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CULTIVAR DESCRIPTION

AAC Redstar hard red spring wheat

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Abstract: AAC Redstar is an early maturing, high-yielding hard red spring wheat (*Triticum aestivum* L.) cultivar that is well adapted to the northern Canadian Prairies and eligible for grades of Canada Western Red Spring (CWRS) wheat. Over 3 yr (2016–2018) of testing in the Parkland Wheat Cooperative registration trials, AAC Redstar was 11% higher yielding than AC Splendor, 6% higher than Parata, and 4% higher than Glenn and Carberry. AAC Redstar matured 3 d earlier than Glenn, 2 d earlier than Carberry, and had similar maturity to Parata. AAC Redstar was shorter than all checks except Carberry and had better lodging resistance compared with all the check cultivars in the registration trial. The test weight and thousand-kernel weight of AAC Redstar were similar to Carberry. The grain protein concentration of AAC Redstar was 0.2% lower than Carberry. AAC Redstar was rated moderately resistant to *Fusarium* head blight, leaf rust, stripe rust, and common bunt. AAC Redstar had resistant reactions to loose smut and stem rust. AAC Redstar was registered under the CWRS market class.

Key words: Triticum aestivum L., hard red spring wheat, cultivar description, grain yield, protein, early maturity, disease resistance.

Résumé : AAC Redstar est une variété de blé roux vitreux de printemps (*Triticum aestivum* L.) hâtive à rendement élevé, bien acclimatée au nord des Prairies canadiennes. Elle est admissible aux classes du blé roux de printemps de l'Ouest canadien (CWRS — « Canada Western Red Spring »). Au cours des trois années (2016–2018) qu'ont duré les essais d'homologation de la Parkland Wheat Cooperative, le rendement d'AAC Redstar a surpassé celui d'AC Splendor de 11 %, celui de Parata de 6 % et celui de Glenn et de Carberry de 4 %. AAC Redstar parvient à maturité trois jours avant Glenn, deux jours avant Carberry et à peu près en même temps que Parata. La paille d'AAC Redstar est plus courte que celle des autres témoins, sauf Carberry, et a mieux résisté à la verse que les autres cultivars lors des essais d'homologation. AAC Redstar a un poids spécifique et un poids de mille grains similaires à ceux de Carberry. Son grain renferme toutefois 0,2 % moins de protéines. AAC Redstar résiste modérément à la fusariose de l'épi, à la rouille des feuilles, à la rouille jaune et à la carie. La variété affiche aussi une certaine résistance au charbon nu et à la rouille de la tige. AAC Redstar a été homologué pour la classe marchande CWRS. [Traduit par la Rédaction]

Mots-clés : Triticum aestivum L., blé roux vitreux de printemps, description de cultivar, rendement grainier, protéine, précocité, résistance à la maladie.

