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CULTIVAR DESCRIPTION

AAC LeRoy Canada Western Red Spring wheat

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Abstract: AAC LeRoy (BW1049) is a hollow stemmed, awned, high-yielding Canada Western Red Spring (CWRS) wheat suited to the growing conditions in western Canada. AAC LeRoy was 10% higher yielding than Unity, the highest yielding check in the Central Bread Wheat Cooperative registration trials (2015–2017). Within the same test, AAC LeRoy was 13% higher yielding than Carberry, a popular CWRS wheat variety across the Canadian Prairies. AAC LeRoy matured 2 d earlier than Carberry and 1 d later than Unity, the earliest maturing check suited for eastern prairie growing conditions. AAC LeRoy was 6 cm shorter with better stem strength than Unity. The lodging score for AAC LeRoy was lower than the mean of the checks. The test weight of AAC LeRoy was similar to the mean of the checks. Over the 3 yr of testing (2015–2017), the 1000-kernel weight of AAC LeRoy was higher than all of the checks, with a grain protein content 0.6% units lower than Carberry. AAC LeRoy was rated as moderately resistant to *Fusarium* head blight (*Fusarium graminearum* Schwabe), leaf rust (*Puccinia triticina* Erikss.), stripe rust (*Puccinia striiformis* Westend.), and stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & E. Henn), including the Ug99 family of stem rusts. It also had a resistant reaction to loose smut [*Ustilago tritici* (Pers.) Rostr.] and an intermediately resistant reaction to common bunt [*Tilletia caries* (DC.) Tul. & C. Tul.]. AAC LeRoy was resistant to orange wheat blossom midge (*Sitodiplosis mosellana* Géhin). AAC LeRoy was registered under the CWRS market class.

Key words: Triticum aestivum L., CWRS, grain yield, quality, disease resistance, orange blossom wheat midge, *Fusarium* head blight, deoxynivalenol.

Résumé : AAC LeRoy (BW1049) est une variété barbue de blé roux de printemps de l'Ouest canadien (CWRS) à tige creuse et à rendement élevé convenant à la culture dans les conditions de croissance de l'Ouest canadien. Le rendement de cette variété dépassait de 10% celui de Unity, témoin qui a enregistré le rendement le plus élevé aux essais d'homologation de la Central Bread Wheat Cooperative (2015-2017). Au terme de ces essais, AAC LeRoy avait produit 13 % plus de grains que Carberry, variété de blé CWRS populaire dans les Prairies canadiennes. AAC LeRoy parvient à maturité deux jours avant Carberry et un jour après Unity, témoin le plus hâtif dans les conditions de croissance caractéristiques à l'est des Prairies. La paille d'AAC LeRoy est plus courte que celle de Unity de 6 cm, mais elle est plus robuste. La note obtenue par AAC LeRoy pour la résistance à la verse était inférieure à la note moyenne des témoins. AAC LeRoy a un poids spécifique similaire à la moyenne des témoins. Au cours des trois années d'essais (2015-2017), le poids de mille grains de la variété a dépassé celui des témoins et la teneur en protéines de son grain était de 0,6 % inférieure à celle de Carberry. AAC LeRoy a été coté modérément résistant à la fusariose de l'épi (*Fusarium graminearum* Schwabe), à la rouille de la feuille (*Puccinia triticina* Erikss.), à la rouille jaune (*Puccinia striiformis* Westend) et à la rouille de la tige (*Puccinia graminis* Pers. f. sp. tritici Eriks. & E. Henn), famille Ug99 incluse. La variété résiste au charbon nu

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[*Ustilago tritici* (Pers.) Rostr.] et résiste moyennement à la carie [*Tilletia caries* (DC) Tul. & C. Tul.]. AAC LeRoy résiste à la cécidomyie du blé (*Sitodiplosis mosellana* Géhin). La variété a été homologuée dans la catégorie commerciale CWRS. [Traduit par la Rédaction]

Mots-clés : Triticum aestivum L., CWRS, rendement grainier, qualité, résistance à la maladie, cécidomyie du blé, fusariose de l'épi, désoxynivalénol.

