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CULTIVAR DESCRIPTION

AAC Hodge Canada western red spring wheat

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Abstract: AAC Hodge (BW1069) is a hollow-stemmed, awned and high yielding Canada Western Red Spring (CWRS) wheat cultivar suited to the growing conditions in Western Canada. AAC Hodge was 6% higher yielding than AAC Viewfield, the highest yielding check in the Central Bread Wheat Cooperative (CBWC) registration trials (2017–2019). Within the same test, AAC Hodge was 16% higher yielding than Carberry. AAC Hodge matured 1 d earlier than Carberry and 2 d later than Unity; Unity is the earliest maturing check in the eastern prairie growing conditions. AAC Hodge was 7 cm shorter with better lodging resistance than Unity. The lodging score for AAC Hodge was lower than the mean of the checks. The test weight of AAC Hodge was similar to the mean of the checks. Over the 3 yr of testing (2017–2019), the 1000-kernel weight of AAC Hodge was equal to, or higher than all the checks. The grain protein content of AAC Hodge was equal to that of AAC Viewfield. AAC Hodge was rated moderately resistant to Fusarium head blight (FHB; *Fusarium graminearum* Schwabe) and resistant to leaf rust (*Puccinia triticina* Erikss.), stripe rust (*Puccinia striiformis* Westend), stem rust (*Puccinia graminis* Pers. f. sp. tritici Eriks. & E. Henn), and common bunt [*Tilletia caries* (DC) Tul. & C. Tul.]. AAC Hodge ranged from resistant to moderately susceptible for its reaction to the Ug99 family of stem rusts. AAC Hodge was resistant to orange wheat blossom midge (OBWM) (*Sitodiplosis mosellana* Géhin). AAC Hodge was registered under the CWRS class.

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

Résumé : AAC Hodge (BW1069) est un cultivar barbu et à tige creuse de blé roux de printemps de l'Ouest Canadien (CWRS) au rendement élevé, bien adapté aux conditions de culture propres à l'Ouest canadien. Son rendement a dépassé de 6 % celui d'AAC Viewfield, le cultivar témoin au rendement le plus élevé lors des essais d'homologation de la Central Bread Wheat Cooperative (CBWC), de 2017 à 2019. Lors des mêmes essais, AAC Hodge a donné un rendement de 16 % supérieur à celui de Carberry. AAC Hodge parvient à maturité un jour avant Carberry et deux jours plus tard que Unity, le témoin le plus hâtif dans les conditions de croissance particulières à l'est des Prairies. AAC Hodge se caractérise par une paille plus courte de 7 cm et une meilleure résistance à la verse que Unity. La note obtenue par AAC Hodge pour la verse était inférieure à la moyenne des témoins. AAC Hodge a un poids spécifique similaire au poids moyen des témoins. Au cours des trois années d'essai (2017-2019), le poids de 1 000 grains d'AAC Hodge était égal ou supérieur à celui des témoins. Le teneur en protéines du grain d'AAC Hodge correspond à celle d'AAC Viewfield. AAC Hodge a été classé modérément résistant à la brûlure de l'épi causée par *Fusarium graminearum* Schwabe et résistant à la rouille de la feuille (*Puccinia triticina* Erikss.), à la rouille jaune (*Puccinia striiformis* Westend), à la rouille de la tige (*Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn) et à la carie [*Tilletia caries* (DC) Tul. & C. Tul.]. AAC Hodge est résistant à modérément sensible à la famille de rouilles de la tige Ug99. AAC Hodge résiste à la cécidomyie du blé (*Sitodiplosis mosellana* Géhin). La variété a été homologuée dans la catégorie CWRS. [Traduit par la Rédaction]