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Introduction

The northern regions of the western Canadian Prairies, or Parkland Region, is the eco-climatic zone which stretches from north-eastern British Columbia throughout northern Alberta, northern Saskatchewan, and northern Manitoba. The northern prairies extend north of 51°N latitude in Manitoba, north of 53°N in Saskatchewan, and north of 55°N in Alberta. The northern prairies are also characterized by prevalence of gray to dark gray soil and lower growing degree days (GDD; Porter and Gawith 1999) compared with the brown to black soil type and higher GDD in the southern prairies (DePauw et al. 2011*a*). The GDD at southern prairie locations such as Brandon (Manitoba) and high (Saskatchewan) are 1456 and 1476 units, whereas the northern prairie locations such as High Level (Alberta) and Grand Prairie (Alberta) have lower GDD values of 1086 and 1208 units, respectively. The mean temperature from April to August is approximately 2 °C lower in northern prairies compared with the southern prairies (DePauw et al. 2011*a*). The killing frost-free days, calculated as the number of days between the last day prior to 1 July and the first day after 1 July with minimum temperature less than 2.2 °C (Hay and Porter 2006), is generally lower in northern prairies compared with the southern prairies (DePauw et al. 2011*a*). The northern prairies are best suited to wheat varieties that grow faster and yield more with fewer GDD, fewer killing frost-free days, and lower mean temperature during the growing season. Thus, a focused and targeted breeding effort is required to breed wheat varieties truly suited to the northern prairies. The majority of the wheat acreage in the Parkland Region is in northern Alberta. This region is characterized by an extremely short growing season, long day length, and short cool nights. Disease pressure in the Parkland Region is typically lower than in the Western and Central Prairies, especially for *Fusarium* head blight (FHB) (*Fusarium graminearum* Schwabe). Stripe rust (*Puccinia striiformis* Westend.) is an emerging threat, and seasonally, orange wheat blossom midge (*Sitodiplosis mosellana* Géhin) pressure can be very high. With recent changes in Canada Western Red Spring (CWRS) gluten strength targets, there is a lot of opportunity for new CWRS varieties to capture space in growers' fields in the Parkland Region with early-maturing lines that have strong agronomic qualities and good disease resistance. AAC Redstar hard red spring wheat was developed at the Brandon Research and Development Centre (BRDC), Agriculture and Agri-Food Canada (AAFC) in Brandon, MB, Canada. Tested as PT488 and 09B12-FJ2D, AAC Redstar was granted registration No. 8923 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 7 Feb. 2020. Plant Breeders' Rights application No. 19-829 was accepted for filing on 1 May 2019.

Breeding Methods and Pedigree

AAC Redstar is derived from the 2009 cross AAC Redwater/CDC Plentiful. The female parent, AAC Redwater (Zi et al. 2017) was derived from the cross Harvest/McKenzie//AC Intrepid (DePauw et al. 1999; Graf et al. 2003; Fox et al. 2010). The male parent, CDC Plentiful was selected from the cross BW282/CDC Go. Both parental lines, AAC Redwater and CDC Plentiful, are currently registered cultivars belonging to the CWRS market class. A detailed description of the breeding history, cultivar evaluations, and Breeder Seed development is outlined in Table 1. Briefly, 24 F_1 plants were increased in the greenhouse at the Beaverlodge Research Farm, AB, during winter 2009–2010 under the designation 09B12. Then, 12 F_2 bulk plots were grown at the Beaverlodge Research Farm in 2010. Spikes (30) were picked from each F_2 plot and planted as $F_{2:3}$ spike-hills in the 2010–2011 contra-season nursery in Palmerston North, NZ. Five spikes were selected per hill "FJ" and planted as single 1 m spike-rows in the 2011 Beaverlodge hybrid nursery; the $F_{3:4}$ row that gave rise to PT488 was designated 09B12-FJ2. $F_{3:4}$ rows were selected based on plant type, resistance to rusts and common bunt [*Tilletia caries* (DC.) Tul. & C. Tul.], protein concentration, flour yield, and mixograph testing. Selected rows were increased as 1 m $F_{3:5}$ single rows in Palmerston North, NZ, in winter 2011–2012 and selected for plant type and leaf rust (*Puccinia triticina* Erikss.) resistance. In 2012, selected $F_{3:6}$ lines were grown as yield plots in a randomized complete block design (RCBD) with 108 entries. Successful lines were based on high yield, early maturity, resistance to lodging, moderate height, acceptable end-use quality (flour yield, falling number, and mixograph), resistance to leaf, stem (*Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn.), and stripe rust, and FHB resistance. Six heads collected from 09B12-FJ2 were grown as 1 m $F_{6:7}$ rows in the Palmerston North, NZ, 2012–2013 contra-season nursery, where the row that became PT488 was designated 09B12-FJ2D and selected to progress to the "F_8 level testing" in 2013. 09B12-FJ2D was tested within an RCBD design with 108 entries, one replication at three locations, and was evaluated in the combined leaf, stem rust, and FHB disease nursery at Brandon, MB. Selections were made on a similar basis as the F_6 generation. This line was subsequently evaluated in the 2014 "ParkA1" test as a 7×7 lattice with two replications at five locations and the 2015 "Parkland B" test as a 5×5 lattice with three replications at seven locations. 09B12-FJ2D was given the designation PT488 and evaluated over 3 yr (2016–2018) in the Parkland Wheat Cooperative registration trial. The variables measured and the operating protocols followed in the registration trial were those approved by the Prairie Recommending Committee for Wheat, Rye and Triticale (http://pgdc.ca/committees_wrt_pd.html). The check cultivars were AC Splendor

