AC Abbey hard red spring wheat

R. M. DePauw, J. M. Clarke, R. E. Knox, M. R. Fernandez, T. N. McCaig, and J. G. McLeod

Semiarid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2 (e-mail: depauw@em.agr.ca). *Received 29 June 1999, accepted 9 September 1999.*

DePauw, R. M., Clarke, J. M., Knox, R. E., Fernandez, M. R., McCaig, T. N. and McLeod, J. G. 2000. **AC Abbey hard red spring wheat**. Can. J. Plant Sci. **80**: 123–127. AC Abbey, hard red spring wheat (*Triticum aestivum* L.), is adapted to the Canadian prairies. It is significantly shorter than any of the check cultivars and has solid stems. AC Abbey expressed higher grain yield, earlier maturity, and heavier kernels than AC Eatonia, the solidstem check cultivar. It is resistant to the wheat stem sawfly (*Cephus cinctus* Nort.) and to prevalent races of common bunt and has moderate resistance to leaf rust and stem rust. AC Abbey is eligible for grades of Canada Western Red Spring wheat.

Key words: *Triticum aestivum* L., red spring wheat, yield, wheat stem sawfly, plant height, maturity

DePauw, R. M., Clarke, J. M., Knox, R. E., Fernandez, M. R., McCaig, T. N. et McLeod, J. G. 2000. **AC Abbey, nouveau cultivar de blé de printemps roux vitreux**. Can. J. Plant Sci. **80**: 123–127. AC Abbey, nouveau cultivar de blé de printemps roux vitreux (*Triticum aestivum* L.) convient pour la culture dans les Prairies canadiennes. Son chaume plein est significativement plus court que celui des cultivars de référence. Il possède un rendement grainier plus élevé, un grain plus lourd et une plus grande précocité que le cultivar à tige pleine AC Eatonia. Il est résistant au cèphe du blé (*Cephus cinctus* Nort.) ainsi qu'aux races dominantes de carie commune. Il est aussi modérément résistant à la rouille des feuilles et à la rouille noire. La nouvelle variété est admissible au classement dans la catégorie des blés de printemps roux de l'ouest canadien.

Mots clés: *Triticum aestivum* L., blé de printemps roux, rendement, cèphe du blé, hauteur de la plante, précocité

AC Abbey, a hard red spring wheat (*Triticum aestivum* L.), was developed at the Semiarid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, Swift Current, SK. It received regional registration No. 4794 from the Variety Registration Office, Food Production and Inspection Branch, Canadian Food Inspection Agency on 22 July 1998.

Pedigree and Breeding Method

AC Abbey derives from the cross BW608/93464//BW591 made in 1987 at the Semiarid Prairie Agricultural Research Centre of Agriculture and Agri-Food Canada, Swift Current, SK. The parent 93464 was developed by V. A. Johnson, Nebraska, from the complex cross CNO-Bb × Gallo (Gns-Ofn ″S″/Bz-Gb) × Mag 27/3/NE 75437. It had high protein concentration under conditions prevalent in Western Canada (DePauw and Townley-Smith 1988). BW591 is an experimental line with a solid stem and good bread-making quality derived from the cross Fortuna/Chris//Chester/Canuck (DePauw and McLeod 1987). BW608 is an experimental line which yielded 15% more grain and 1.8 percentage units lower protein concentration than the solid-stem check, Leader (DePauw and McLeod 1987). It expressed good preharvest sprouting resistance, and reduced height with strong straw. BW608 was derived from the complex cross Columbus/6/Canuck/5/Fortuna/Park//RL4137/4/Fortuna/(Lee-Norin10B)GB56/3/Canthatch/4351-331//Chinook/4351-331/4/RL4137. The F_2 seed was inoculated with common bunt [caused by *Tilletia laevis* Kuhn in Rabenh., and *T. caries* (DC.) Tul. & C. Tul.] races L1, L16, T1, T6, T13 and T19, and grown as individual plants in a leaf rust (caused by *Puccinia recondita* Roberge ex Desmaz.) and stem rust (caused by *P. graminis* Pers.:Pers. f.sp. *tritici* Eriks. & E. Henn.) epiphytotic nursery near Swift Current. The rust races were representative of those found the year previous (Kolmer and Liu 1997). The F_3, F_5, and F_7 generations were grown as head rows in a winter nursery near Brawley, California, to multiply seed for early generation tests. In the F_4, F_6, and F_8 generations, 89, 36, and 36 lines, respectively, were screened for maturity, stem solidness, grain yield potential and grain protein concentration using early generation screening procedures (DePauw et al. 1989). Time to maturity and grain yield potential were measured in replicated trials at two locations in southern Saskatchewan; grain protein concentration was assessed on a composite of the two replications from each location using near infrared reflectance spectroscopy (Williams 1979). In the same generations, reaction to leaf and stem rust was scored in an epiphytotic nursery near Glenlea, Manitoba. Remnant seed from the yield trials was used to assess end-use suitability and kernel characteristics. Selected F_8 lines were screened for reaction to loose smut [caused by *Ustilago tritici* (Pers.) Rostr.] using a mixture of races T2, T10, and T39 and common bunt using the same races as in the F_2 generation. An experimental line, 8702-EN2A, was evaluated in the Western Bread Wheat 'A 1' in 1992, the Western Bread Wheat 'B' in 1993, and in the Western Bread Wheat Cooperative tests from 1994 to 97 as BW691.

