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CULTIVAR DESCRIPTION

AAC Penhold Canada Prairie Spring Red wheat

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Abstract: AAC Penhold, an awned hard red spring wheat (*Triticum aestivum* L.) cultivar, yielded significantly more grain than check cultivar 5700PR while maturing 2 d earlier and was 7.5 cm shorter in stature. The seed size was significantly larger than 5700PR and 5701PR, with a test weight significantly heavier than both checks. AAC Penhold expressed resistance to prevalent races of leaf rust and common bunt and moderate resistance to *Fusarium* head blight and stem rust. AAC Penhold had higher grain and flour protein than the checks and improved Hagberg falling number, amylograph viscosity, and water absorption. AAC Penhold is eligible for grades of the Canada Prairie Spring Red wheat market class.

Key words: Triticum aestivum L., wheat, cultivar description, grain yield, disease resistance, semidwarf, grain quality.

Résumé : AAC Penhold est un cultivar barbu de blé roux vitreux de printemps (*Triticum aestivum* L.) dont le rendement grainier surpasse sensiblement celui de la variété témoin 5700PR. Il parvient aussi à maturité deux jours plus tôt et sa paille est plus courte de 7,5 cm. Ses grains sont significativement plus gros que ceux des cultivars témoins 5700PR et 5701PR, avec une densité spécifique nettement supérieure. AAC Penhold résiste aux races courantes de la rouille des feuilles et de la carie. Il résiste aussi modérément à la fusariose et à la rouille de la tige. Le grain et la farine d'AAC Penhold sont plus riches en protéines que ceux des cultivars témoins, et la variété se démarque par un meilleur temps de chute de Hagberg ainsi que par une viscosité à l'amylographe et une absorption de l'eau supérieures. AAC Penhold est admissible aux classes de la catégorie « blé roux de printemps Canada Prairie ». [Traduit par la Rédaction]

Mots-clés : Triticum aestivum L., blé, description de cultivar, rendement grainier, résistance à la maladie, semi-nain, qualité du grain.

Introduction

AAC Penhold, a hard red spring wheat (*Triticum aestivum* L.) cultivar, was developed at the Swift Current Research and Development Centre (SCRDC), Agriculture and Agri-Food Canada (AAFC), Swift Current, SK. It received registration no. 7565 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 11 July 2014. AAC Penhold was granted Plant Breeders' Rights certificate no. 5090 by the Plant Breeders' Rights Office on 7 Aug. 2015.

Pedigree and Breeding Methods

AAC Penhold is derived from the cross 5700PR/HY644-BE//HY469 made in 2004 at SCRDC, AAFC, Swift Current, SK. The cross was assigned the designation C0401. The cultivar, 5700PR, which derives from the cross N91-3051/AC

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Foremost (Thomas et al. 1997), was crossed with the *Fusarium* head blight (FHB) resistant parent, HY644-BE, which has additional leaf rust resistance backcrossed into HY644 from the Kyoto University accession KU3198, having *Lr70* and another gene that is *Lr52* or an allele of *Lr52* (Hiebert et al. 2014). HY644 was derived from the cross A16//Alpha*4/BgBSR/3/Sceptre/Ning 8331 (McCallum and Seto-Goh 2010). The F_1 plants were top-crossed to the experimental line HY469, which derives from the cross Grandin/*2 AC Karma (Knox et al. 1995). The F_1 seeds were multiplied at Plant and Food Research, Lincoln, New Zealand.

