CULTIVAR DESCRIPTION

AAC Chiffon soft white spring wheat

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Randhawa, H. S., Graf, R. J. and Sadasivaiah, R. S. 2014. **AAC Chiffon soft white spring wheat**. Can. J. Plant Sci. **94**: 1303–1308. AAC Chiffon is a soft white spring wheat (*Triticum aestivum* L.) cultivar that meets the end-use quality specifications of the Canada Western Soft White Spring (CWSWS) class. AAC Chiffon is well-adapted to the irrigated wheat growing regions of southern Alberta and southern Saskatchewan, and for rain-fed production in the western prairies. Based on data from the Western Soft White Spring Wheat Cooperative registration trials from 2008 to 2011, AAC Chiffon exhibited higher grain yield than the check cultivars, similar maturity, and taller stature with moderate straw strength. AAC Chiffon expressed resistance to the prevalent races of stripe rust, intermediate responses to powdery mildew, kernel black point and leaf rust, and susceptibility to stem rust, common bunt, loose smut and *Fusarium* head blight. Based on end-use quality analysis performed by the Grain Research Laboratory of the Canadian Grain Commission, AAC Chiffon was eligible for grades of CWSWS wheat.

Key words: *Triticum aestivum* L., cultivar description, wheat (soft white spring), grain yield, quality, disease resistance

Randhawa, H. S., Graf, R. J. et Sadasivaiah, R. S. 2014. **Le blé tendre blanc de printemps AAC Chiffon**. Can. J. Plant Sci. **94**: 1303–1308. AAC Chiffon est une variété de blé tendre blanc de printemps (*Triticum aestivum* L.) qui satisfait aux normes de qualité relatives à l'usage final de la classe « blé tendre blanc de printemps de l'Ouest canadien » (CWSWS). Le cultivar est bien adapté aux régions du sud de l'Alberta et du sud de la Saskatchewan où le blé est cultivé sous irrigation, de même qu'aux zones de production sous régime pluvial des prairies de l'Ouest. Selon les données obtenues dans le cadre des essais d'homologation coopératifs de l'Ouest réalisés entre 2008 et 2011 sur le blé tendre blanc, le rendement de AAC Chiffon dépasse celui des variétés témoin, prend le même nombre de jours pour parvenir à maturité et pousse plus haut, sa paille étant d'une robustesse moyenne. AAC Chiffon résiste aux races courantes de la rouille jaune, affiche une réaction intermédiaire au blanc, au point noir du grain et à la rouille des feuilles, et est sensible à la rouille de la tige, à la carie, au charbon nu et à la brûlure de l'épi causée par *Fusarium*. Selon l'analyse de la qualité en vue de l'usage finale effectuée par le Laboratoire de recherches sur les grains de la Commission canadienne des grains, AAC Chiffon respecte les normes de la classe CWSWS.

Mots clés: *Triticum aestivum* L., description de cultivar, blé (tendre blanc de printemps), rendement grainier, qualité, résistance à la maladie

AAC Chiffon is a high-yielding, soft white spring wheat (*Triticum aestivum* L.) cultivar developed by Agriculture and Agri-Food Canada (AAFC), Lethbridge Research Centre (LRC), Lethbridge, Alberta, and released in 2012. It was assigned registration number 7359 by the Variety Registration Office, Canadian Food Inspection Agency on 2013 Apr. 12. AAC Chiffon is well adapted for irrigated production in southern Alberta and southern Saskatchewan as well as rain-fed production in the western prairie region of western Canada. AAC Chiffon meets the end-use quality characteristics of the Canada Western Soft White Spring (CWSWS) wheat class.

Pedigree and Breeding Methodology

AAC Chiffon was developed from the cross AC Reed/SWS53 made at the AAFC Lethbridge Research Centre in Lethbridge, Alberta, in 2001. AC Reed is a soft white spring wheat cultivar released by Agriculture and Agri-Food Canada, Lethbridge (Sadasivaiah et al. 1993). SWS53 is a selection from an F_4 bulk of unknown parentage from the United States Department of Agriculture, Agricultural Research Service (USDA-ARS) at Aberdeen, ID, USA. The F_1 generation was grown in a greenhouse in 2001 and F_2 plants were grown at a contra-season nursery in Lincoln, New Zealand, in 2001/2002. In 2002, several hundred F_3 heads were picked from space-planted bulk plots grown in Vauxhall, AB, with further culling based on kernel visual distinguishability (KVD) requirements and black point incidence. The remaining 47 heads were grown as F_4 rows in Lincoln, New Zealand, in 2002/03. One F_4 line