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

Name	Gen.	Year	Activity — Number of lines — Locations
09B12	F_0	2009	Final cross made in a growth cabinet at Beaverlodge Research Farm, Beaverlodge AB.
09B12	F_1	2009–2010	24 plants increased in greenhouse at Beaverlodge Research Farm, Beaverlodge, AB.
09B12	F_2	2010	12 bulk plots seeded in Beaverlodge (10BVR_F2_125-136); harvested 30 spikes per plot (360 total).
09B12-FJ	$F_{2:3}$	2010–2011	163 hills planted in Palmerston North, NZ (11PNH_03666-03828). Up to five spikes per hill harvested out of all 163 hills.
09B12-FJ2	$F_{3:4}$	2011	815 rows of 09B12 (A1 to FU5) grown as 1 m single rows in Beaverlodge hybrid nursery. Selection for agronomics, seed appearance, resistance to rusts and common bunt, protein concentration, flour yield, and mixograph (FJ2 planted as single row).
09B12-FJ2	$F_{3:5}$	2011–2012	156 rows of 09B12 (A1 to FU5) grown as 1 m single rows in Palmerston North, NZ. Selection for agronomics and leaf rust resistance (FJ2 planted as single row).
09B12-FJ2	$F_{3:6}$	2012	"FJ2" line progressed to "F6" level (PR6FHB4) test. Yield trial; RCBD, one replication at four locations (Beaverlodge, AB; Saskatoon, SK; Melfort, SK; Brandon, MB); agronomic, quality, rust, and FHB nursery testing. Spikes out of plot harvested to send to NZ in F7 generation.
09B12-FJ2D	$F_{6:7}$	2012–2013	Six heads from F6 plot sent to Palmerston North, NZ, as a 1 m row nursery. Selection for agronomics and leaf rust resistance as well as quality parameters from F6 yield plot.
09B12-FJ2D	$F_{6:8}$	2013	Line progressed to "F8" level (PR3F8) test. Yield trial; RCBD, one replication at three locations (Melfort, SK; Saskatoon, SK; Beaverlodge, AB); agronomic, quality, rust, and FHB nursery testing.
09B12-FJ2D	$F_{6:9}$	2014	Line progressed to "A" level (Park A1) test. Yield trial; 7×7 lattice with two replications at five locations (Brandon, MB; Saskatoon, SK; Melfort, SK; Beaverlodge, AB; Dawson Creek, BC).
09B12-FJ2D	$F_{6:10}$	2015	Line progressed to "B" level (Park B) test. Yield trial; 5×5 lattice with three replications at seven locations (Saskatoon, SK; Melfort, SK; Westlock, AB; Neapolis, AB; Edmonton, AB(1); Edmonton, AB(2); Beaverlodge, AB).
PT488	$F_{6:11\text{-}13}$	2016–2018	Line progressed to Parkland "C" registration test. Yield trial; 5×6 lattices with three replications all years; 12 locations in 2016 (MB: Roblin, Neepawa; SK: Lake Lenore, Glaslyn, Melfort, Kernen; AB: Beaverlodge, Lacombe, Edmonton, Neapolis; BC: Ft.St. John, Dawson Creek); 11 locations in 2017: Not grown in Dawson Creek; 2017/2018 Neepawa was changed to Dauphin, MB.
Breeder Seed Production			
PT488	$F_{6:11}$	2016	Breeder Seed spikes: 250 random spikes were selected from a rogued increase plot grown at Saskatoon, SK.
PT488	$F_{6:12}$	2017	Breeder Seed isolation rows: 250 lines were grown in 1 m rows grown near Brandon, MB with a 100 ft isolation distance from any other wheat; 23 were removed for lack of uniformity.
PT488	$F_{6:13}$	2018	Breeder Seed rows: 15 m rows grown at Indian Head, SK with 10 m isolation distance from other wheat. 227 rows were grown. Lines were rogued for uniformity and seven lines were culled.