In 2005 at SCRDC, about 12 000 F_2 seeds were inoculated with common bunt [*Tilletia laevis* Kühn in Rabenh., and *T. tritici* (Bjerk.) G. Wint. in Rabenh.] races L16 and T19 (Hoffmann and Metzger 1976) and planted 10 cm apart in 90-m-long rows. The rows were spaced 23 cm apart with alternating rows planted with CDC Kestrel winter wheat (Fowler 1997), which is susceptible to leaf rust (*Puccinia triticina* Eriks.) and stem rust (*P. graminis* Pers.:Pers. f. sp. *tritici* Eriks. & E. Henn.). A leaf rust and stem rust epiphytotic nursery was established by planting genotypes lacking genes for resistance to prevalent races of leaf and stem rust in every fifth spring wheat row and needle-inoculating a sample of these plants, followed by regular sprinkler irrigation. Representative leaf rust races found the previous year were applied (McCallum and Seto-Goh 2006). The stem rust races used were QTHJF (C25), RHTSC (C20), RKQSC (C63), RTHJF (C57), TMRTF (C10), and TPMKC (C53) (Roelfs and Martens 1988; Fetch et al. 2015). From the disease nursery, 346 disease-free, early-maturing F_2 plants with semi-dwarf stature and strong straw were selected, threshed individually, and further selected for response to diseases that infect kernels such as common bunt, FHB caused by *Fusarium graminearum* Schwabe teleomorph *Gibberella zeae* (Schwein.) Petch, *F. avenaceum* (Fr.) Sacc., and *F. culmorum* (Wm.G. Smith) Sacc., black point caused by *Cochliobolus sativus* (Ito & Kurib.) Drechs. ex Dastur, *Alternaria alternata* (Fr.) Keissl., *Pyrenophora tritici-repentis* (Died.) Drechs., and ergot caused by *Claviceps purpurea* (Fr.) Tul. The F_3 seed of 254 F_2-derived individuals was planted in 2-m-long rows in a contra season nursery near Lincoln, New Zealand. From these, 119 lines were selected on the basis of time to maturity comparable to the check commercial cultivars, plant height, straw strength, shattering, and were harvested as individual rows.

In the F_4 generation, seed of the 119 lines was inoculated with common bunt and grown near Swift Current in a nursery of single-row plots 1.5 m long. The rows were spaced 23 cm apart with alternating rows planted with CDC Kestrel winter wheat. A rust epiphytotic nursery was established by planting genotypes lacking genes for resistance to prevalent races of leaf and stem rust in every 12th plot and inoculating a sample of plants within the row with representative rust races followed by regular sprinkler irrigation. Each F_4 genotype was also grown in a nursery near Portage La Prairie, MB, and inoculated with FHB, leaf rust, and stem rust, followed by regular sprinkler irrigation. The selection criteria combined over both nurseries were resistance to FHB, leaf rust, stem rust, common bunt, and leaf spotting diseases, strong straw of a semidwarf height, maturity within the range of the control cultivars, and non-shattering spike attributes. Five heads were selected from each of the 71 F_4 lines that met the combined selection criteria in both nurseries. Heads were threshed individually and grain examined for the same kernel diseases as in the $F_{2:3}$ generation. The 71 F_5 families comprising 312 lines were grown out in a contra season nursery of 2-m-long rows near Irwell, New Zealand; 203 lines were selected on the same basis as the F_3 and were harvested individually on a row basis.

In the $F_{4:6}$ generation, 203 lines were grown in four-row plots with a harvested area of 2.76 m^2 near Swift Current and Indian Head, SK, and Lethbridge, AB. Five spikes were collected from the FHB nursery at Portage la Prairie, MB, that met the same selection criteria as in the F_4 generation. Agronomic plots were harvested at maturity and the grain weight of each plot was measured. Seed weight and kernel diseases were measured on the whole grain sample. A subsample was submitted to the Central Quality Laboratory, Cereal Research Centre, AAFC, Winnipeg, MB, to determine end-use suitability for the Canada Prairie Spring Red (CPSR) market class. In the F_7 generation, 21 families at five lines per family were grown out in 2-m-long rows near Irwell. Families were selected on the basis of grain quality and kernel attributes assayed on grain from the F_6 yield trial. Within family selection criteria included time to maturity, height, straw strength, and seed shattering.

In the $F_{6:8}$ generations, 76 lines were grown in agronomic trials near Swift Current, Indian Head, and Lethbridge. Grain was harvested and processed similarly to grain from the F_6 plots. In the F_6 and F_8 generations, reaction to leaf and stem rust was used as a selection criterion based on results of an epiphytotic nursery near Glenlea, MB. In the F_6 and F_8 generations, response to *Fusarium* head blight was assessed in a FHB nursery near Portage la Prairie. Selected F_8 lines were screened for reaction to a mixture of races T2, T9, T10, and T39 of loose smut [*Ustilago tritici* (Pers.) Rostr.] (Nielsen 1987) and races L16 and T19 of common bunt. Through this breeding process, the experimental line C0401-HH45E met all selection criteria at each generation.