[1]*Deceased.*

Abbreviations: **CWSWS**, Canada Western Soft White Spring; **DON**, deoxynivalenol; **FHB**, *Fusarium* head blight; **SD**, standard deviation

was selected and grown in Lethbridge in an initial yield trial in 2003. Based on favourable agronomic traits, four F_6 head rows taken from the yield trial were grown in Lincoln, New Zealand, in 2003/2004. In spring 2004, an F_7 line (04-PR219) was grown in a preliminary yield trial in Lethbridge. High yield, acceptable agronomic and disease resistance traits, and favourable end-use quality allowed advancement to the Western Soft White Spring Wheat Cooperative (SWSWC) Registration trial as SWS389, where it was evaluated for 3 yr (2005–2007). Excessive heterogeneity within and among the F_6-derived F_{10} breeder line plots prompted the selection of 10 heads from each of the nine breeder lines after extensive roguing. These head rows were grown in Leeston, New Zealand in 2007/2008 where off-type rows from each of the breeder lines were discarded. Bulking of the remaining rows for each breeder line provided sufficient seed increase for these nine lines to re-enter the registration trial in 2008. Purified breeder line 07-389-S76 was designated SWS408 and evaluated for 3 yr.

The SWSWC registration trial was grown at six irrigated locations (Lethbridge, Diamond City, Vauxhall, Bow Island, Saskatoon and Outlook) and five rain fed locations (Lethbridge, Lacombe, Edmonton, Indian Head, Morden) across the Canadian prairies. The criteria used for evaluation included grain yield, maturity, plant height, resistance to lodging, shattering, resistance to prevalent diseases, and end-use quality characteristics. The soft white spring wheat cultivars AC Andrew (Sadasivaiah et al. 2004) and Sadash (Sadasivaiah et al. 2009) were used as the agronomic checks; AC Reed (Sadasivaiah et al. 1993) and Sadash were used for quality comparisons.

Artificially inoculated field nurseries were used to determine reactions to leaf rust (*P. triticina* Eriks. = *P. recondita* Roberge ex Desmaz.) and stem rust (*Puccinia graminis* Pers.: Pers. f. sp. *tritici* Eriks. & e. Henn.) at the AAFC Cereal Research Centre (CRC), Winnipeg, MB, using the modified Cobb scale (Peterson et al. 1948). Seedling infection type reactions were determined in the greenhouse for leaf rust races MBDS (12-3), MGBJ (74-2), TJBJ (77-2), TDBG (06-1-1) and MBRJ (128-1) (McCallum et al. 2013) and to stem rust races TMRTK (C10), RKQSR (C63), TPMKR (C53) RTHJT (C57), QTHST (C25) MCCF (C17) and RHTSK (C20) (Fetch et al. 2011). Reactions to stripe rust (*Puccinia striiformis* Westend) were recorded on a 1–100% disease severity scale (except for 2008 when a scale of 1–6 was used) based on natural field infection in Lethbridge, AB, and Creston, BC. Fusarium head blight (FHB) {caused by Fusarium graminearum Schwabe [teleomorph Gibberella zeae (Schwein.) Petch]} tolerance was evaluated at Glenlea, MB, in field nurseries that were spray inoculated with a macroconidial suspension and rated using a visual index (% incidence × % severity/100) as described by Gilbert and Woods (2006). Resistance to loose smut [*Ustilago tritici* (Pers.) Rostr.] was estimated as described

Table 1. Mean grain yield of AAC Chiffon and the check cultivars in the Western Soft White Spring Wheat Cooperative registration trials (2008 – 2011)

	Grain yield (kg ha^{-1})									
Entry	2008	2009	2010	2011	Overall mean	% AC Andrew	Irrigated[z] mean	% AC Andrew	Rain fed[y] mean	% AC Andrew
AC Reed	7740	6725	5467	5759	6416	91	6856	92	5883	89
AC Andrew	8130	7829	6027	6303	7071	100	7462	100	6598	100
Sadash	7910	7948	6242	6903	7260	103	7733	104	6688	101
AAC Chiffon	8150	8345	6278	7004	7448	105	7714	103	7127	108
LSD	529	447	185	196	248		344		363	
Site-Years	10	11	10	11	42		23		19	

[z]Irrigated locations were Lethbridge, Vauxhall, Bow Island, Diamond City, Outlook and Saskatoon.
[y]Rain-fed locations were Lethbridge Dry, Lacombe, Edmonton, Indian Head, and Morden. No yield data were recorded for Edmonton in 2008 and Lethbridge in 2010.