Note: RCBD, randomized complete block design; FHB, Fusarium head blight.

Table 2. Yield ($kg{\cdot}ha^{-1}$) of AAC Redstar and check cultivars in the Parkland Wheat Cooperative registration trials (2016–2018).

	Zone 1[a]			Zone 2[b]			Zone 3[c]			Overall			All sites 2016–2018	
Cultivar	2016	2017	2018	2016	2017	2018	2016	2017	2018	2016	2017	2018	$kg{\cdot}ha^{-1}$	% Chk
Glenn	4157	6271	4827	4117	5216	5134	5394	5480	4658	4746	5513	4896	5051.5	101.6
AC Splendor	3727	6365	3915	4140	4830	4804	5061	4956	4552	4533	5162	4546	4765.3	95.8
PT472	4793	—	—	4614	—	—	5535	—	—	5125	—	—	—	—
Parata	4389	6563	3976	4273	5370	5226	5555	5249	4746	4935	5543	4772	4980.3	100.2
Carberry	4276	6478	4640	4334	5106	5292	5362	5546	4834	4854	5553	4930	5092.0	102.4
AAC Redstar	**4829**	**6315**	**4705**	**4888**	**5217**	**5627**	**6001**	**5798**	**4941**	**5421**	**5693**	**5092**	**5278.6**	**106.2**
Mean of checks	4268	6419	4339	4295	5130	5114	5381	5308	4698	4839	5443	4786	4972.3	—
$LSD_{0.05}$[d]	480	1015	545	216	339	512	274	374	355	180	253	278	284	—
No. of tests	2	2	2	4	4	4	6	5	6	12	11	12	35	—

Note: % Chk, % of the mean of the checks.
[a]Zone 1 test locations: 2016 — Neepawa, Roblin; 2017 — Dauphin, Roblin; 2018 — Dauphin, Roblin.
[b]Zone 2 test locations: 2016 — Kernen, Melfort, Lake Lenore, Glaslyn; 2017 — Kernen, Melfort, Lake Lenore, Glaslyn; 2018 — Kernen, Melfort, Lake Lenore, Glaslyn.
[c]Zone 3 test locations: 2016 — Ft. St. John, Edmonton, Beaverlodge, Lacombe, Neaplois, Dawson Creek; 2017 — Ft. St. John, Edmonton, Beaverlodge, Lacombe, Neaplois; 2018 — Ft. St. John, Dawson Creek, Edmonton, Beaverlodge, Lacombe, Neaplois.
[d]Appropriate least significant difference (LSD) to make comparisons of AAC Redstar to Glenn, AC Splendor, Parata, Carberry, PT472. $P \leq 0.05$ includes the appropriate genotype by environment interaction.

Table 3. Summary of agronomic traits of AAC Redstar and check cultivars in the Parkland Wheat Cooperative registration trials (2016–2018).

Cultivar	Maturity (d)	Height (cm)	Lodging[a] (1–9)	Test weight ($kg{\cdot}hL^{-1}$)	Kernel weight ($mg{\cdot}kernel^{-1}$)	Protein (%)
Glenn	104	94	2.1	82.2	37.6	14.9
AC Splendor	100	98	3.0	78.6	38.5	15.0
Parata	100	100	3.0	80.4	36.7	15.2
Carberry	102	86	2.3	80.2	39.5	14.6
AAC Redstar	**101**	**92**	**1.9**	**80.2**	**39.5**	**14.4**
Mean of checks	102	93	2.6	80.4	38.1	14.9
$LSD_{0.05}$[b]	1.5	2.9	1	0.7	0.9	0.4
No. of tests	35	35	35	35	35	35

[a]Lodging scale: 1 = vertical, 9 = flat.
[b]Appropriate least significant difference (LSD) to make comparisons of AAC Redstar to Glenn, AC Splendor, Parata, Carberry. $P \leq 0.05$ includes the appropriate genotype by environment interaction.