C0401-HH45E was evaluated in the preregistration trial High Yield Wheat B Test in 2009 and entered into the registration trial High Yield Wheat Cooperative (HYWC) Test from 2010 to 2012 as HY1319. The HYWC test consisted of 28 experimental lines and two check commercial cultivars grown in a 5×6 lattice design with three replications at up to 13 locations per year. The check cultivars were 5700PR and 5701PR, and Conquer

Table 1. Grain yield (kg ha^{-1}) of AAC Penhold compared with check cultivars and mean of the check cultivars in the High Yield Wheat Cooperative Test (2010–2012).

	Zone 1[a]			Zone 2			Zone 3			Zone 4			Mean[b]
Entry	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010–2012
5700PR	3005	3607	3674	4402	4752	3965	5603	5423	3957	2420	3682	4989	4152
5701PR	3619	4232	3974	4354	5530	4385	5365	5692	4122	3775	6953	5289	4578
Check mean	3312	3920	3824	4378	5141	4175	5484	5558	4040	3098	5317	5139	4365
Conquer	—	—	3222	—	—	4161	—	—	4370	—	—	5132	—
AAC Penhold	3862	4001	3842	4104	4946	4264	5427	5671	4267	2914	5185	5281	4427
CV	7.4	6.6	6.7	7.8	4.5	5.6	5.5	7.6	7.0	14.7	4.5	5.7	10.6
$LSD_{0.05}$[c]	191	298	186	270	234	193	241	522	239	807	510	496	207
No. of trials	5	4	5	4	4	4	4	4	4	1	1	1	36

[a]Zone 1: Brandon and Glenlea (MB), Indian Head (SK), and Rosebank and Souris (MB); Zone 2: Beiseker and Three Hills (AB), Kamsack, Kernen, Regina, Scott, and Swift Current (SK); Zone 3: Beaverlodge, Lacombe, and Ellerslie (AB), and Melfort (SK); Zone 4: Lethbridge (irrigated, AB). CV, coefficient of variance.
[b]Means are based on LSMEANS procedure of SAS.
[c]LSD, least significant difference ($P \leq 0.05$) includes the appropriate genotype × environment interaction variation.

Table 2. Three-year means[a] of agronomic characteristics of AAC Penhold compared with the check cultivars grown in the High Yield Wheat Cooperative Test (2010–2012).

Entry	Maturity (d)	Lodging score[b] (1–9)	Height (cm)	Test weight (kg hL^{-1})	Kernel weight (mg)
5700PR	107.3	1.5	79.8	77.2	36.8
5701PR	105.7	1.8	81.4	75.6	37.5
Check mean	106.5	1.6	80.6	76.4	37.1
AAC Penhold	105.3	1.3	72.3	78.4	42.9
$LSD_{0.05}$[c]	1.5	0.4	2.6	0.6	1.3
No. of trials	34	19	41	34	34

[a]Means are based on LSMEANS procedure of SAS.
[b]Straw strength rated on a scale of 1 to 9, where 1 = all plants in a plot are erect and 9 = all plants in a plot are lying horizontally.
[c]LSD, least significant difference ($P \leq 0.05$) includes the appropriate genotype × environment interaction variation.

(Brown et al. 2017) was added in 2012 when the number of experimental lines was reduced to 27. The choice of check cultivars, the variables measured, and the protocols followed in the HYWC test were described in the operating procedures of the Prairie Recommending Committee for Wheat, Rye, and Triticale (Anonymous 2013; http://www.pgdc.ca/committees_wrt.html). The MIXED procedure of SAS® (Littell et al. 2006) was used to perform yearly analyses for agronomic data with environments and their interactions considered random effects and cultivar treated as a fixed effect.