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

Introduction

Wheat (*Triticum aestivum* L.) is grown across the globe as a principle component of the human diet and animal feed. The Food and Agriculture Organization (FAO) data reports the 2020–2021 global gross wheat production at 777 million metric tonnes from a harvested area of 225 million hectares (FAOSTAT 2021). Canada ranked 5th amongst the wheat producing nations with 35 million tonnes of wheat produced from a cropped area of 9.5 million hectares in 2020 (FAOSTAT 2021). Canada, known for its premium quality red spring wheat, is the second largest exporter of wheat valued at 6.3 billion dollars (Grains Canada 2021). A recent report by Toth et al. (2019) shows a steady yield increase in Canada over the past three decades. This increase in yield is critical for sustaining increasing demand for wheat, which provides 16% of the calories and 25% of the protein in human diet globally (Braun et al. 2010). The CWRS class of bread wheat constituted 69% of the total western Canadian acres in 2020 (www.grainscanada.gc.ca). Due to its steady yields, optimum disease resistance, and excellent milling and baking attributes, CWRS wheat is the preferred cereal rotation crop across the Canadian Prairies. Canadian farmers manage good returns on their wheat due to the high market demand and the export of CWRS wheat from Canada. The new and improved field ready cultivars facilitate increased agricultural productivity and marketability under sustainable production systems.

AAC Hodge is a hard red spring wheat cultivar developed by the Agriculture and Agri-Food Canada (AAFC), Brandon Research and Development Centre, Brandon, Manitoba, Canada. It was registered by Variety Registration Office of the Canadian Food Inspection Agency under the registration number 9099. AAC Hodge is best adapted to the Canadian Prairie growing conditions and is protected by Plant Breeder's Rights Application Number 20-10257 effective 2020-06-04.

Pedigree and Breeding Methods

AAC Hodge is derived from a cross of BW430/BW897. The female parent BW430 was derived from a cross between Alsen (Frohberg et al. 2006) and BW313. Alsen (ND 674//ND 2710/ND 688) was released by the North Dakota Agricultural Experiment Station in 2000. The line BW313 was derived from a cross between RL4763*2/Howell. The male parent BW897 was an advanced line derived from a cross with Prodigy (Graf et al. 2003) crossed twice with Alsen (Prodigy/2*Alsen). Alsen was developed by incorporating the FHB resistance from Sumai 3 into an adapted background that had good stem and leaf rust resistance, yield, and quality characteristics (Frohberg et al. 2006). Prodigy, a hard red spring wheat, was developed by Saskatchewan Wheat Pool Research and Development. Prodigy is resistant to stem rust and leaf rust and has strong straw (Graf et al. 2003). This complex cross was developed to generate a high-yielding CWRS wheat variety adapted to the eastern Canadian prairies, with broad resistance to leaf and stem rust, FHB, and resistance to the OBWM. AAC Hodge tested positive for markers linked to genes *Lr14a, Lr16, Lr23, Lr34, Sr11, UtBW278, Fhb1, Fhb-5AS, Sm1, PinB, Sbm, SNN-1, 7BxOE, Wx-B1, PPd-D1-2,* and *RhtB* (Toth et al. 2019).

AAC Hodge was developed using the modified pedigree breeding method. The final cross for AAC Hodge was made at the AAFC, Cereal Research Centre in 2008. In 2008–2009, the F_1 seeds were grown as 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 were collected from the selected 3 m rows. The F_2-derived lines were further selected based on agronomic, disease resistance, and grain quality up to the F_6 generation. The F_6-derived lines were then tested in advanced yield trials at multiple locations and further selections were done based on agronomic, disease and grain/flour quality attributes. Finally, the line BJ08B-NP-24-NGNB-10-N was tested in the CBWC registration trials as BW1069 for 3 yr (2017–2019). A detailed description of the breeding history and breeder seed development is given 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 6 blocks as 5 entries per group and 3 replicates. The agronomic check cultivars included in the CBWC were Unity (BW362) (Fox et al. 2010), Glenn (ND747) (Mergoum et al. 2006), Carberry (BW874) (DePauw et al. 2011) and AAC Viewfield (Cuthbert et al. 2019). The yield data from all three replicates were collected from all 13 locations. The final plot yields at similar moisture content were converted to yield per unit area ($kg \cdot ha^{-1}$). Days to maturity was recorded as days from seeding to when seeds resisted denting by fingernail (16%–18% moisture), and maturity data from all the 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 stem extension 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 grams per 1000-kernels.

