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CULTIVAR DESCRIPTION

AAC Magnet Canada Western Red Spring wheat

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Abstract: AAC Magnet (BW1045) is an awned, hollow-stemmed, high-yielding Canada Western Red Spring (CWRS) wheat adapted to growing conditions in the Canadian Prairies. AAC Magnet was 5% higher yielding than Glenn and yielded 2% more than Carberry, a popular CWRS wheat variety across the Canadian Prairies. AAC Magnet matured 2 d earlier than Carberry and a day later than Unity, the earliest maturing check. AAC Magnet had the same height as Glenn and was shorter with better stem strength compared with Unity. AAC Magnet had better lodging scores compared with Unity. Over the 3 yr of testing (2015–2017), the test weight of AAC Magnet was slightly lower than the lowest checks, whereas the 1000-kernel weight of AAC Magnet was higher than all of the checks. The grain protein content of AAC Magnet was 0.3% lower than Carberry. AAC Magnet was rated moderately resistant to *Fusarium* head blight (*Fusarium graminearum* Schwabe), resistant to leaf rust (*Puccinia triticina* Erikss.) and stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & E. Henn). AAC Magnet was moderately susceptible/susceptible to resistant to the Ug99 family of stem rusts, resistant to loose smut [*Ustilago tritici* (Pers.) Rostr.], intermediately resistant to stripe rust (*Puccinia striiformis* Westend.), susceptible to common bunt [*Tilletia caries* (DC.) Tul. & C. Tul.], and moderately susceptible to leaf spot complex. AAC Magnet was susceptible to orange wheat blossom midge (*Sitodiplosis mosellana* Géhin). Based on the milling and baking performance over 3 yr (2015–2017) evaluated by the Grain Research Laboratory, Canadian Grain Commission, AAC Magnet was classified as CWRS wheat.

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

Résumé : AAC Magnet (BW1045) est une variété de blé roux de printemps de l'Ouest canadien à haut rendement (CWRS). Ce cultivar barbu et à tige creuse est bien acclimaté aux conditions de croissance des Prairies canadiennes. Le rendement d'AAC Magnet dépassait celui de Glenn de 5% et celui de Carberry, variété de blé CWRS populaire dans les Prairies, de 2%. AAC Magnet parvient à maturité deux jours avant Carberry et un jour après Unity, le témoin le plus hâtif. AAC Magnet donne un plant de même taille que Glenn, mais à paille un peu plus courte et plus robuste que celle de Unity. Il résiste mieux à la verse que cette dernière variété. Au cours des trois années d'essais (2015–2017), le poids spécifique d'AAC Magnet a été légèrement inférieur à celui des témoins au poids le plus bas, mais son poids de mille grains dépassait celui des autres témoins. Le grain d'AAC Magnet renferme 0,3% moins de protéines que celui de Carberry. AAC Magnet a été coté modérément résistant à la fusariose de l'épi (*Fusarium graminearum* Schwabe) et résiste à la rouille de la feuille (*Puccinia triticina* Erikss.) et de la tige (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & E. Henn). La variété est modérément sensible/sensible à résistante à la famille Ug99 des rouilles de la tige. Elle résiste au charbon nu [*Ustilago tritici* (Pers.) Rostr.], est moyennement résistante à la rouille jaune (*Puccinia striiformis* Westend), sensible à la carie [*Tilletia caries* (DC.) Tul. & C. Tul.] et modérément sensible au complexe de la tache foliaire. AAC Magnet est sensible à la cécidomyie (*Sitodiplosis mosellana* Géhin). La variété a

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été classée dans les blés CRWS en fonction des résultats meuniers et boulangers de trois ans (2015–2017) obtenus par le Laboratoire de recherches sur les grains de la Commission canadienne des grains. [Traduit par la Rédaction]

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

Introduction

Canada is the 7th largest producer of wheat, with approximately 30 million t of wheat produced in 2018 (www.fao.org/faostat). The total Canadian seeded area for wheat was approximately 10 million ha, out of which, 7 million ha were for spring wheat, 2.5 million ha for durum, and 0.5 million ha for winter wheat (Statistics Canada 2018, Table 32-10-0359-01). The Canada Western Red Spring (CWRS) class is a hard red spring wheat class with superior milling, high protein, and excellent baking quality. The CWRS class accounts for approximately 60% of the annual wheat production in Canada (www.grainscanada.gc.ca). The export potential, superior cultivars, and suitability as a rotation crop makes wheat an important crop for Canadian farmers. With the changing climate, increased disease and insect pest pressure, and reduced land for farming, there is an urgent need to develop climate- and pest-resilient wheat cultivars to feed the growing world population.