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Introduction

Bread wheat (*Triticum aestivum* L.) is a major component of the staple diet for the majority of the world population. Based on recent Food and Agricultural Organization data, global gross wheat production was valued at $110 billion USD, originating from an estimated cropped area of 220 million ha in 2016 (FAOSTAT 2018). Canada ranks 7th amongst the wheat-producing nations, with 30 million t of wheat produced (FAOSTAT 2018) from a cropped area of 10 million ha (Statistics Canada 2018, Table 32-10-0359-01). Wheat yield per hectare has been steadily increasing in Canada over the last 25 yr at the rate of roughly 48 kg ha^{-1} (Toth et al. 2019). Recently, the rate of yield gain for hard red spring wheat in western Canada was estimated at 0.67% per year (Thomas and Graf 2014). The majority of the bread wheat (76%) grown in western Canada is spring wheat and is classified under the Canada Western Red Spring (CWRS) wheat class (www.grainscanada.gc.ca). CWRS wheat is preferred as a cereal rotation crop due to the steady yields, optimum disease resistance, and excellent milling and baking attributes. The export potential and marketability of CWRS wheat makes it a commodity of choice for Canadian grain handlers and exporters. For continued agricultural productivity, sustainability, and marketability, focused efforts are needed to develop improved CWRS wheat varieties with high yields at reduced input costs.

AAC LeRoy is a hard red spring wheat cultivar developed by the Agriculture and Agri-Food Canada (AAFC) Brandon Research and Development Centre at Brandon, MB. It was registered by the Variety Registration Office of the Canadian Food Inspection Agency, Ottawa, ON, under registration number 8577. AAC LeRoy meets the end-use quality specifications of the CWRS class and is best adapted to the Canadian Prairies growing conditions.

Pedigree and Breeding Methods

AAC LeRoy was derived from the cross of BW431/BW874. The female parent, BW431, was a breeding line derived from the cross between 00H01*F57 and 98B19*T99. BW431 is a semi dwarf with resistance to stripe rust and midge, along with good gluten strength. The male parent, Carberry (BW874), is a doubled haploid line derived from a cross between Alsen and Superb with high grain yield and high protein potential (DePauw et al. 2011). Alsen (ND674//ND2710/ND688), released by the North Dakota Agricultural Experiment Station in 2000, was developed by incorporating the *Fusarium* head blight (FHB) resistance from Sumai 3 into an adapted background that also had good stem and leaf rust resistance, yield, and quality characteristics (Frohberg et al. 2006). Superb, a hard red spring wheat developed at the Cereal Research Centre (CRC), AAFC, is tolerant to preharvest sprouting and resistant to leaf and stem rust (Townley-Smith et al. 2010). This complex cross was made to generate a high-yielding CWRS wheat variety adapted to the eastern Canadian prairies with broad resistance to leaf and stem rust, improved resistance to FHB, and resistance to orange wheat blossom midge. AAC LeRoy tested positive for markers linked to genes *Lr21*, *Sr7a*, *Sr9b-2*, *YrR61**, *UtBW278*, *Fhb-5AS**, *Sm1*, *PinA*, *Sbm*, *GluAx2**, *GliD*, *Kauz 1-feh*, *Vrn-B1**, *PPd-D1-2*, and *RhtB* (Toth et al. 2019).

AAC LeRoy was developed using the modified pedigree breeding method. The final cross for AAC LeRoy was made at CRC, AAFC, in 2008. In 2008–2009, the F_1 seeds were grown in a pair of 1.5-m rows near Leeston, New Zealand. The F_2 seeds harvested from Leeston were grown near Portage la Prairie, MB, as 3-m rows with 40 seeds per row. A total of 250 spikes was collected from the 3-m rows. The F_2-derived lines were further selected based on agronomic, yield/protein, disease resistance, and grain quality up to the F_6 generation. The F_6-derived spikes were then tested in advanced yield trials at multiple locations and further testing was done based on disease and grain/flour quality attributes. Finally, the line BH11A-NP-162-NPNG-13-N was tested in the Central Bread Wheat Cooperative (CBWC) registration trials as BW1049 for 3 yr (2015–2017). A detailed description of the breeding history and breeder seed development is outlined in Table 1.

Agronomic data collection

The CBWC registration trial consisted of 30 entries tested at up to 13 locations within Manitoba and Saskatchewan using a rectangular lattice design with six groups with five entries per group and three replicates. The 2015–2017 CBWC registration trials had Unity (BW362) (Fox et al. 2010), Glenn (ND747) (Mergoum et al. 2006), Carberry (BW874) (DePauw et al. 2011), and AAC Viewfield (BW965) (Cuthbert et al. 2019) as the recommended checks. The yield data from all three replicates were collected from all locations. The final plot yields at similar moisture contents were converted to yield per unit area (kg ha^{-1}). Days to maturity was recorded as days from seeding to when seeds resisted denting by a fingernail (16%–18% moisture), and data from all the

Table 1. Population size and activities at each generation leading to the development of BW1049 hard red spring wheat.