Table 1. Population size and activities at each generation leading to the development of AAC Hodge (BW1069) hard red spring wheat.

Name	Generation	Year	Activity, Number of Lines, and Location
BJ08B	F_0	2008	Final cross made in a growth cabinet.
BJ08B	F_1	2009–2010	F1 seeds grown in a 1.5 m row near Leeston, NZ. 50 heads were harvested.
BJ08B	F_2	2010	F2 seeds grown as 45, 3 m rows, ~40 seeds/row grown near Portage la Prairie (Portage), MB. 250 heads were harvested.
BJ08B-N-24	$F_{2:3}$	2010–2011	25 selected lines were grown near Palmerston North (PN), NZ as hills (one hill was BJ08B-NP-24). The harvested seeds were bulked.
BJ08B-NP-24-N	$F_{2:4}$	2011	118 BJ08B-NP lines were grown in a 1 m row nursery near Portage, MB (one row was BJ08B-NP-24-N). Selection for agronomics, seed appearance, resistance to rusts and common bunt, protein concentration, flour yield, and mixograph.
BJ08B-NP-24-NG	$F_{2:5}$	2011–2012	75 BJ08B-NP lines were grown near PN, NZ as rows (one row was BJ08B-NP-24-NG). Selection for agronomics and leaf rust resistance.
BJ08B-NP-24-NGN	$F_{2:6}$	2012	5 BJ08B-NP lines were tested in a single replicate yield test at three locations (MB: Glenlea, Portage; SK: Saskatoon). BJ08B-NP-24-NGN was one line in this test. Selections based on agronomic, quality, and disease parameters. 25 heads harvested per selected line and sent as 1 head/row to PN.
BJ08B-NP-24-NGNB-10	$F_{6:7}$	2012–2013	46 selected lines were grown near PN in 1.5 m rows. BJ08B-NP-24-NGNB made up 19 of these lines. Selection for agronomics and leaf rust resistance as well as quality parameters from F_7 seeds.
BJ08B-NP-24-NGNB-10-N	$F_{6:8}$	2013	14 BJ08B-NP lines were tested in single replicate yield tests at three locations (MB: Brandon; SK: Melfort, Saskatoon). BJ08B-NP-24-NGNB made up 8 of these lines. Selection based on agronomics, disease resistance, and quality.
—	—	2014	No F9 test this year due to a transition phase between wheat breeders.
BJ08B-NP-24-NGNB-10-N	$F_{6:9}$	2015	1 BJ08B-NP-24-NGNB-10-N line tested in the Central Bread Wheat "A" test. Yield test, two replicates at five locations (MB: Brandon, Portage; SK: Melfort, Saskatoon, Indian Head). Increased in Saskatoon.
BJ08B-NP-24-NGNB-10-N	$F_{6:10}$	2016	1 line in the Central Bread Wheat "B" test. Yield test, three replicates at ten locations (MB: Brandon, Portage, Morden, Fort Whyte; SK: Indian Head, Melfort, Kernen. Saskatoon; AB: Beaver Lodge, Lacombe). Increased in Indian Head.
BW1069	$F_{6:11\text{-}13}$	2017–2019	1 line progressed to Central Bread Wheat "C" registration test. Yield test, three replicates at 13 locations/year (MB: Portage, Brandon, Souris, Dauphin or Neepawa, Morden, Fort Whyte; SK: Indian Head, Pense, Kamsack or Yorkton, Melfort, Kernen, Waldheim, Moose Jaw).
Breeder seed production			
BW1069	$F_{6:11}$	2017	Breeder seed spikes: 250 random spikes were selected from a rogued increase plot grown near Rosebank, MB.
BW1069	$F_{6:12}$	2018	Breeder seed isolation rows: 250 lines were grown in 1 m rows grown near Brandon, MB with a 10 m isolation distance from any other wheat.
BW1069	$F_{6:13}$	2019	Breeder seed rows: 15 m rows grown at Indian Head, SK with 10 m isolation distance from other wheat. 225 rows were grown. Lines were rogued for uniformity and 23 lines were pulled. Approximately 400 kg of breeder was produced.