Table 2. Agronomic characteristics of AAC Chiffon and the check cultivars in the Western Soft White Spring Wheat Cooperative registration trials (2008–2011)

Entry	Maturity (d)	Height (cm)	Lodging (1–9)	Shattering (1–9)	Kernel mass (g)	Test weight (kg hL^{-1})
AC Reed	111	83	3.1	2.2	33.9	76.9
AC Andrew	113	86	3.0	2.2	34.9	76.8
Sadash	114	89	3.1	2.2	36.2	78.7
AAC Chiffon	113	96	3.9	2.5	40.0	77.4
LSD	0.74	1.23	0.31	0.24	0.9	0.5
Site-years	37	40	25	14	27	21

by Menzies et al. (2003). Evaluation of common bunt [*Tilletia laevis* Kuhn in Rabenh. and *T. tritici* (Bjerk.) (Bjerk.) R. Wolff] resistance was conducted at the AAFC Lethbridge Research Centre using a composite of races L1, L16, T1, T6, T13 and T19, and planting into cold soil (Gaudet and Puchalski 1989; Gaudet et al. 1993) in early spring. Reactions to powdery mildew (*Blumeria graminis* DC. f. sp. *tritici* Em. Marchal) were recorded using a 1–6 scale (1 = resistant; 6 = highly susceptible) based on natural field infection in the registration trials. For leaf spot diseases (caused by *Pyrenophora tritici-repentis, Stagonospora nodorum, Septoria tritici*, and *Cochliobolus sativus*) reactions, disease severity was observed from natural infection in the field but specific pathogens were not determined.

End-use quality was evaluated by the Canadian Grain Commission, Grain Research Laboratory, Winnipeg, MB, based on composite samples for each test entry prepared from selected irrigated sites based on the protein concentration and grade of the check cultivars. Grain from locations where the checks produced a poor sample was not included in the quality composites.

Analyses of variance were conducted using a combined mixed effects model for agronomic data with years, environments, and their interactions treated as random effects; and cultivar treated as a fixed effect. The least significant difference (LSD) test was used to identify significant differences from the check cultivars. For end-use quality data there were no replicated observations within years, hence standard deviation was reported.

Performance and Adaptation

Based on evaluation in the SWSWC registration trial over 42 site-years (2008–2011), AAC Chiffon had significantly higher ($P \leq 0.05$) grain yield than the check cultivars AC Reed and AC Andrew but was similar to Sadash. Overall, AAC Chiffon yielded (7448 kg ha^{-1}) 16% more than AC Reed (6416 kg ha^{-1}), 5% more than AC Andrew (7071 kg ha^{-1}) and 3% more than Sadash (7260 kg ha^{-1}). Evaluated under irrigated conditions for 23 site-years, AAC Chiffon was equal in yield to Sadash; however, across 19 site-years of rain fed environments, AAC Chiffon had significantly greater ($P \leq 0.05$) grain yield than all of the checks, being 8 and 7% higher than AC Andrew and Sadash, respectively (Table 1). The physiological maturity of AAC Chiffon (113 d) was equal to AC Andrew (113 d) and 1 d earlier than Sadash (114 d). AAC Chiffon was significantly ($P \leq 0.05$) taller and had weaker straw strength ($P \leq 0.05$) than all three check cultivars. AAC Chiffon had significantly higher kernel mass (40.0 g) than both AC Andrew (34.9 g) and Sadash (36.2 g). The test weight of AAC Chiffon (77.4 kg hL^{-1}) was significantly greater than those of AC Reed (76.9 kg hL^{-1}) and AC Andrew (76.8 kg hL^{-1}), but significantly lower than Sadash (78.7 kg hL^{-1}) (Table 2).

AAC Chiffon exhibited good levels of resistance to the prevalent races of stripe rust and powdery mildew. It exhibited intermediate to moderately susceptible reactions to kernel black point [principally caused by *Alternaria alternata* (Fr.:Fr.) Keissl.], moderately resistant to moderately susceptible reactions to leaf rust, and moderately susceptible to susceptible reactions to stem rust (Table 3). Similar to other cultivars in this wheat class, AAC Chiffon was susceptible to common bunt, loose smut and Fusarium head blight (Table 3).

The milling and baking characteristics of AAC Chiffon were determined in 2008, 2009 and 2011 by the Canadian Grain Commission, Grain Research Laboratory, Winnipeg, MB. The protein concentration of AAC Chiffon (10.2%) was equal to the mean of the quality checks. The Hagberg falling number (372 s), flour yield (75.8%), and amylograph peak viscosity (470 BU) were slightly lower than the mean of checks. Cookie spread and cookie ratio (spread/height) for AAC Chiffon (82.6 mm, 8.5) were similar to Sadash. Overall, AAC Chiffon had rheological and baking properties similar to AC Reed and Sadash (Table 4).