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(Fox et al. 2007), Glenn (Mergoum et al. 2006), Parata (Spaner et al. 2016), Carberry (DePauw et al. 2011*b*), and in 2016, PT472, an unregistered line from the BRDC, AAFC. The data for the test were analyzed for individual years and combined following a mixed model design in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA), with environments and replications as random effects and genotype as a fixed effect. In the registration trials, the stem rust races were TPMK, TMRT, RHTS, QTHS, RTHJ, RKQS, and MCCF (Fetch et al. 2011). The leaf rust inoculum comprised a mixture of prevalent races isolated from the western Canadian prairies as determined from yearly survey studies (McCallum et al. 2016, 2017). Resistance to races T2, T9, T10, and T39 of loose smut [*Ustilago tritici* (Pers.) Rostr.] (Menzies et al. 2003) and resistance to a mixture of prevalent races (L1, L16, T1, T6, T13, and T19) of common bunt (Gaudet and Puchalski 1989; Gaudet et al. 1993) were evaluated in the Parkland Wheat Cooperative registration trials. Resistance to FHB was tested using the macroconidial spore suspension (University of Manitoba, Carman, MB) or corn spawn (Morden Research and Development Centre, MB) inoculum. An equal proportion of four isolates (M1-07-2/15ADON, M3-07-2/15ADON, M7-07-1/3ADON, and M9-07-1/3ADON) of *F. graminearum* was also evaluated in the Parkland Wheat Cooperative registration trials. End-use quality analyses were conducted at the Grain Research Laboratory, Canadian Grain Commission using approved methods (American Association of Cereal Chemists 2000) each year on composite grain samples from all locations with no serious down-grading factors. End-use quality data from the composite samples of AAC Redstar and check cultivars for each year were used as replicates to estimate least-square means for all quality traits over the 3 yr of testing.

Plant descriptive characteristics were recorded from a three-replicate trial conducted in a RCBD at the AAFC Saskatoon Research Farm in Saskatoon, SK, during 2018 and 2019. This trial included the reference cultivars AAC Redwater and CDC Plentiful. All characteristics were recorded as prescribed in the Objective Description Form of the Variety Registration Office, Canadian Food Inspection Agency.

Performance

Agronomy

Averaged over 35 site-years AAC Redstar was significantly higher yielding than the mean of the checks ($P < 0.05$), and averaged 11% higher than AC Splendor, 6% higher than Parata, and 4% higher than either Glenn and Carberry (Table 2). AAC Redstar had similar maturity to Parata, was 2 d earlier than Carberry, 3 d earlier than Glenn, and 1 d later than AC Splendor. AAC Redstar was shorter than all checks except Carberry and had a lower mean lodging rating than all the checks (Table 3). Test weight, kernel weight, and whole grain protein concentration were similar to Carberry.

Disease

FHB index and DON accumulation of AAC Redstar were consistently equal to or lower than Carberry (Table 4). AAC Redstar was resistant to the prevalent races of stem rust and loose smut, and moderately resistant to leaf rust, stripe rust, and common bunt (Tables 5 and 6).

End-use quality

AC Redstar was deemed eligible for all grades of the CWRS wheat class. The results of end-use quality testing are summarized in Tables 7 and 8. AAC Redstar had a consistently high falling number and clean wheat flour yield. Grain protein content was within the range of the checks, except in 2018 when it was slightly lower. Dough strength as determined by extensograph was consistently higher than Carberry in all 3 yr of testing (Table 8).

Other traits

These morphological characters were recorded using field plots grown in Saskatoon in 2018 and 2019 and used for registration purposes.