Disease testing

The line BW1069 was evaluated for disease reaction to leaf, stem, and stripe rust, FHB, common bunt, loose smut, and OBWM in CBWC trials between the years 2017–2019. Field nurseries inoculated with either a macroconidial spore suspension (University of Manitoba, Carman) or corn spawn [Morden Research and Development Centre, Manitoba (MRDC)] inoculum,

Table 2. Yield (kg·ha^{-1}) of AAC Hodge (BW1069) and check cultivars in the Central Bread Wheat Cooperative, 2017–2019.

	Zone 1[a]				Zone 2[b]				All sites	
									2017–2019	
Cultivar	2017	2018	2019	2017–2019	2017	2018	2019	2017–2019	kg·ha^{-1}	% Unity
Unity VB	5612	5101	4882	5199	5086	4557	6017	5220	5164	100
Glenn	5486	4735	4565	4929	5245	4242	5632	5040	4933	96
Carberry	5736	4526	4494	4919	5384	4391	5503	5093	4961	96
AAC Viewfield	5709	5431	4871	5337	5819	4954	6113	5629	5410	105
AAC Hodge	6424	5486	5405	5772	6252	4945	6276	5825	5755	111
Mean of checks	5636	4948	4703	5096	5384	4536	5816	5245	5117	—
$LSD_{0.05}$	286	243	214	244	264	201	220	209	231	—
No. of tests	6	6	6	18	4	6	3	13	31	—

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

[a]Zone 1 test locations: 2017 — Brandon, Souris, Morden, Fort Whyte, Dauphin, Portage la Prairie; 2018 — Brandon, Souris, Morden, Fort Whyte, Dauphin, Portage la Prairie; 2019 — Brandon, Fort Whyte, Souris, Morden, Neepawa, Portage la Prairie.

[b]Zone 2 test locations: 2017 — Melfort, Indian Head, Kernen, Moose Jaw; 2018 — Kamsack, Melfort, Pense, Indian Head, Kernen, Moose Jaw; 2019 — Indian Head, Kernen, Melfort.

Table 3. Summary of agronomic traits of AAC Hodge (BW1069) and check cultivars in the Central Bread Wheat Cooperative, 2017–2019.

	Maturity (d)[a]	Height (cm)[b]	Lodging[c] (1–9)	Test weight (kg·hL^{-1})	Kernel weight (mg·kernel^{-1})	Protein (%)
Cultivar	2017–2019	2017–2019	2017–2019	2017–2019	2017–2019	2017–2019
Unity	92	93	2.0	80.8	36.0	14.0
Glenn	94	86	1.3	83.5	35.7	14.3
Carberry	95	81	1.2	81.3	37.2	14.5
AAC Viewfield	94	76	1.2	82.0	35.5	13.9
AAC Hodge	94	86	1.1	81.7	37.2	13.9
Mean of Checks	94	84	1.4	81.9	36.1	14.2
$LSD_{0.05}$	1.75	3.29	31.23	1.14	3.14	3.87
CV	1.27	2.09	0.32	0.4	0.57	0.26
No. of tests	33	33	22	35	35	35

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

[a]2019 – Waldheim omitted from maturity data.

[b]2017 – Kamsack omitted from height data; 2019 – Waldheim omitted from height data.