Other Characteristics

Plant characteristics were recorded from greenhouse increases and experimental field plots grown in 2012 and 2013 at Lethbridge, AB.

Seedling Characteristics

Coleoptile colour: Very weak anthocyanin colouration.
Juvenile growth habit: Erect.
Seedling leaves: Glabrous leaf sheaths and blades of lower leaves.
Tillering capacity (at low densities): Medium.

Table 3. Disease severity and ratings[z] for AAC Chiffon and the check cultivars in the Western Soft White Spring Wheat Cooperative registration trials (2008–2011)

	Leaf rust[y]				Stem rust[x]				Stripe rust[w]					
Entry	2008	2009	2010	2011	2008	2009	2010	2011	2008 Leth	2009 Leth	2010 Leth	2010 Cres	2011 Leth	2011 Cres
AC Reed	35 I	30 MR	37.5 I	12.0 MR	99 S	90 S	60 S	20 S	1.6 MR	10 R	60 S	60 S	80 S	65 S
AC Andrew	30.0 MR	12.5 MR	27.5 MR	12.7 MR	10 RMR	10 RMR	35 I	3 R	2.1 I	45 I	10 MR	20 I	45 I	65 S
Sadash	27.5 MR	3.7 R	16.5 MR	3.7 R	10 R	5 R	15 MR	10 I	1.4 MR	10 R	0 R	0 R	5 R	5 R
AAC Chiffon	40 MS	20 MR	35 I	15.3 MR	50 MS	70 S	50 MS	80 S	1.8 MR	10 R	20 MR	5 R	25 MR	10 MR

	Common bunt[v]				Loose smut[u]				Powdery mildew[t]			Kernel black point[t]			
Entry	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2008	2009	2010	2011
AC Reed	65 VS	77 VS	36 S	84 S	63 MS	70 MS	77 S	–	2.1 I	2.2 I	4 MS	12 MS	6.3 I	5.4 MS	3.0 MR
AC Andrew	37 MS	39 I-MS	20 MS	61 S	59 MS	100 S	67 MS	44 I	2.0 MR	2.3 I	1 R	8 MS	7.9 MS	3.0 I	4.0 I
Sadash	44 S	54 VS	44 S	68 S	3 R	84 S	2 R	0 R	2.0 MR	2.5 I	1 R	10 MS	7.5 MS	4.1 MS	3.0 MR
AAC Chiffon	31 I	42 MS	20 MS	49 S	52 I	86 S	71 MS	77 S	2.0 MR	2.3 I	1 R	8 MS	8.8 MS	3.4 I	4.0 I

	Root rot (%)			Leaf spot				FHB index						DON			
Entry	2008	2009	2010	2008	2009	2010	2011	2008 Glenlea	2009 Carmen	2009 Glenlea	2010 Carmen	2010 Glenlea	2011 Glenlea	2008	2009	2010	2011
AC Reed	5	0	5.0	6.2 MS	28	8.3 MS	24 I	15.3 MS	21.0 MS	28.0 I	24.6 I	3.8 R	5.3 MR	11.1	30.4	21.0	10.6
AC Andrew	20	5	3.7	2.5 R	21	7.8 I	37 MS	15.3 MS	28.9 MS	38.0 MS	46.8 S	51.0 S	9.2 MR	11.3	–	26.9	7.3
Sadash	5	5	5.0	4.5 MR	29	8.3 MS	53 S	33.7 S	30.9 MS	43.3 S	34.1 MS	34.3 MS	16.7 MS	12.6	26.1	36.7	7.5
AAC Chiffon	5	20	13.0	2.5 R	24	7.8 I	55 S	28.0 S	16.9 I	35.0 MS	41.2 MS	62.2 S	13.7 I	13.9	26	18.9	9.2

[z]Disease rating class: R = resistant, RMR = resistant to moderately resistant, MR = moderately resistant; I = intermediate rating; MS = moderately susceptible, S = susceptible.
[y]Inoculum was a composite of all leaf rust disease survey collections made the previous year from Manitoba and Saskatchewan (McCallum et al. 2013).
[x]Races used include TMRTK, RKQSR, TPMKR, QTHST, RHTSK and MCCFR.
[w]Reaction rated under conditions of natural infection.
[v]The inoculum used was a composite of races T-1, T-6, T-13, and T-19 of *T. tritici* and L-7 and L-16 of *T. laevis* mixed in a 1:1:1:1:2:2 ratio (vol/vol).
[u]Races used include T2, T9, T10 and T39.
[t]Reaction rated under conditions of natural infection.