Name	Gen.	Year	Activity — Number of lines — Locations
BH11A	F_0	2008	Final cross made in a growth cabinet.
BH11A	F_1	2008–2009	F_1 seeds were grown in 1.5 m rows near Leeston, NZ.
BH11A-N	F_2	2009	F_2 seeds grown as 50, 3-m rows, ~40 seeds/row grown near Portage, MB. 250 spikes were harvested.
BH11A-NP-162	$F_{2:3}$	2009–2010	169 F3 rows were grown near PN, NZ as hills.
BH11A-NP-162-N	$F_{2:4}$	2010	49 lines were grown in a 1-m row nursery near Portage la Prairie, MB. Selection for agronomics, seed appearance, resistance to rusts and common bunt, protein concentration, flour yield, and mixograph.
BH11A-NP-162-NP	$F_{2:5}$	2010–2011	23 lines were grown near PN, NZ as hills. Selection for agronomics and leaf rust resistance.
BH11A-NP-162-NPN	$F_{2:6}$	2011	8 lines were tested in a single replicate yield test at three locations (MB: Glenlea, Brandon; SK: Saskatoon). Selections based on agronomic and disease parameters, 15 spikes harvested per selected line and sent as 1 spike/row to PN.
BH11A-NP-162-NPNG-13	$F_{6:7}$	2011–2012	13 lines were grown near PN in 1.5 m rows. Selection for agronomics and leaf rust resistance as well as quality parameters from F_6 seeds.
BH11A-NP-162-NPNG-13-N	$F_{6:8}$	2012	11 lines were tested in unreplicated yield tests at three locations (MB: Brandon, Glenlea, Portage). Selection based on agronomics, disease resistance, and quality.
BH11A-NP-162-NPNG-13-N	$F_{6:9}$	2013	1 line in the Central Bread Wheat "A" test. Yield test, two replicates at five locations (MB: Glenlea, Brandon, Morden, Melfort; SK: Indian Head).
BH11A-NP-162-NPNG-13-N	$F_{6:10}$	2014	1 line in the Central Bread Wheat "B" test. Yield test, three replicates at eight locations (MB: Portage, Brandon, Morden; SK: Indian Head, Melfort, Kernen; AB: Beaverlodge, Lacombe).
BW1049	$F_{6:11–13}$	2015–2017	1 line progressed to Central Bread Wheat "C" registration test. Yield test, three replicates at 13 site–years (MB: Portage la Prairie, Brandon, Souris, Dauphin, Morden, Fort Whyte, Neepawa; SK: Indian Head, Pense, Kamsack, Melfort, Kernen, Walheim, Moose Jaw).
Breeder seed			
BW1049	$F_{6:11}$	2015	Breeder seed spikes: 250 random spikes were selected from a rogued increase plot grown at Rosebank, MB.
BW1049	$F_{6:12}$	2016	Breeder seed isolation rows: 250 lines were grown in 1 m rows grown near Brandon, MB with 10 m of isolation distance from any other wheat.
BW1049	$F_{6:13}$	2017	Breeder seed rows: 15 m rows grown at Indian Head, SK with 10 m of isolation distance from any other wheat. 157 rows were grown. Lines were rogued for uniformity and 14 lines were pulled. Approximately 200 kg of breeder was produced.

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replicates were collected multiple times per week. The plant height was measured in centimeters from the ground to top of the spikes, excluding the awns after the extension growth had ceased. Lodging was recorded on a 1–9 scale, where 1 was upright and 9 was completely lodged. Test weight was measured on cleaned grain samples and reported as kilograms per hectolitre. Kernel weight was measured using a minimum of 200 undamaged kernels and recorded as milligrams per kernel.