[c]Lodging scale: 1 = vertical, 9 = flat. 2019 – Waldheim omitted from lodging data.

with an equal proportion of 4 isolates HSW-15-27 (15 ADON), HSW-15-39 (3 ADON), HSW-15-57 (15 ADON), HSW-15-87 (3 ADON) of *Fusarium graminearum* Schwabe, 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* Eriks.) 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 the MRDC. Experiments were also conducted in the greenhouse to evaluate seedling reactions to six leaf rust races, MBDS (12-3), MGBJ (74-2), TJBJ (77-2), TDBG (11-180-1), TDBG (06-1-1) 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, Alberta (Randhawa et al. 2012). Common bunt [*Tilletia caries* (DC) Tul. & C. Tul.] resistance was recorded at the Lethbridge Research and Development Centre, Lethbridge, Alberta, Canada using a composite of races L1, L16, T1, T6, T13, and T19, and planting

Table 4. Fusarium head blight VRI[a], DON, ISD[b] and FDK[c] for AAC Hodge (BW1069) and check cultivars in the Central Bread Wheat Cooperative, 2017–2019.

	FHB Morden 2017					FHB Morden 2018					FHB Morden 2019				
Entry	Avg VRI %	VRI rate	Avg DON	ISD	ISD rate[b]	Avg VRI %	VRI rate	Avg DON	ISD	ISD rate	Avg VRI %	VRI rate	Avg DON	ISD	ISD rate
Unity	45.6	I	15.5	12.0	I	41.3	S	3.8	4.9	MR	44.5	MS	10.7	—	—
Glenn	36.5	I	17.8	13.2	I	25.7	I	3.5	4.2	MR	23.4	MR	7.3	—	—
Carberry	33.9	I	21.7	15.5	I	16.5	MR	4.4	4.5	MR	28.8	I	8.5	—	—
AAC Viewfield	43.5	I	32.9	22.5	MS	20.2	I	6.3	5.7	I	40.5	MS	18.4	—	—
AAC Hodge	18.9	MR	9.3	7.5	MR	11.3	MR	1.7	2.3	MR	13.5	MR	4.9	—	—
	FHB Carman 2017					FHB Carman 2018					FHB Carman 2019				
	29.3	I	8.33	7.2	MR	16.3	I	2.2	3.0	MR	42	MS	MR	—	—
Glenn	12.3	MR	9.33	7.2	MR	15.8	I	3.1	3.7	MR	18	MR	MR	—	—
Carberry	10.3	MR	8	6.4	MR	10.7	MR	3.0	3.4	MR	12.3	MR	MR	—	—
AAC Viewfield	23.7	I	16.67	12.2	I	8.9	MR	4.3	4.1	I	28.4	I	MR	—	—
AAC Hodge	9	MR	8	6.4	MR	7.1	MR	1.4	2.2	R	11.5	MR	MR	—	—
	FHB PEI 2017					FHB PEI 2018					FHB PEI 2019				
Entry	Inc.	Sev.	Index	FDK	DON	Inc.	Sev.	Index	FDK	DON	Inc.	Sev.	Index	FDK	DON
Unity	8	7	56.0	4	25.2	—	—	—	—	—	7.8	6.0	46.5	—	—
Glenn	8	6	48.0	3	25.8	—	—	—	—	—	7.5	6.0	45.0	—	—
Carberry	8	7	56.0	3	14.0	—	—	—	—	—	8.0	6.5	52.0	—	—
AAC Viewfield	8	6	48.0	4	22.9	—	—	—	—	—	8.3	5.5	45.3	—	—
AAC Hodge	8	6.3	50.7	2.0	7.3	—	—	—	—	—	8.0	5.8	46.0	—	—

Note: This table displays FHB resistance of AAC Hodge against the check varieties in inoculated nurseries at Carman MB, Morden MB, and Charlottetown PEI. Disease rating class: R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.

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

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

[c]FDK = Fusarium Damage Kernels.