Seedling characteristics

Coleoptile colour: weak anthocyanin expression.
Juvenile growth habit: semi-erect to intermediate.
Seedling leaves: medium green, glabrous.

Adult plant characteristics

Growth habit: intermediate.
Flag leaf: medium green, recurved, glabrous sheath and blade, medium length and width, waxy blade.
Culm: straight to slightly curved, glabrous, moderate waxiness.

Spike characteristics

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

Spikelet characteristics

Glumes: medium to long and narrow width; slightly pubescent; rounded shoulder shape; beak is short with slight curve.
Lemma: straight.

Kernel characteristics

Type: hard, medium red in colour.
Size: medium size, medium length, medium width; elliptical shape; angular cheeks; short to medium brush hairs; crease with narrow width and medium depth.
Embryo: medium size, oval.

Maintenance and Distribution of Pedigreed Seed

Breeder Seed of AAC Redstar was produced using 250 random spikes from a rogued seed increase plot grown

Table 4. Fusarium head blight VRI[a], DON, and ISD[b] for AAC Redstar and check cultivars in the Parkland Wheat Cooperative registration trials (2016–2018).

	2016			2017			2018		
Cultivar	VRI[a]	DON	ISD[b]	VRI[a]	DON	ISD[b]	VRI[a]	DON	ISD[b]
Morden FHB									
Glenn	23R	21	15R	22MR	11	9MR	20MR	3MR	4MR
AC Splendor	56MS	30	21I	59S	17	13I	29I	8I	7I
PT472	53MS	33	23MS	—	—	—	—	—	—
Parata	39MR	37	25MS	25MR	13	10MR	10MR	2MR	2MR
Carberry	29MR	26	18MR	14MR	12	9MR	13MR	3MR	4MR
AAC Redstar	**31MR**	**25**	**18MR**	**26MR**	**8**	**7MR**	**8MR**	**3MR**	**3MR**
Carman FHB									
Glenn	11MR	21	14	8MR	7	18MR	17I	5I	5I
AC Splendor	17I	14	10	59S	13	38MS	36S	8MS	8MS
PT472	14MR	44	28	—	—	—	—	—	—
Parata	13MR	31	20	20I	11	27I	20I	4I	4I
Carberry	20I	42	27	15MR	10	24I	12MR	3MR	3MR
AAC Redstar	**14MR**	**24**	**16**	**13MR**	**9**	**21MR**	**5MR**	**3MR**	**3MR**

Note: Disease rating class: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible; DON, deoxynivalenol.
[a]FHB index: (percentage of infected heads × percentage of diseased florets on infected heads)/100.
[b]ISD = 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 Redstar and check cultivars in the Parkland Wheat Cooperative registration trials (2016–2018).

	Leaf rust[a] (Morden, MB)			Stem rust[b] (Brandon, MB)			Stripe rust[c] (Creston, BC)		Stripe rust (Lethbridge, AB)			
Cultivar	2016	2017	2018	2016	2017	2018	2016	2017	2016	2017	2018 (1)	2018 (2)
Glenn	28MR	27MR	1MR	10R	10MR	5MR	25I	1R	15MR	40MS	20I	7R
AC Splendor	32MR	30MR	1I	5R	5R	2MR	85S	20MR	45MS	80S	85S	30I
PT472	—	—	—	20MR	—	—	25I	—	10MR	—	—	—
Parata	2MR	6R	1R	5R	5R	5MR	5R	1R	15MR	15MR	60S	25I
Carberry	4MR	1R	1R	5R	10MR	5MR	5R	1R	10MR	TR	10MR	2R
AAC Redstar	**12MR**	**13MR**	**1R**	**7MR**	**5R**	**1R**	**25I**	1R	**10MR**	**2R**	**1R**	**2R**

Note: Disease rating class: R, resistant (1%–10%); MR, moderately resistant (11%–30%); I, intermediate (31%–39%); MS, moderately susceptible (40%–60%); S, susceptible (>60%). Disease response category: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.
[a]Severity is the percentage of leaf/stem area affected by rust. Reaction is the descriptive classification of disease based on percent severity.
[b]Severity is the percentage of stem infected with stem rust using the Modified Cobb Scale.
[c]Severity is the percentage of leaf area affected by rust. Dominant pustule reaction for stripe rust.