Disease testing

The line BW1049 was evaluated for disease reaction to leaf, stem, and stripe rust, FHB, common bunt, loose smut, leaf spots, and orange blossom midge in CBWC trials between the years 2015 and 2017. Field nurseries inoculated with either a macroconidial spore suspension (University of Manitoba, Carman, MB) or corn spawn [Morden Research and Development Centre (MRDC), Morden, MB] inoculum, with an equal proportion of four isolates (M1-07-2/15ADON; M3-07-2/15ADON; M7-07-1/3ADON; M9-07-1/3ADON) of *Fusarium graminearum* Schwabe, which was used to evaluate tolerance to FHB. The visual rating index (VRI = % incidence × % severity/100) was recorded as described by Gilbert and Woods (2006) and the ISD (incidence severity DON) rating was calculated as (0.2 × mean incidence + 0.2 × mean severity + 0.6 × mean DON). Reactions to leaf (*Puccinia triticina* Erikss.) and stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & E. Henn) diseases were assessed using the modified Cobb scale (Peterson et al. 1948) in inoculated field nurseries at MRDC. Experiments were also conducted in the greenhouse to evaluate seedling reactions to four leaf rust races, MBDS (12-3), MGBJ (74-2), TJBJ (77-2), and MBRJ (128-1) (McCallum and Seto-Goh 2006), and six stem rust races, TMRTF (C10), RKQSC (C63), TPMKC (C53), RTHJF (C57), QTHJF (C25), and RHTSC (C20) (Fetch 2005; Jin et al. 2008). Natural field infections were used to assess the disease severity and reaction to stripe rust (*Puccinia striiformis* Westend.) near Lethbridge, AB (Randhawa et al. 2012). Common bunt [*Tilletia caries* (DC.) Tul. & C. Tul.] resistance was recorded at the Lethbridge Research and Development Centre, Lethbridge, using a composite of races L1, L16, T1, T6, T13, and T19, and planting inoculated seed into cold soil (Gaudet and Puchalski 1989; Gaudet et al. 1993). The reaction to loose smut [*Ustilago tritici* (Pers.) Rostr.] was assessed by inoculating wheat spikes with a composite of races T2, T9, T10, and T39 (Menzies et al. 2003) and rating the progeny plants grown in a greenhouse from the infected seeds. The reaction to midge (*Sitodiplosis mosellana* Géhin) feeding damage was assessed by visually inspecting the midge-damaged kernels on mature spikes. Sixty spikes (20 spikes per replicate from three replicates) were collected per entry and were analyzed under a dissecting microscope for larval feeding damage symptoms. Based on the type of damage, the entries were classified as resistant, susceptible, or undamaged.

Grain and flour quality evaluation

Evaluation of end-use quality was conducted by the Grain Research Laboratory (GRL) of the Canadian Grain Commission (CGC) in Winnipeg, MB. Protein content and grade of the check cultivars were used to prepare composite samples from all test locations, which were subsequently used in tests to measure grain protein (%), flour protein (%), protein loss (%), falling number (s), α-amylase activity (amylograph; BU), clean flour yield (%), flour yield (0.50 ash; %), flour ash (%), starch damage (%), farinograph properties, and dough development properties using standard analytical methods as outlined in the Prairie Recommending Committee for Wheat, Rye and Triticale operating procedures (Prairie Recommending Committee for Wheat, Rye and Triticale 2015).

The PROC MIXED module (SAS version 9.4, SAS Institute Inc., Cary NC) with years, environments, and their interactions treated as random effects and cultivar as a fixed effect was used to generate means and standard errors. The least significant difference (LSD) was then calculated using the formula LSD = standard error × TINV × (1 − 0.05/2, df), where the TINV(*P*, df) function returns the *t* value corresponding with the two-tailed probability *P* (*P* value) and the specified degrees of freedom (df). The LSD was used to analyze the improvements of AAC LeRoy over the check cultivars.

The end-use quality data are non-replicated observations within years.

Performance

Based on 32 site–years of testing over 3 yr, AAC LeRoy was higher yielding than Glenn (17%), Carberry (13%), AAC Viewfield (11%), and Unity (10%) (Table 2).

AAC LeRoy matured 2 d earlier than Carberry and was earlier than all checks except Unity (Table 3). AAC LeRoy was 6 cm shorter in height and had better lodging resistance compared with Unity (Table 3). AAC LeRoy had a similar test weight as the checks and higher kernel weight compared with all of the checks (Table 3). The grain protein content of AAC LeRoy was 0.2 units lower than Unity, and 0.6 units lower than Carberry and AAC Viewfield (Table 3).