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Table 5. Rust disease severities and ratings of AAC Hodge (BW1069) and check cultivars in the Central Bread Wheat Cooperative, 2017–2019.

	Leaf rust[a]			Stem rust[b]			Stripe rust[c]			Ug99[b]		
Cultivar	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
Unity	40 MR	15 MR	57 MS	10 MR	1 R	10 R	70 S	29I	67 S	—	—	50 MS S
Glenn	17 MR	13 MR	35 I	10 MR	1 R	10 R	15 MR	23 I	38 I	20 M	—	5 MR MS
Carberry	0 R	2 R	13 MR	5 R	1 R	5 R	0 R	9 R	22 MR	12 MR	—	20 MS
AAC Viewfield	5 R	2 R	27 MR	10 MR	1 R	10 MR	15 MR	10 MR	50 S	7 R MR	—	20 MS
AAC Hodge	3 R	0 R	17 MR	5 R	1 R	1 R	TR	2 R	10 R	3 R	—	20 MR MS

Note: This table displays rust resistance of AAC Hodge against the check varieties in inoculated nurseries. 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. 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.

[c]Severity is the percentage of leaf area affected by rust. Dominant pustule reaction for stripe rust.

Table 6. Bunt, smut, leaf spot and midge ratings of AAC Hodge (BW1069) and check cultivars in the Central Bread Wheat Cooperative, 2017–2019.

	Common bunt[a]			Loose smut[b]			Leaf spots[c]			OBWM[d]					
Cultivar	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017[e]	2017[f]	2018[e]	2018[g]	2019[e]	2019[h]
Unity	1 MR	0 R	2 R	—	38	—	2.3	3	—	3:1:6	3:0:7	4:1:4	7:2:1	7:1:3	3:0:2
Glenn	10 I	23 I	10MR	—	19	—	1.3	4	—	0:10:0	0:10:0	0:5:0	0:10:0	0:9:1	0:5:0
Carberry	2 MR	0 R	0 R	—	0	—	2.7	3	—	0:10:0	1:7:2	0:5:0	0:10:0	0:10:0	0:5:0
AAC Viewfield	10 I	10 MR	5 R	—	72	—	2.0	4	—	0:9:1	0:9:1	0:5:0	0:10:0	0:10:0	0:5:0
AAC Hodge	0 R	12 MR	5 R	—	65	—	1.7	3	—	4:0:6	4:0:6	5:0:5	8:0:2	10:0:0	4:0:6

Note: Disease rating class: 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]OBWM rating R:S:U (Resistant:Susceptible:Undamaged).

[e]Brandon, MB.

[f]Morden, MB.

[g]Indian Head, SK.

[h]Melfort, SK.

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 OBWM feeding damage was assessed by visually inspecting the midge damaged kernels on mature spikes. Forty-five spikes (15 spikes per replicate from three replicates) were collected per entry and were analyzed under a dissecting microscope for larval feeding damage symptoms. Based on 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, Manitoba. Protein content and grade of 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 (%; 0.5% ash basis), 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 2021).

The data analysis was performed using AGROBASE Generation II®. The years, environments, and their interactions were treated as random effects, and cultivar as a fixed effect, and the model was used to generate means and standard errors. The least significant difference (LSD) was then calculated using the formula

Table 7. Wheat and flour analytical data[a] for AAC Hodge (BW1069) and check cultivars from the Central Bread Wheat Cooperative (2017–2019).