Response to several diseases was assessed in specialized disease nurseries from 2009 to 2011. Leaf and stem rust seedling infection types were assessed using stem rust races QTHJF (C25), RHTSC (C20), RKQSC (C63), RTHJF (C57), TMRTF (C10), and TPMKC (C53) (Roelfs and Martens 1988; Fetch et al. 2015) and leaf rust races MBDS (12-3), MBRJ (128-1), MGBJ (74-2), TDBG (06-1-1), TDBJ (70-1), and TJBJ (77-2) (McCallum and Seto-Goh 2006). Field evaluations of leaf and stem rust reactions, using leaf rust races representative of those found the previous year and the same stem rust races as for the seedling tests, were measured annually in epiphytotic nurseries near Glenlea, MB. Reaction to FHB was assessed in artificially inoculated field tests conducted annually near Glenlea and Carman, MB, Ottawa, ON, and Charlottetown, PEI (Gilbert and Woods 2006). To determine the response to loose smut, a mixture of the prevalent races T2, T9, T10, and T39 was injected into florets at anthesis of plants grown in the field and the inoculated seed subsequently grown out and rated in a greenhouse (Menzies et al. 2003). To determine the response to common bunt, a mixture of prevalent races L1, L16, T1, T6, T13, and T19 was used to inoculate the seed planted in mid-April of each year near Lethbridge. (Gaudet and Puchalski 1989). The race designations are those described by Nielsen (1987) for loose smut and Hoffmann and Metzger (1976) for common bunt.

Table 3. Reactions of AAC Penhold and check cultivars to leaf and stem rust in the High Yield Wheat Cooperative Test (2010–2012) grown at various locations.

	Field leaf rust						Field stem rust						Ug99[c] and variants stem rust		
	2010		2011		2012		2010		2011		2012		2010	2011	2012
	Severity[a]	Rating	Severity	Rating	Severity	Rating	Severity[b]	Rating	Severity	Rating	Severity	Rating	Severity[b]/ rating	Severity/ rating	Severity/ rating
5700PR	S	S/R	10.0	R	25.0	MR	20	R	20	I	20	I	15R–MR	15MR	10 R
5701PR	0	R	1.0	R	0.3	R	7	R	5	R	5	I	15M	—	20 I
Conquer	—	—	—	—	20.7	MR	—	—	—	—	25	I	—	—	10 I
AAC Penhold	0	R	0.3	R	1.7	R	3	R	5	R	10	MR	5R–MR	5R–MR	1 R

[a]Severity is the percentage of leaf area affected by leaf rust. Rating is the descriptive classification of disease based on percent severity. R, resistant = 0%–10%; MR, moderately resistant = 11%–30%; I, intermediate resistance = 31%–39%; MS, moderately susceptible = 40%–60%; S, susceptible >60%; —, no value. Ratings such as R–MR indicate a range in disease response, in this example resistant to moderately resistant.

[b]Severity is the percentage of the stem infected with stem rust using the Modified Cobb Scale.

[c]Severity and disease response category to stem rust races Ug99 and variants in a nursery near Njoro, Kenya.

Table 4. Reactions of AAC Penhold and check cultivars to yellow rust, common bunt, and loose smut in the High Yield Wheat Cooperative Test (2010–2012) grown at various locations.

	Yellow rust								Common bunt						Loose smut					
	2010				2011		2012													
	Lethbridge		Creston		Lethbridge		Lethbridge		2010		2011		2012		2010		2011		2012	
	Severity[a]	Rating[b]	Severity	Rating	Severity	Rating	Severity	Rating	Severity[c]	Rating[b]	Severity	Rating	Severity	Rating	Severity[d]	Rating[b]	Severity	Rating	Severity	Rating
5700PR	5	R	2	S	30	I	68	S	2	R–MR	10	MR	3	R	16	MR	25	MR	11	R
5701PR	5	R	15	I	17	I	43	I	21	MS	18	I	17	MR	48	I	38	I	48	I
Conquer	—	—	—	—	—	—	53	S	—	—	—	—	0	R	—	—	—	—	11	R
AAC Penhold	3	R	10	R	48	S	5	VR	0	R–MR	0	R	4	R	31	MR	36	I	5	R

[a]Severity is the percentage of leaf area affected by yellow rust. Rating is the descriptive classification of disease based on percent severity. R, resistant = 0%–10%; MR, moderately resistant = 11%–30%; I, intermediate resistance = 31%–39%; MS, moderately susceptible = 40%–60%; S, susceptible >60%; —, no value. Ratings such as R–MR indicate a range in disease response, in this example resistant to moderately resistant.

[b]Dominant pustule reaction in the case of yellow rust and descriptive classification in the case of common bunt and loose smut; categories: VR, very resistant; R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, Susceptible; VS, very susceptible.

[c]Percentage of spikes with common bunt symptoms.

[d]Percentage of plants with loose smut symptoms.

Table 5. *Fusarium* head blight reactions of AAC Penhold and check cultivars grown in Glenlea and Carman in the High Yield Wheat Cooperative Test (2010–2012).