AAC Magnet 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 with the Variety Registration Office, Canadian Food Inspection Agency, Ottawa, ON, in June 2018 under registration number 8578. AAC Magnet 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 Magnet was derived from the cross of BW388/BW430. This complex cross was developed to generate a high-yielding CWRS wheat variety adapted to the Canadian Prairies, with broad resistance to leaf and stem rust and improved resistance to *Fusarium* head blight (FHB). The female parent, BW388 (5603HR), originated from a cross of McKenzie//FHB5227/Lars made in Berthoud, CO, in 1998, where McKenzie is a Canadian hard red spring cultivar (Graf et al. 2003). BW388 is a hard red wheat with good resistance to pre-harvest sprouting, leaf rust (*Puccinia triticina* Eriks.), and moderate resistance to stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Erikss. & E. Henn). The male parent BW430 is a hybrid between Alsen (ND716) and BW313 (RL4979). Alsen (ND674//ND2710/ND688), released by the North Dakota Agricultural Experiment Station in 2000, was developed by incorporating the 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). BW313 is a selection of RL4763*2/Howell and received its midge resistance from the soft red winter wheat Howell. AAC Magnet was confirmed to carry markers linked to genes *Lr14a*, *Lr16*, *Lr23*, *Lr34*, *Sr7a*, *Sr8a*, *Sr9b-2*, *Sr11*, *UtBW278*, *PinA*, *Sbm*, *GluAx2**, *TaSdr-B*, *Sus2-2b*, *Vrn-B1**, *PPd-D1-2*, and *VrnD1*.

AAC Magnet was developed using a doubled haploid (DH) breeding method. The final cross for BW1045 was made at the Agriculture and Agri-Food Canada, Cereal Research Centre, Winnipeg, MB, in 2010 to produce F_1 seeds, and the embryos from the F_1 plants were subjected to corn pollination for plant regeneration (Forster and Thomas 2010). The DH lines were increased near Leeston, New Zealand. The seeds were harvested from Leeston as one progeny row per DH plant. The lines were selected based on agronomic traits (height, lodging, and maturity) and leaf rust resistance. The selected lines were then tested in an un-replicated yield test at three locations (Brandon and Glenlea, MB; Saskatoon, SK) in 2012 and selections were made based on agronomic traits, disease resistance, and quality attributes. In 2013, the line BJ14*A0135 was evaluated in the Central Bread Wheat (CBW) "A" test for yield in two replicates at five locations (Glenlea, Brandon, and Melfort, MB; Indian Head Saskatoon, SK). In 2014, the line was tested for agronomic, disease, milling, and baking performance in three replicates from eight locations (Portage, Brandon, and Morden, MB; Indian Head, Melfort, and Kernen, SK; Beaverlodge and Lacombe, AB) in the CBW "B" test. Ultimately, one line from the generated DHs was advanced and designated as BW1045, which was evaluated in the CBW "C" registration trials for 3 yr (2015–2017). A detailed description of the breeding history, cultivar evaluations, 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 included 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 replicates were collected multiple times

Table 1. Breeding history of AAC Magnet (BW1045) hard red spring wheat.

Name	Gen.	Year	Activity — Number of lines — Locations
BJ14	F_0	2010	Final cross made in a growth cabinet.
BJ14	DH	2011	Doubled haploid plants generated.
BJ14*A0135	DH	2011–2012	Winter nursery rows at Leeston, NZ; height, lodging, maturity, leaf rust resistance.
BJ14*A0135	DH	2012	Line tested in unreplicated yield tests at three locations (MB: Brandon, Glenlea; SK: Saskatoon). Selection based on agronomics, disease resistance and quality.
BJ14*A0135	DH	2013	Line in the Central Bread Wheat "A" test. Yield test, two replicates at five locations (MB: Glenlea, Brandon, Melfort; SK: Indian Head, Saskatoon).
BJ14*A0135	DH	2014	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).
BW1045	DH	2015–2017	Line progressed to Central Bread Wheat "C" registration test. Yield test, three replicates at 13 site–year (MB: Portage la Prairie, Brandon, Souris, Dauphin, Fort Whyte, Morden, Neepawa; SK: Indian Head, Pense, Kamsack, Melfort, Kernen, Moose Jaw).
Breeder seed			
BW1045	DH	2015	Breeder seed spikes: 250 random spikes were selected from a rogued increase plot grown at Rosebank, MB.
BW1045	DH	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. 115 lines were lost to flooding in isolation plots.
BW1045	DH	2017	Breeder seed rows: 15-m rows grown at Indian Head, SK, with 10 m of isolation distance from any other wheat. 135 rows were grown. Lines were rogued for uniformity and 16 lines were pulled. Approximately 249 kg of breeder was produced.