AAC LeRoy had adequate resistance to diseases prevalent in the Canadian Prairies. AAC LeRoy was rated moderately resistant to FHB by the disease evaluation team of the Prairies Grain Development Committee. Over 3 yr of testing (2015–2017), AAC LeRoy expressed moderately resistant reactions to FHB at Carman and Morden (Table 4). It had lower deoxynivalenol (DON) levels than AAC Viewfield in the inoculated nurseries (Table 4). AAC LeRoy was moderately resistant to the prevalent races of leaf and stem rusts. It was also rated moderately resistant to the Ug99 family of stem rust (Table 5). AAC LeRoy was rated as resistant to loose smut, intermediately resistant to common bunt, and moderately susceptible to leaf spot disease complex based on 3 yr data (Table 6). AAC LeRoy was resistant to orange blossom

Table 2. Yield (kg ha^{-1}) of AAC LeRoy (BW1049) and check cultivars in the Central Bread Wheat Cooperative (2015–2017) tests.

	Zone 1[a]			Zone 2[b]			All sites 2015–2017	
Cultivar	2015	2016	2017	2015	2016	2017	Kg ha^{-1}	% Unity
Unity VB	4645	3822	5603	3377	4871	4598	4499	100
Glenn	4285	3667	5441	3184	4086	4582	4234	94
Carberry	4342	3702	5813	3263	4236	4664	4364	97
AAC Viewfield	4574	3310	5735	3454	4556	4840	4446	99
AAC LeRoy	4946	4338	6394	3458	5255	5129	4948	110
Mean of checks	4461	3625	5648	3319	4437	4671	4386	98
$LSD_{0.05}$	557	617	525	762	751	831	354	—
No. of tests	3	5	6	5	6	7	32	—

Note: LSD, least significant difference appropriate to make comparisons of AAC LeRoy to Unity, Glenn, Carberry, and BW 965; $P \leq 0.05$, includes the appropriate genotype × environment interaction.

[a]Zone 1 test locations: 2015 — Dauphin, Portage la Prairie, Souris; 2016 — Brandon, Souris, Morden, Neepawa, Fort Whyte; 2017 — Brandon, Souris, Morden, Fort Whyte, Dauphin.

[b]Zone 2 test locations: 2015 — Kamsack, Kernen, Indian Head, Melfort, Pense; 2016 — Kamsack, Melfort, Pense, Indian Head, Kernen, Waldheim; 2017 — Kamsack, Melfort, Pense, Indian Head, Kernen, Waldheim.

Table 3. Summary of agronomic traits of AAC LeRoy (BW1049) and check cultivars in the Central Bread Wheat Cooperative (2015–2017) tests.

Cultivar	Maturity (d)	Height (cm)	Lodging score[a] (1–9)	Test weight (kg hL^{-1})	Kernel weight (mg kernel^{-1})	Protein (%)
Unity	94	95	2.4	80	33.8	14.6
Glenn	95	90	1.4	82	34.2	14.9
Carberry	97	83	1.5	80	34.6	15.0
AAC Viewfield	96	79	1.3	80	32.7	15.0
AAC LeRoy	95	89	1.8	81	36.1	14.4
Mean of checks	96	87	2	81	34	15
$LSD_{0.05}$	2	3	0.3	—	—	—
No. of tests	29	32	26	31	31	31

Note: LSD, least significant difference appropriate to make comparisons of BW1049 to Unity, Glenn, Carberry, and AAC Viewfield. $P \leq 0.05$, includes the appropriate genotype × environment interaction.

[a]Lodging score on a scale of 1–9, where 1 = vertical and 9 = flat.

wheat midge based on phenotypic data on midge tolerance and the presence of the *Sm1* gene marker (Table 6).

Grain and flour quality attributes of AAC LeRoy were tested by GRL in Winnipeg, MB. End-use quality assessment using the established methods (AACC 2000) was performed on a composite sample formulated from trial locations, with grain samples representative of the best hard red spring wheat grades available. A pre-determined quantity of final grain was made by varying the proportion of grain from each location to achieve a final protein concentration approximating the average for the crop in the given year. AAC LeRoy met the milling and baking performance of the CWRS class of wheat. The grain protein was similar to Unity and lower than the other checks (Table 7). AAC LeRoy had lower protein loss than Carberry and was similar to the other checks. Flour protein (%) was similar to Unity and falling number was similar to Glenn. Amylograph (BU) and clean flour yield (%) were higher than Carberry. Flour ash (%) was higher than all of the checks in 2015–2016, but lower than all of the checks in the year 2017. Starch damage was higher than all of the checks except Glenn. Flour yield (0.05 ash, %) was lower than all of the checks in the years 2015 and 2016 and similar to all checks in 2017 (Table 7). Water absorption measured on the farinograph directly relates to the amount of bread that can be produced from a given weight of wheat flour. The farinograph absorption was similar to or higher than Carberry and AAC Viewfield within the tested years (2015–2017), and dough stability was higher than Carberry and Unity in 2016 and 2017 (Table 8). Baking quality was assessed using the Canadian short process (Preston et al. 1982) for 2014 and

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Table 4. *Fusarium* head blight VRI[a], DON, and ISD[b] for AAC LeRoy (BW1049) and check cultivars in the Central Bread Wheat Cooperative (2015–2017) tests.

