of diseases and insect pests is an important strategy for maintaining food safety and yield potential. One of the most effective means of disease control is the deployment of genetically resistant or tolerant cultivars. Wheat has several economically important disease and insect pests. As the Canadian Prairies has a diverse range of environments, the range for biotic stresses varies.

For example: stem rust, leaf rust and Fusarium head blight (FHB) are particularly important disease resistance traits in eastern Saskatchewan and Manitoba, whereas they are less important in Alberta and western Saskatchewan. In the case of FHB, breeding for resistance is also very important from a food and feed safety standpoint.

Figure 1. Important disease and insect pests in which genetic resistance is being incorporated into winter wheat at the AAFC Lethbridge Research Centre

	Canadian Prairies	
	West	East
Stem Rust		✓
Leaf Rust	✓	✓
Stripe Rust	✓	✓
Fusarium Head Blight		✓
Leaf Spots	✓	✓
Wheat Streak Mosaic	✓	✓
Common Bunt	✓	✓
Wheat Stem Sawfly	✓	
Russian Wheat Aphid	✓	

Broadening Marketability

The potential for winter wheat could be enhanced if additional end-use quality profiles that meet the needs of diverse end-users were developed. In Western Canada, spring wheat (including durum) is marketed as eleven different classes or subclasses, whereas winter wheat has been limited to two end-use quality profiles.

Research is underway to broaden the end-use quality profile of Western Canadian winter wheat to enhance the marketability of the crop. The objective is to develop spring and winter wheat end-use quality profiles that are equal to each other so that they can be commingled and receive the same price.

Current Market Classes

- CWRW: Hard red type for French, flat & steamed breads, and noodles
- CWGP: High energy type for the feed and bio-fuel markets

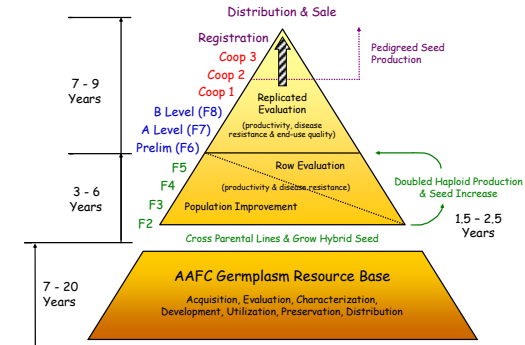
New Quality Profiles:

- Soft White for pastry and baby food applications
- Hard White for bread and noodle applications
- Premium Hard Red for high volume pan breads, as an environmentally friendly alternative to CWRW.

Long Term Commitment

Plant breeding is a long term undertaking. The development of improved winter wheat varieties normally takes 10 to 15 years from the time of the initial cross to the delivery of a field ready cultivar (Figure 2). In addition to traditional breeding approaches which rely heavily on replicated field testing and disease nurseries, the program also uses modern “high-tech” methods such as doubled haploidy and molecular marker assisted selection to increase the speed and efficiency of the process.

Figure 2. Generalized progression of breeding material in the winter wheat breeding program at the AAFC Lethbridge Research Centre



Past and Future Successes

Winalta	1961	CWRW
Sundance	1971	CWRW
Norstar	1977	CWRW
AC Readymade	1991	CWRW
AC Tempest	1999	CWRW
AC Bellatrix	1999	CWRW
Radiant	2004	CWRW
Broadview	2009	CWGP
W434 (potential)	2010	CWRW
W448 (potential)	2010	CWGP

Acknowledgments

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