Table 6. Bunt, smut, and leaf spot of AAC Redstar and check cultivars in the Parkland Wheat Cooperative registration trials (2016–2018).

	Common bunt[a] (Lethbridge, AB)			Loose smut[b]			Leaf spots[c] (Melfort, SK)			Leaf spots[c] (Swift Current, SK)		
Cultivar	2016	2017	2018	2016	2017	2018	2016	2017	2018	2016	2017	2018
Glenn	3R	15I	4R	0R	—	34MR	8.0I	2.3	2.7	10S	—	—
AC Splendor	10MR	4MR	10MR	5R	—	17MR	8.3MS	2.7	3.3	10S	—	—
PT472	6MR	—	—	—	—	—	8.7MS	—	—	10S	—	—
Parata	4MR	0R	0R	0R	—	38I	10.3S	5.7	3.0	10S	—	—
Carberry	2R	1MR	0R	0R	—	0R	10.7S	3.0	3.3	10S	—	—
AAC Redstar	**0R**	**3MR**	**0R**	**0R**	—	**8R**	**11.0S**	**2.7**	**4.0**	**10S**	—	—

Note: Midge data were not collected as both parents are susceptible to orange blossom wheat midge. Disease rating class: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.
[a]Bunt data represented as severity (percentage of heads 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.

Table 7. Wheat and flour analytical data for AAC Redstar and check cultivars from the Parkland Wheat Cooperative registration trials (2016–2018).

	Flour characteristics					Milling performance			
Cultivar	Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylo-graph (BU)	Clean wheat flour yield (%)[a]	Flour yield (0.50% ash) (%)	Flour ash (%)	Starch damage (%)
2016									
Glenn	14.1	13.1	0.9	310	480	74.8	77.5	0.43	8.6
AC Splendor	15.3	14.3	0.9	385	520	75.9	75.5	0.47	6.4
PT472	14.6	13.9	0.7	465	660	76.8	79.5	0.39	6.3
Parata	14.9	14	0.8	475	575	75.7	77.5	0.43	7.2
Carberry	14.1	13.2	0.9	330	345	75.4	78	0.42	7.4
AAC Redstar	**14.4**	**13.7**	**0.7**	**435**	**650**	**78.2**	**78.5**	**0.41**	**6.5**
2017									
Glenn	14.4	13.6	0.8	360	725	75.3	79.0	0.40	8.4
AC Splendor	14.7	13.9	0.8	395	590	76.2	78.0	0.42	6.8
Parata	14.0	13.4	0.6	400	570	76.8	79.0	0.40	7.6
Carberry	14.4	13.4	0.9	380	520	75.9	78.5	0.41	7.9
AAC Redstar	**14.0**	**13.4**	**0.6**	**430**	**695**	**77.2**	**79.0**	**0.40**	**7.0**
2018									
Glenn	15.0	14.2	0.8	400	785	75.7	78.5	0.41	8.3

Table 7. (*concluded*).

Cultivar	Flour characteristics: Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylo-graph (BU)	Milling performance: Clean wheat flour yield (%)[a]	Flour yield (0.50% ash) (%)	Flour ash (%)	Starch damage (%)
AC Splendor	15.3	14.4	0.9	430	580	76.4	78.0	0.42	6.8
Parata	15.3	14.4	0.9	460	730	77.2	78.5	0.41	7.0
Carberry	15.2	14.1	1.0	405	555	76.1	77.5	0.43	7.5
AAC Redstar	**14.6**	**14.0**	**0.7**	**525**	**715**	**77.8**	**78.5**	**0.41**	**6.6**

Note: End-use quality testing was performed by the Grain Research Lab of the Canadian Grain Commission on a composite sample of each cultivar. The American Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission for determining the various end-use quality traits on a composite of 6–10 locations each year.