Cultivar	Flour characteristics					Milling performance			
	Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylo-graph (BU)	Clean flour yield (%)[b]	Flour yield (0.5% ash) (%)	Flour ash (%)	Starch damage (%)
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 Hodge	14.1	13.4	0.7	415	945	77.9	79.0	0.40	8.5
2018									
Unity	14	13.4	0.6	400	885	76.5	78.5	0.41	8.2
Glenn	14.2	13.5	0.6	345	745	75.4	79.0	0.40	8.6
Carberry	14.5	13.8	0.7	385	530	76.1	79.0	0.40	7.6
AAC Viewfield	13.8	13.4	0.5	385	615	76.4	78.5	0.41	7.6
AAC Hodge	14.1	13.2	0.9	395	995	77.1	78.5	0.41	8.3
2019									
Unity	—	—	—	—	—	—	—	—	—
Glenn	14.8	14.1	0.7	335	495	74.8	77.0	0.44	7.8
Carberry	15.2	14.2	1.0	360	355	75.9	77.0	0.44	6.9
AAC Viewfield	14.5	13.9	0.7	385	445	75.8	77.5	0.43	7.4
AAC Hodge	14.5	13.6	0.8	355	440	77.3	77.0	0.44	7.9

Note: End-use quality testing[a] was performed by the Grain Research Laboratory (GRL) of the Canadian Grain Commission (CGC) on a composite sample of each cultivar.

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

[b] Dexter and Tipples (1987). All millings at the CGC's GRL 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.

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 Hodge over the check cultivars. The end-use quality data are non-replicated observations within years.

Performance

The 2017–2019 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 (Cuthbert et al. 2019) as the recommended checks. Based on 33 site-years of testing over 3 yr, AAC Hodge was higher yielding than Glenn (17%), Carberry (16%), AAC Viewfield (6%) and Unity (11%) (Table 2).

AAC Hodge matured 1 d earlier than Carberry and was the same or earlier than all checks except Unity (Table 3). AAC Hodge was 7 cm shorter in height and had better lodging resistance compared with Unity. AAC Hodge had a similar test weight to the checks and higher or equivalent kernel weight to the checks. The grain protein content of AAC Hodge was equivalent to AAC Viewfield but 0.1% lower than Unity (Table 3).

AAC Hodge had strong resistance to diseases prevalent in the eastern Canadian Prairies. AAC Hodge was rated moderately resistant to FHB by the disease evaluation team of the Prairie Grain Development Committee. Over 3 yr of testing (2017–2019), AAC Hodge expressed moderately resistant reactions to FHB at the Carman and Morden, Manitoba locations (Table 4). It had lower or equivalent mean deoxynivalenol (DON) levels than all checks in the inoculated nurseries (Table 4). AAC Hodge was resistant to the prevalent races of leaf, stem and stripe rust (Table 5). It was also rated resistant to common bunt (Table 6). Based on 3 yr of data, AAC Hodge is resistant to OWBM based on phenotypic data on midge tolerance and the presence of *Sm1* gene marker (Table 6).

Grain and flour quality attributes of AAC Hodge were tested by the Grain Research Laboratory in Winnipeg, Manitoba, Canada. 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

Table 8. Dough properties and baking qualities for AAC Hodge (BW1069) and check cultivars from the Central Bread Wheat Cooperative (2017–2019).

	Dough properties						Baking quality				
	Farinograph			Extensograph			Lean no time (LNT) method[a]				
Cultivar	Abs (%)[b]	DDT (min)[c]	Stability (min)	EXT Area	EXT Rmax	EXT ength	Abs (%)[b]	Mixing time (min)	Mixing energy (whr/kg)	Loaf volume (cm^3)	Loaf top ratio
2017											
Unity	63.8	5.75	7.0	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	11.0	119	470	20.6	71	3.4	9.4	805	0.48
AAC Hodge	62.4	10.50	12.5	144	682	17.9	69	4.3	11.7	800	0.59
2018											
Unity	65.1	5.25	7.0	87	366	18.8	72	2.9	7.8	765	0.50
Glenn	65.9	9.00	13.0	139	689	16.7	73	4.1	10.3	845	0.58
Carberry	64.8	7.25	8.0	101	443	18.4	73	3.5	8.8	790	0.52
AAC Viewfield	64.9	7.25	10.0	114	480	19.3	72	3.5	9.0	795	0.51
AAC Hodge	63.7	9.25	14.0	140	715	16.3	72	4.3	10.1	800	0.60
2019											
Unity	—	—	—	—	—	—	—	—	—	—	—
Glenn	66.0	7.00	8.5	150	685	17.9	73	4.3	11.0	900	0.64
Carberry	64.6	6.75	7.5	124	471	20.6	72	3.5	8.6	775	0.50
AAC Viewfield	65.0	7.00	10.0	125	557	18.2	72	3.6	8.4	785	0.48
AAC Hodge	63.3	8.50	11.5	146	750	16.2	71	4.4	10.8	810	0.59