per week. The plant height was measured in centimeters from the ground to the top of the spikes, excluding the awns, after completion of stem elongation. 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

AAC Magnet was evaluated for disease reaction to leaf, stem, and stripe rusts, FHB, common bunt, loose smut, leaf spots, and orange blossom midge in the CBWC trials during 2015–2017. 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 resistance 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* Eriks. & 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

End-use quality was evaluated by the Grain Research Laboratory (GRL) of the Canadian Grain Commission (CGC) in Winnipeg, MB. Protein content and grade of

Table 2. Yield (kg ha^{-1}) of AAC Magnet (BW1045) 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	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
BW965	4574	3310	5735	3454	4556	4840	4446	99
AAC Magnet	4451	4128	5479	3269	4447	4724	4444	99
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 Magnet to Unity, Glenn, Carberry, and AAC Viewfield; $P \leq 0.05$, 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.

the check cultivars were used as criteria 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 Magnet over the check cultivars.

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

Performance

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. Based on 32 site–years of testing over 3 yr, AAC Magnet was higher yielding than Glenn (5%) and Carberry (2%). AAC Magnet had a yield identical to AAC Viewfield, but 1% less yielding compared with Unity (Table 2). None of the yield comparisons between AAC Magnet and the check cultivars were statistically significant.

AAC Magnet matured significantly earlier (2 d) than Carberry and a day later than Unity, the earliest maturing check (Table 3). AAC Magnet was significantly shorter and had better lodging tolerance than Unity (Table 3). AAC Magnet had a higher kernel weight than the checks. The test weight of AAC Magnet was lower than all of the checks and significantly lower than Glenn (Table 3). The grain protein content of AAC Magnet was not significantly different compared with the checks (Table 3).

AAC Magnet had adequate resistance to diseases prevalent in the Canadian Prairies. Overall, it 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 Magnet expressed a resistant reaction to FHB at Carman and Morden in 2015 and 2016. It expressed an intermediate reaction to FHB in Carman and moderately resistant reaction at Morden in 2017 (Table 4). AAC Magnet had the lowest deoxynivalenol (DON) levels compared with all of the checks in the inoculated nurseries (Table 4). AAC Magnet was resistant to the prevalent races of leaf and stem rusts. It had a range of reactions from moderately susceptible/susceptible to resistant to the Ug99 family of stem rust (Table 5). Over 3 yr of testing, it was rated to have intermediate resistance to stripe rust, and susceptible reaction to common bunt (Table 6). AAC Magnet had an intermediate to susceptible reaction to common bunt, resistant reaction to loosed smut, and

Table 3. Summary of agronomic traits of AAC Magnet (BW1045) 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 Magnet	95	90	1.7	79	37.1	14.7
Mean of checks	96	87	2	81	34	15
$LSD_{0.05}$	2	3	0.3	1.47	4.1	0.6
No. of tests	29	32	26	31	31	31

Note: LSD, least significant difference appropriate to make comparisons of BW1045 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.

Table 4. *Fusarium* head blight VRI[a], DON, and ISD[b] for AAC Magnet (BW1045) 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
Carberry	15.1MR	9.5	7.6	11.8MR	17.2	12	10.3MR	8	6.4 MR	37	7
AAC Viewfield	21.5I	15	11.1	31.8MS	43.5	28.6	23.7I	16.7	12.2I	38	13
AAC Magnet	7R	8	6	2.3R	4.8	3.6	9MR	13	9.2I	22	2.4
	Morden FHB										
Unity	50I	18.3	13.8MR	41.2MR	25.5	18.0MR	46I	15.5	12I		
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	53MS	41.8	28.1MS	44I	32.9	22.5MS		
AAC Magnet	32MR	13	10R	8.3R	11.0	8.3R	19MR	11.6	9MR		

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).

moderately susceptible reaction to leaf spot. AAC Magnet is susceptible to orange blossom wheat midge (Table 6).

Grain protein, milling, and flour baking properties of AAC Magnet were tested by the Grain Research Laboratory in Winnipeg, MB. End-use quality assessment (AACC 2000) was done on a composite sample formulated from different 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 Magnet met the milling and baking performance of the CWRS class of wheat. Grain protein content was similar to or higher than Unity and lower than the other checks (Table 7). AAC Magnet had lower protein loss than Carberry, but higher than the other checks. Flour protein (%) was similar to Unity and lower than the other checks. Falling number was higher than Glenn and AAC Viewfield in 2015 and 2016, but lower than all of the checks in 2017. Clean flour yield was higher than all of the checks except Unity. Amylograph (BU) was lower than all of the checks in 2015 (except Carberry) and 2017, but was better than Glenn, Carberry, and AAC Viewfield in 2016. Flour ash (%) was within the range of the checks. Starch damage was consistently lower than Unity and Glenn over the tested years (2015–2017). Flour yield (0.05 ash, %) was similar to all of the checks (Table 7). Water absorption measured on the farinograph