	Glenlea, inoculated FHB nursery												Carman, inoculated FHB nursery					
	2010				2011				2012				2010		2011		2012	
Entry	Index[a] (%)	Rating[b]	DON[c]	ISD[d]	Index (%)	Rating	DON	ISD	Index (%)	Rating	DON	ISD	Index (%)	Rating	Index (%)	Rating	Index (%)	Rating
5700PR	24	I	25.7	40.3	14	I	4.1	3.6	20	MS	7.8	23.0	52	S	50	MS	56	S
5701PR	26	MS	18.7	39.0	21	S	5.5	5.2	9	MR	9.1	17.1	49	S	43	MS	45	MS
Conquer	—	—	—	—	—	—	—	—	21	S	9.0	24.7	—	—	—	—	58	S
AAC Penhold	7	R	10.8	20.8	4	R	1.8	1.8	5	R	4.4	14.9	15	MR	22	I	27	I

[a]FHB, *Fusarium* head blight disease index = (percentage of infected heads × percentage of diseased florets on infected heads)/100.
[b]Disease response categories: R, resistant; MR, moderately resistant; I, intermediate in reaction; MS, moderately susceptible; S, susceptible.
[c]DON, deoxynivalenol (ppm).
[d]ISD, incidence severity DON index = [(0.2 × incidence) + (0.2 × severity) + (0.6 × DON)].

Table 6. *Fusarium* head blight reactions of AAC Penhold and check cultivars grown in Ottawa and Charlottetown in the High Yield Wheat Cooperative Test (2010–2012).

	Ottawa				Charlottetown							
	2010	2011		2012	2010			2011				2012
	Index[a]	Index	DON[b]	Index	Index 1	Index 2	FDK[c] (0–10)	Index 1	Index 2	FDK[c] (0–10)	DON	Index 1
5700PR	18	42	19	41	26	64	10	36	63	6	25	41
5701PR	17	55	18	38	25	63	10	32	64	8	18	40
Conquer	—	—	—	17	—	—	—	—	—	—	—	46
AAC Penhold	31	35	16	37	23	41	10	22	43	7	22	37
$LSD_{0.05}$[d]	—	9	—	11	18	20	—	15	21	—	—	8

[a]*Fusarium* head blight score based on a scale of 1 to 100, in which 1 = no symptoms of blight and 100 = all florets in all spikes are infected with *Fusarium*.
[b]DON, deoxynivalenol (ppm).
[c]FDK, *Fusarium*-damaged kernels on a 1 to 10 scale, where 1 = low and 10 = high.
[d]LSD, least significant difference ($p \leq 0.05$) includes the appropriate genotype × environment interaction.

Table 7. End-use suitability[a] analyses, using a 74% extraction flour for all flour testing, of AAC Penhold, control cultivars, and the mean of the control cultivars, based on the High Yield Wheat Cooperative Test (2010–2012).

	Wheat protein (%)	Flour protein (%)	Protein loss (%)	Hagberg fall no. (s)	Amylograph viscosity (BU)[b]	Flour yield 0.5 ash (%)	Flour ash (%)	Flour colour[c] (L^*)	Flour colour (a^*)	Flour colour (b^*)	Starch damage (megazeme)	Particle size index
5700PR	12.7	11.9	0.8	356.7	623	77.5	0.44	94.7	0.38	8.52	27.5	41.3
5701PR	13.1	12.3	0.8	400.0	678	78.7	0.41	94.9	0.38	9.10	25.4	43.8
Mean of checks	12.9	12.1	0.8	378.3	651	78.1	0.43	94.8	0.38	8.81	26.4	42.5
AAC Penhold	13.9	12.9	1.0	445.0	737	77.3	0.44	94.2	0.51	10.07	26.9	42.5
SD[d]	0.05	0.05	—	15	5	0.34	0.005	—	—	—	0.08	0.9

[a]American Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission, for determining the various end-use suitability traits on a composite of 6–10 locations each year.
[b]Amylograph viscosity expressed in Brabender units (BU).
[c]Flour colour by spectrophotometer colour: L^* = brightness, b^* = yellowness, a^* = redness on the CIE scale.
[d]SD, standard deviation based on repeated testing of Allis mill check samples and standard bake flour sample with replicate tests carried out over an extended period of time each season, provided by Grain Research Laboratory, Canadian Grain Commission. —, no value.