[a]Dexter and Tipples (1987). All millings at the Grain Research Laboratory, Canadian Grain Commission are performed in rooms with environmental control maintained at 21 °C and at 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.

Table 8. Dough properties and baking qualities for AAC Redstar and check cultivars from the Parkland Wheat Cooperative registration trials (2016–2018).

	Dough properties						Baking quality				
	Farinograph			Extensograph			Lean no time[a]				
Cultivar	Abs (%)[b]	DDT (min)[c]	MTI (BU)[d] stability (min)	EXT area	EXT R_{max}	EXT length	Abs (%)	Mixing time (min)	Mixing energy (Wh·kg^{-1})	Loaf volume (cm^3)	Loaf top ratio
2016											
Glenn	65.9	5.00	10.5	155	710	18.4	74	4.3	11.9	905	0.71
AC Splendor	65.6	6.25	10.0	127	563	19.1	72	3.6	11.3	795	0.56
PT472	64.8	6.75	9.5	124	502	20.0	73	3.0	8.9	815	0.55
Parata	65.4	7.25	9.5	128	499	20.9	72	3.2	9.5	825	0.54
Carberry	64.4	5.50	6.5	93	378	19.7	71	3.3	9.0	785	0.56
AAC Redstar	**65.3**	**7.50**	**11.5**	**156**	**612**	**20.9**	**72**	**3.2**	**9.8**	**805**	**0.57**
2017											
Glenn	66.9	8.25	9.5	127	547	18.7	74	3.9	10.2	870	0.61
AC Splendor	65.7	6.75	10.0	113	431	20.8	73	2.8	8.3	815	0.50
Parata	64.4	7.75	10.0	106	472	18.3	71	3.4	8.6	775	0.46

Table 8. (*concluded*).

Cultivar	Dough properties						Baking quality				
	Farinograph			Extensograph			Lean no time[a]				
	Abs (%)[b]	DDT (min)[c]	MTI (BU)[d] stability (min)	EXT area	EXT R_{max}	EXT length	Abs (%)	Mixing time (min)	Mixing energy (Wh·kg^{-1})	Loaf volume (cm^3)	Loaf top ratio
Carberry	64.9	5.50	5.5	94	354	20.7	72	2.9	7.7	770	0.49
AAC Redstar	**65.2**	**7.00**	**10.0**	**117**	**474**	**19.8**	**72**	**3.0**	**7.9**	**750**	**0.49**
2018											
Glenn	67.1	9.75	11.0	151	664	19.1	74	3.9	10.8	840	0.56
AC Splendor	66.1	7.25	8.5	98	412	18.5	73	2.8	8.3	770	0.41
Parata	66.3	7.5	11.0	107	445	19.1	73	3.3	9.0	770	0.43
Carberry	66.3	6.25	7.0	94	371	20.0	73	3.3	10.0	745	0.45
AAC Redstar	**66.4**	**6.50**	**11.5**	**129**	**544**	**19.0**	**73**	**3.2**	**9.8**	**795**	**0.53**

[a]Dupuis and Fu (2016).
[b]Abs: Farinograph Absorption. American Association of Cereal Chemists (2002).
[c]DDT: Farinograph Dough Development Time measured in minutes.
[d]MTI: Farinograph Mixing Tolerance Index expressed in Brabender Units (BU).

at Saskatoon, SK, in 2016. These spikes were grown as an isolated group of 1 m single spike-rows in 2017 in Brandon, MB; 23 lines were rejected for lack of uniformity. In 2018, 227 pre-breeder seed rows were grown at the Seed Increase Unit, Indian Head, SK; each 15 m length row was rogued for uniformity, and seven rows were discarded. The remaining rows were inspected and harvested in bulk, producing 265 kg of Breeder Seed. Multiplication; distribution of all other pedigreed seed classes will be handled by SeCan, 400-300 Terry Fox Dr., Kanata, ON K2K 0E3, Canada (https://www.secan.com/).

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