	2015			2016			2017				
	VRI	DON	ISD	VRI	DON	ISD	VRI	DON	ISD	VRI	DON
Cultivar	Carman FHB									Ottawa FHB	
Unity	31.5I	12	9.6	23.3I	11.2	8.8	29.3I	8.3	7.2MR	43	8.8
Glenn	3.9R	12	8.3	9R	8	6.4	12.3MR	9.3	7.2MR	35	9.0
Carberry	15.1MR	9.5	7.6	11.8MR	17.2	12	10.3MR	8	6.4 MR	37	7.0
AAC Viewfield	21.5I	15	11.1	31.8MS	43.5	28.6	23.7I	16.7	12.2I	38	13.0
AAC LeRoy	13.3MR	12.5	9.2	16.7I	13.6	10	15.3I	10	8.0MR	12	5.6
	Morden FHB										
Unity	50I	18.3	13.8MR	41.2MR	25.5	18.0MR	46I	15.5	12.0I		
Glenn	32MR	23.5	16.4MR	12.9R	17.6	12.5R	37I	17.8	13.2I		
Carberry	41MR	15.2	11.8MR	39.8MR	22.1	15.9MR	34MR	21.7	15.5I		
AAC Viewfield	46I	22.7	16.4MR	53.0MS	41.8	28.1MS	44I	32.9	22.5MS		
AAC LeRoy	27MR	16.5	12.0MR	29.8MR	20.9	14.9MR	32MR	18	13.2I		

Note: Disease rating class: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible. DON, deoxynivalenol.

[a]VRI, visual rating index: (percentage of infected heads × percentage of diseased florets on infected heads)/100.

[b]ISD, incidence severity DON: visual incidence + visual severity + DON = (0.2 × mean incidence + 0.2 × mean severity + 0.6 × mean DON).

Table 5. Rust disease severities and ratings of AAC LeRoy (BW1049) and check cultivars in the Central Bread Wheat Cooperative (2015–2017) tests.

	Leaf rust[a]			Stem rust[b]			Stripe rust[c]				UG99[b]		
Cultivar	2015	2016	2017	2015	2016	2017	2015	2016[d]	2016[e]	2017	2015	2016	2017
Unity	37I	30MR	40MR	20I	10MR	10MR	40S	60S	95S	70S	40M	50S	—
Glenn	6R	25MR	17MR	10MR	5R	10MR	2R	17MR	35I	15MR	25M	53S	20M
Carberry	4R	0.3R	0R	5R	2R	5R	2R	10MR	25I	0R	15M	43S	12MR
AAC Viewfield	10R	10R	5R	15MR	5R	10MR	15I	25I	15MR	15MR	3MS	18S	7RMR
AAC LeRoy	27MR	23MR	22MR	20MR	10MR	10MR	25I	10MR	25I	10MR	—	17M	12RMR

[a]Severity is the percentage of leaf/stem area affected by rust. Reaction is the descriptive classification of disease based on percent severity. Disease rating class: R, resistant (1%–10%); MR, moderately resistant (11%–30%); I, intermediate (31%–39%); MS, moderately susceptible (40%–60%); S, susceptible (>60%).

[b]Severity is the percentage of stem infected with stem rust using the Modified Cobb Scale. Disease response categories: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.

[c]Severity is the percentage of leaf area affected by rust. Dominant pustule reaction for stripe rust. Disease response categories: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.

2015 and the Lean No Time test (Dupuis and Fu 2017) in 2016. The loaf volume (cm^3) for AAC LeRoy was better than all of checks and was similar to Glenn, whereas the loaf top ratio was better than all of the checks in 2016 but not Glenn in 2017 (Table 8).