Table 8. Farinograph and remix baking, using a 74% extraction flour for all flour testing, of AAC Penhold, control cultivars, and the mean of the control cultivars, based on the High Yield Wheat Cooperative Test (2010–2012).

	Farinograph			Remix baking (150 ppm ascorbic acid)							
Entry	Absorption (%)	DDT[a] (min)	Stability (min)	Baking absorption (%)	Peak time	Mixing energy[b] (W h kg^{-1})	Loaf volume (mL)	Loaf volume $protein^{-1}$	Appearance	Crumb structure	Crumb colour
5700PR	65.6	8.8	11.0	62.0	2.9	5.8	956	80.6	8.4	5.5	6.7
5701PR	62.1	12.9	26.2	60.7	2.4	4.5	978	79.8	8.4	5.5	6.5
Mean of checks	63.8	10.9	18.6	61.3	2.7	5.1	967	80.2	8.4	5.5	6.6
AAC Penhold	65.4	8.8	16.5	63.0	2.3	4.7	957	74.4	8.4	5.5	6.3
SD[c]	0.2	0.4	2.6	1.4	NA[d]	0.3	0.2	45	NA	NA	NA

[a]DDT is the farinograph dough development time.
[b]Mixing energy expressed as Watt-hours per kilogram.
[c]SD, standard deviation based on repeated testing of Allis mill check samples and standard bake flour sample with replicate tests carried out over an extended period of time each season, provided by Grain Research Laboratory, Canadian Grain Commission.
[d]NA, not available.

A sample of grain of HY1319 and the check cultivars from each location was submitted to the Canadian Grain Commission (Winnipeg, MB) to determine grain grade and protein concentration. End-use suitability was determined on a composite sample made up from sites with grain samples representative of the top Canada Prairie Spring wheat grades available. The quantity of grain from a location was adjusted to achieve a final composite protein concentration approximating that of the average for the crop that year. A consistent quantity of grain within a location for all experimental lines was used to make up the composite each year. All end-use suitability analyses were performed by personnel at the Grain Research Laboratory, Canadian Grain Commission, following the protocols of the American Association of Cereal Chemists (American Association of Cereal Chemists 2000).

Performance

AAC Penhold is a high grain yield, red seeded, awned, semidwarf experimental line. Averaged over 36 trials in three years, AAC Penhold produced significantly more grain than 5700PR (Table 1) and matured earlier (Table 2). AAC Penhold was significantly shorter than 5700PR and 5701PR (Table 2). The straw strength of AAC Penhold, as measured by its lodging score, was significantly stronger than 5701PR. The test weight of AAC Penhold was significantly heavier than both the controls and the seed size of AAC Penhold was significantly larger than both 5700PR and 5701PR (Table 2). AAC Penhold was resistant to leaf rust and common bunt, moderately resistant to stem rust and FHB, and intermediately resistant to loose smut (Tables 3, 4, 5, and 6).

Other Characteristics

Seedling

Very strong intensity of anthocyanin colouration of coleoptile.

Spike

Tapering to parallel sided, medium density, erect attitude at maturity, medium to strong glaucosity, white to cream chaff colour at maturity.

Awns

Length equal to spike, white to cream colour.

Lower glume

Glabrous.

Lower glume shoulder

Narrow to medium width, straight shape, with a medium to long beak that is straight to slightly curved.

Kernel

Medium red colour.

Germ

Medium size, round in shape.

End-use suitability

In general, AAC Penhold had quality parameters within the range of the checks with notably improved wheat and flour protein, Hagberg falling number, amylograph viscosity, farinograph absorption, and remixing baking absorption (Tables 7 and 8). AAC Penhold is eligible for grades of the market class Canada Prairie Spring Red.

Maintenance and Distribution of Pedigreed Seed

The 100 Breeder Lines originated from F_6-drived F_{10} single plants of C0401-HH45E grown near Swift Current in 2010, followed by growing as 108 pre-Breeder Lines in 3-m-long rows near Swift Current in 2011 and again as 15-m-long rows near Indian Head in 2012. Approximately 159 kg of Breeder Seed is available. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, SK S0G 2K0, Canada. AAC Penhold has been released for distribution and multiplication by SeCan, 501-300 March Road, Kanata, ON K2K 2E2, Canada.

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