Table 5. Rust disease severities and ratings of AAC Magnet (BW1045) 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	2016	2017
Unity	37I	30MR	40MR	20I	10MR	10MR	40S	60S	95S	70S	50S	—
Glenn	6R	25MR	17MR	10MR	5R	10MR	2R	17MR	35I	15MR	53S	20M
Carberry	4R	0.3R	0R	5R	2R	5R	2R	10MR	25I	0R	43S	12MR
AAC Viewfield	10R	10R	5R	15MR	5R	10MR	15I	25I	15MR	15MR	18S	7RMR
AAC Magnet	0R	0MR	0R	5R	10R	5R	2.0R	50MS	75S	5R	10MSS	7R

[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; RMR, both resistant and moderately resistant pustules are present on the same plant; MSS, both moderately susceptible and susceptible pustules present on the same plant.
[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.
[d]Tested at Lethbridge, AB.
[e]Tested at Creston, BC.

Table 6. Bunt, smut, leaf spot, and midge ratings of AAC Magnet (BW1045) 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 Magnet	39S	18I	31S	2.1R	14	—	8.7MS	10S	2.3	—	0:8:2	0:6:4

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).

directly relates to the amount of bread that can be produced from a given weight of wheat flour. Farinograph absorption was lower than all of the checks within the tested years (2015–2017), and dough stability was higher than Unity and Carberry (Table 8). Baking quality was assessed using the Canadian short process (Preston et al. 1982) for 2014 and 2015 and the Lean No Time test (Dupuis and Fu 2017) in 2016. AAC Magnet loaf volume (cm^3) was higher than Carberry and the loaf top ratio was higher than all of the checks except Glenn within the tested years (2015–2017; Table 8).

Other Characteristics

The morphological characteristics were recorded using experimental field plots grown in 2016 and 2017 at Saskatoon, SK.

Seedling characteristics

Coleoptile colour: absent.
Juvenile growth habit: semi-erect to intermediate.
Seedling leaves: medium green, glabrous.
Tillering capacity (at low densities): (seeded at regular density).

Adult plant characteristics

Growth habit: intermediate.
Flag leaf attitude: intermediate.
Flag leaf: medium green, recurved, glabrous sheath and blade, slightly waxy blade, long and narrow width, glabrous margins.
Culm: straight, glabrous, slight waxiness.

Spike characteristics

Shape: erect and parallel sided.

Table 7. Wheat and flour analytical data[a] for AAC Magnet (BW1045) 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 Magnet	15.1	14.1	1	350	400	76.3	77.5	0.43	7.3
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 Magnet	13.9	12.9	1.0	395	535	75.8	76.0	0.46	7.5
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 Magnet	14.4	13.6	0.8	360	460	76.8	79.5	0.39	7.4

[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.

Table 8. Dough properties and baking qualities for AAC Magnet (BW1045) 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 Magnet	63.8	7.5	35	9	120	514	18.9	68	4.9	11.6	1000	—
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 Magnet	62.9	5.75	—	9	129	490	20.8	70	3.7	10.1	810	0.60
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 Magnet	62.4	7.25	—	9.5	134	525	20.7	69	3.7	10.4	825	0.56

[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.

Length: short.
Density: lax to medium dense.
Attitude: erect.
Colour: brown at maturity.
Awns: awned.

Spikelet characteristics

Glumes: long and medium width; slightly pubescent; rounded shoulder shape; beak is short with acumi nate shape.
Lemma: straight.

Kernel characteristics

Type: hard, medium red in colour.
Size: medium size, medium length, narrow width; oval shape; rounded cheeks; medium brush hairs; medium wide and medium deep crease.
Embryo: small size, oval.

Maintenance and Distribution of Pedigreed Seed

Breeder seed of AAC Magnet 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. 115 lines were lost to flooding in isolation plots. In 2017, a 15-m row was grown from each of the 135 remaining isolation rows at the Indian Head Seed Increase Unit. Prior to bulk harvesting the breeder rows, 16 rows were discarded. The remaining uniform plots were inspected and harvested in bulk, producing 249 kg of breeder seed. Multiplication and distribution of all other pedigreed seed classes will be handled by FP Genetics Inc., 426 McDonald Street, Regina, SK S4N 6E1, Canada; phone: 306-791-1045; fax: 306-791-1046; website: https://www.fpgenetics.ca/contact.php; email: info@fpgenetics.ca.

Contributions

S. Kumar and S.L. Fox performed selections and progression of lines to finally select AAC Magnet (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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