Other Characteristics

The morphological characteristics were recorded using experimental field plots grown in 2016 and 2017 at Saskatoon, SK. The characteristics were compared with two reference varieties, Carberry and Vesper (Thomas et al. 2013), for morphological distinctness.

Seedling characteristics

Coleoptile colour: reddish.

Juvenile growth habit: semi-erect to intermediate.

Seedling leaves: medium green, glabrous.

Adult plant characteristics

Growth habit: intermediate to semi-prostrate.

Flag leaf attitude: intermediate.

Flag leaf: medium green, recurved, glabrous sheath and blade, slightly waxy blade, long and medium width, glabrous margins.

Culm: straight, glabrous, slight waxiness.

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Table 6. Bunt, smut, leaf spot, and midge ratings of AAC LeRoy (BW1049) and check cultivars in the Central Bread Wheat Cooperative (2015–2017) tests.

	Common bunt[a]			Loose smut[b]			Leaf spots[c]			Midge[d]		
Cultivar	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Unity	0R	2R	1MR	4R	7	—	7.0I	10S	2.3	6:1:4	4:1:5	4:0:5
Glenn	8R	16I	10I	4R	0	—	6.0MR	10S	1.3	0:9:1	0:7:3	0:10:1
Carberry	0R	0R	2MR	0R	0	—	8.3MS	10S	2.7	0:9:1	0:8:2	0:8:2
AAC Viewfield	26MS	19I	10I	2R	0	—	7.0I	9MS	2.0	0:10:1	0:9:1	0:9:1
AAC LeRoy	26MS	2R	3MR	0R	0	—	8MS	10S	2.7	3:2:5	5:0:5	3:1:7

Note: Disease rating categories: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.

[a]Bunt data represented as severity (percentage of spikes with bunt symptoms) and ratings.

[b]Loose smut data represented as severity (percentage of plants with loose smut symptoms) and ratings

[c]Leaf spot data represented as severity (percentage of leaves with leaf spot symptoms) and ratings.

[d]Midge rating, R:S:U (Resistant:Susceptible:Undamaged).

Table 7. Wheat and flour analytical data[a] for AAC LeRoy (BW1049) and check cultivars from the Central Bread Wheat Cooperative (2015–2017) tests.

Cultivar	Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylo-graph (BU)	Clean flour yield (%)[b]	Flour yield (0.50 ash) (%)	Flour ash (%)	Starch damage (%)
2015									
Unity	15.1	14.6	0.5	450	695	76	75.5	0.47	7.7
Glenn	15.3	14.4	0.8	320	500	75	77	0.44	8.3
Carberry	15.6	14.3	1.3	360	400	75	78	0.42	7.1
AAC Viewfield	15.9	14.8	1.1	320	420	74.9	77	0.44	7.1
AAC LeRoy	15.2	14.6	0.6	300	345	76.1	75.5	0.47	7.9
2016									
Unity	13.2	12.4	0.8	405	755	76.5	77	0.44	8.3
Glenn	13.8	13.0	0.8	325	525	74.4	76.5	0.45	8.7
Carberry	14.3	13.3	1.0	370	350	75.4	76.5	0.45	7.4
AAC Viewfield	13.8	13.0	0.8	370	455	75.3	77.5	0.43	7.2
AAC LeRoy	13.4	12.7	0.7	335	470	75.9	76.0	0.46	8.4
2017									
Unity	14.3	13.6	0.7	435	900	77.2	79.0	0.40	8.1
Glenn	14.6	13.9	0.7	380	830	75.3	79.5	0.39	8.2
Carberry	14.8	13.9	0.9	375	510	75.7	79.0	0.40	7.9
AAC Viewfield	14.9	14.2	0.7	430	685	75.4	79.5	0.39	7.5
AAC LeRoy	14.1	13.4	0.8	390	645	76.6	80	0.38	8

[a]American Association of Cereal Chemists methods were followed by the Grain Research Laboratory (GRL), Canadian Grain Commission (CGC) for determining the various end-use quality traits on a composite of 6–10 locations each year.

[b]See Dexter and Tipples (1987). All millings at GRL, CGC are performed in rooms with environmental control maintained at 21 °C and 60% relative humidity. Common wheat is milled on an Allis-Chalmers laboratory mill using the GRL sifter flow as described by Black et al. (1980). Flour yield is expressed as a percentage of cleaned wheat on a constant moisture basis.

Spike characteristics

Shape: erect and parallel sided.
Length: short.
Density: lax to medium.
Attitude: erect.
Colour: tan at maturity.
Awns: awned.