Table 4. Mean end-use quality data[z] for AAC Chiffon and the check cultivars in the Western Soft White Spring Wheat Cooperative registration trials (2008, 2009 and 2011)

Cultivar	Test weight (kg hL^{-1})	Wheat protein (%)	Flour protein (%)	Protein loss (%)	Hagberg falling number (s)	Amylograph viscosity (BU)	Flour yield (%)	Flour ash (%)	Flour agtron colour	Starch damage (megazyme)	Particle size index
AC Reed	82.3	10.4	9.3	1.0	373	498	76.2	0.49	84.7	3.5	70.0
Sadash	83.7	9.9	8.9	1.1	383	458	76.3	0.48	85.7	3.4	70.7
Mean of Checks	83.0	10.2	9.1	1.1	378	478	76.3	0.48	85.2	3.5	70.3
AAC Chiffon	82.5	10.2	9.3	1.0	372	470	75.8	0.47	85.0	3.3	70.7
SD	0.8	0.2	0.3	0.21	9.3	51.3	0.8	0.02	7.5	0.2	1.8

		Farinograph 54–21[y]				Alveograph				Cookie	
Cultivar	Alkaline water retention capacity	Absorption (%)	Dough development time (min)	Mixing tolerance index (BU)	Stability (min)	Length	P	W	Area	Spread (mm)	Ratio (spread/height)
AC Reed	64.5	54.4	1.5	128	1.5	111.7	29.3	46.7	6.7	83.0	8.7
Sadash	67.7	54.3	1.7	132	1.2	84.7	34.0	49.7	7.7	82.6	8.5
Mean of Checks	66.1	54.4	1.6	130	1.3	98.2	31.7	48.2	7.2	82.8	8.6
AAC Chiffon	65.4	53.7	1.7	113	1.5	146.7	30.3	63.3	9.7	82.6	8.5
SD	1.9	0.8	0.2	16.7	0.2	53.8	3.2	17.5	2.7	1.4	0.5

[z]End-use quality testing was conducted by the Grain Research Lab of the Canadian Grain Commission on composite samples from various locations.
[y]American Association of Cereal Chemists (2002).

Adult Plant Characteristics
Growth habit: Intermediate.
Flag leaf: Dark green with glabrous sheath and blade. Weak auricle colouration, and auricle margins are glabrous. Flag leaf sheath has a strong waxy bloom.
Flag leaf attitude: Drooping (recurved).
Upper culm internode: Straight at maturity with weak waxiness. It has a hollow stem with thin walls.
Culm colour: Glabrous.

Spike Characteristics
Shape: Oblong.
Length: Long.
Density: Dense.
Attitude: Erect.
Rachis: Glabrous rachis margin
Colour: White at maturity.
Awns: Awned.

Spikelet Characteristics
Glumes: Medium length and width; lower glume is glabrous; glume shoulders are oblique; medium shoulder width; glume beak is acuminate and of medium length; sparse internal glume hairs, internal imprint of lower glume is absent. Glumes are white in colour at maturity.
Lemma: Slightly curved.

Kernel Characteristics
Type: Soft, white in colour.
Shape: Ovate to oval in shape with rounded to slightly angular cheeks.
Size: Medium sized with medium length and medium to wide width.
Brush: Medium sized with mid-long brush hairs.
Embryo: Med-sized oval shape; crease is mid-wide and mid-deep.

Maintenance and Distribution of Pedigreed Seed

Breeder Seed development of AAC Chiffon was initiated in 2011 by picking random heads from a rogued F_{12} increase plot grown in Lethbridge. These 120 selections were grown as head rows near Lincoln, New Zealand during the winter of 2011/12, with 105 pre-breeder seed lines harvested. The seed from 100 pre-breeder seed lines were subsequently replanted at the AAFC Seed Increase Unit at Indian Head. Following the elimination of variant and off-type lines in summer 2012, 81 F_{14} breeder lines were inspected by the Canadian Food Inspection Agency and harvested in bulk to form the initial Breeder Seed. The breeder seed of AAC Chiffon will be maintained by the Indian Head Seed Increase Unit, AAFC, Indian Head, Saskatchewan, Canada S0G 2K0. Multiplication and distribution of the all other pedigreed seed classes will be handled by SeedNet, Box 1150, Vulcan, Alberta, Canada T0L 2B0.

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