[a]Dupuis and Fu (2016).
[b]Abs: Absorption measured as percent.
[c]DDT: Farinograph Dough Development Time measured in minutes.

quantity of final grain was made up 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 Hodge met the milling and baking performance of the CWRS class of wheat. The grain protein was the same as AAC Viewfield and lower than the other checks (Table 7). The protein loss of AAC Hodge was similar to the checks. Flour protein (%) and falling number (s) were similar to Unity. The peak viscosity measured by the amylograph (BU) was higher or similar to all of the checks. The clean flour yield (%) was higher than all of the checks. Flour ash (%) was equivalent or higher than the checks. Starch damage was higher than all of the checks except Glenn in 2018. Flour yield (0.5% ash, %) was equivalent or lower than the checks (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 lower than the checks, and dough stability was higher than the checks (Table 8). The loaf volume (cm^3) for AAC Hodge was similar to AAC Viewfield and lower than Glenn. The loaf top ratio was similar to Glenn and higher than the other checks (Table 8).

Other Characteristics

The morphological characteristics were recorded using experimental field plots grown in 2019 and 2020 at Saskatoon, SK. The characteristics were compared with two reference varieties AAC LeRoy (Kumar et al. 2019*a*) and AAC Magnet (Kumar et al. 2019*b*) for morphological distinctness.

Seedling characteristics

Coleoptile colour: White to slightly purple.
Juvenile growth habit: semi-prostrate to intermediate.
Seedling leaves: medium green, glabrous.

Adult plant characteristics

Growth habit: intermediate.
Flag leaf attitude: intermediate to drooping.
Flag leaf: medium green, medium-recurved, glabrous sheath and blade, auricles absent, pronounced waxy blade.
Culm: straight, glabrous and weak-medium waxy upper internode.

Spike characteristics

Shape: erect and parallel sided.
Length: medium.

Density: medium.
Attitude: erect.
Colour: light brown maturity.
Awns: awned.

Spikelet characteristics

Glumes: medium-long length, narrow-medium width, glabrous pubescent, straight shoulder shape, beak is short to medium with acuminate shape.

Kernel characteristics

Type: hard, medium to dark red in colour.
Size: medium size, medium to long length, medium width, ovate shape, rounded cheeks, short brush hairs, narrow width, and mid-deep crease.
Embryo: small to medium size, oval to elliptical shape.

Maintenance and Distribution of Pedigreed Seed

Breeder Seed of AAC Hodge was produced using 250 random spikes from a rogued increase plot grown near Rosebank, MB, in 2017. Two hundred and fifty lines were grown as an isolated group of 1 m head rows in 2018 near the Brandon Research and Development Centre. Head rows which lacked uniformity or had poor seed production were discarded. In 2019, a 15 m row was grown from each of the 225 selected isolation rows at the Indian Head Seed Increase Unit. Prior to bulk harvesting the breeder rows, 23 rows were discarded. The remaining uniform plots were inspected and bulk harvested, producing approximately 400 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. AAC Hodge is a OBWM resistant variety and to maintain the effectiveness of the *Sm1* gene against the insect, the certified seed will include AAC Hockley as a 10% interspersed susceptible refuge.

Author Contributions

Drs. S. Kumar and S. L. Fox performed selections and progression of lines to finally select AAC Hodge (BW1069). Dr. 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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