Spikelet characteristics

Glumes: long and medium wide width; slightly pubescent; rounded shoulder shape; beak is medium to long with acuminate shape.
Lemma: straight.

Kernel characteristics

Type: hard, medium to dark red in colour.

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Table 8. Dough properties and baking qualities for AAC LeRoy (BW1049) and check cultivars from the Central Bread Wheat Cooperative (2015–2017) tests.

	Dough properties							Baking quality				
	Farinograph				Extensograph			CSP[a] (2015)/lean no time (2016–2017)				
Cultivar	Abs.[b] (%)	DDT (min)	MTI (BU)	Stability (min)	Ext. area	Ext. R_{max}	Ext. length	Abs. (%)	Mixing time (min)	Mixing energy (W h kg^{-1})	Loaf volume (cm^3)	Loaf top ratio
2015												
Unity	65.3	5.75	45	6	87	355	19.5	69	3.4	9.1	1005	—
Glenn	65.6	8	30	9.5	151	691	18.5	70	5.5	13.6	980	—
Carberry	63.9	6	30	8	108	418	20.8	68	4.5	11.6	985	—
AAC Viewfield	64.5	8.25	30	9.5	117	449	20.5	69	4.5	11.4	980	—
AAC LeRoy	64.8	7.75	40	7.5	114	463	19.8	69	4.5	11.1	1005	—
2016												
Unity	63.6	4.75	—	6	73	300	19	70	2.9	8.3	795	0.55
Glenn	65.6	5.50	—	9.5	122	624	16.4	73	3.8	10.5	910	0.67
Carberry	63.7	5.50	—	5.5	90	353	20.5	71	3.0	8.3	790	0.55
AAC Viewfield	63.6	5.75	—	7.5	91	358	20.3	71	3.1	7.8	825	0.51
AAC LeRoy	63.4	5.50	—	8	93	451	16.6	70	3.6	9.6	865	0.69
2017												
Unity	63.8	5.75	—	7	89	332	21.4	71	2.9	7.5	740	0.40
Glenn	64.6	9.75	—	11.5	153	680	18.8	72	4.0	10.4	840	0.59
Carberry	64.0	7.25	—	7.5	97	352	22.1	71	3.2	8.6	780	0.48
AAC Viewfield	63.8	7.75	—	11	119	470	20.6	71	3.4	9.4	805	0.48
AAC LeRoy	64.5	6.50	—	9	104	419	19.8	72	3.6	9.2	780	0.50

[a]CSP, Canadian short process (Preston et al. 1982); DDT, farinograph dough development time measured in minutes; MTI, farinograph mixing tolerance index, expressed in Brabender units (BU); Ext., external.
[b]Abs., absorption; AACC 2000.

Size: medium size, medium length, narrow to medium width; oval shape; rounded cheeks; medium brush hairs; medium wide and shallow to mid-deep crease.
Embryo: small to medium size, round to oval shape.

Maintenance and Distribution of Pedigreed Seed

Breeder seed of AAC LeRoy was produced using 250 random spikes from a rogued seed increase plot grown at Rosebank, MB, in 2015. Two hundred and fifty lines were grown as an isolated group of 1 m head rows in 2016 at the Brandon Research and Development Centre. Sixty lines were lost to flooding in isolation plots and 23 isolation rows did not produce enough seeds. Ten lines were discarded due to lack of uniformity within the rows. In 2017, a 15-m row was grown from each of the 157 remaining isolation rows at the Indian Head Seed Increase Unit. Prior to bulk harvesting the breeder rows, 14 rows were discarded. The remaining uniform plots were inspected and bulk harvested, producing 200 kg of breeder seed. Multiplication and distribution of all other pedigreed seed classes will be handled by Alliance Seed, 24th Floor, 333 Main Street, Winnipeg, MB R3C 4E2, Canada; website: http://www.allianceseed.com. AAC LeRoy is a midge-resistant variety, and to maintain the effectiveness of the *Sm1* gene against wheat orange blossom midge, certified seed will include AAC Redberry as a 10% interspersed susceptible refuge.

Contributions

S. Kumar and S.L. Fox performed selections and progression of lines to finally select AAC LeRoy (BW1049). S. Kumar analysed the registration trial data, generated varietal identification data for Variety Registration and Plant Breeders' Rights including the necessary documentation, and wrote the manuscript. The other authors contributed agronomic and disease evaluation data from the registration trials.

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