Table 1. Degree of pith filling the lumen of each internode of the main culm of AC Abbey and check cultivars

Cultivar	Internode[y]	Solidness rating[z] 1994	1995	1996	1997	Mean[x]
Neepawa	1	2.3	1.8	2.2	2.1	2.1
	2	1.7	1.3	1.7	1.6	1.5
	3	1.3	1.1	1.2	1.1	1.1
	4	1.0	1.2	1.0	1.0	1.0
AC Eatonia	1	3.7	3.3	3.2	4.3	3.6
	2	3.8	4.0	4.0	4.3	4.0
	3	3.4	3.0	3.4	4.3	3.5
	4	2.8	2.6	2.3	3.3	2.7
Lancer	1	3.9	3.8	3.0	4.3	3.7
	2	4.1	3.9	3.9	4.1	4.0
	3	3.9	3.4	3.7	4.0	3.7
	4	2.8	2.8	2.2	3.1	2.7
Leader	1	3.5	3.3	2.6	3.0	3.1
	2	3.6	3.3	3.4	3.2	3.3
	3	3.1	2.8	2.6	3.2	2.9
	4	2.4	2.7	1.7	2.7	2.4
AC Abbey	1	3.4	3.1	2.6	3.4	3.1
	2	3.4	3.0	3.1	3.4	3.2
	3	2.6	2.0	2.3	2.7	2.4
	4	3.1	2.4	2.0	3.2	2.7
Replications		4	2	2	3	

Std error of difference $Cultivar_i\ Node_k$ - $Cultivar_j\ Node_k$ =0.17

[z]Solidness rating based 10 plants per entry per rep per year. 1 = no pith in lumen of internode; 5 = pith fills entire lumen of the internode.
[y]Internodes numbered consecutively from base of plant (1) to base of spike (5).
[x]Means are weighted by the number of replicates split and error variation for each year.

Table 2. Yield potential of AC Abbey compared with check cultivars, based on data from the Western Bread Wheat Cooperative test, 1994–1997

Name	Yield kg ha^{-1} Zone 1[z] 1994	1995	1996	1997	Mean[y]	Zone 2 1994	1995	1996	1997	Mean	Grand Mean
Neepawa	2750	3690	3570	3390	3350	3610	4140	4200	4310	4090	3960
Laura	2780	3990	3760	3500	3510	3890	4340	4290	4380	4250	4120
AC Elsa	2850	4180	4000	3860	3720	3970	4370	4600	4540	4390	4280
AC Eatonia	2660	3750	3230	3200	3210	3420	3920	3950	3990	3840	3740
AC Abbey	2540	3980	3790	3520	3460	3660	4170	4510	4390	4210	4080
LSD	410	340	500	370	270	230	230	230	240	160	110
# tests	2	2	2	2	8	8	11	10	10	39	47

[z]Zone 1 locations in the Brown soil zone of southern Saskatchewan and south western Alberta; zone 2 locations in the Dark Brown and Black soil zones of Saskatchewan and Alberta.
[y]All means are weighted by the number of tests within a zone.

While in the Cooperative tests, leaf and stem rust seedling infection types were assessed by pathologists at the Cereal Research Centre, Agriculture and Agri-Food Canada (AAFC), Winnipeg, MB. Stem rust races used for 1 or more years were: QTH (C25), RTH (C57), RRQ (C63), TMR (C10), TMR (C95), and TPM (C53). Leaf rust races used for 1 or more years were: Race 1, Race 15, KBG, MBDS (12-3), MBR, (39-2), MBRJ (10-2), MCDS (1-2),MCR, MFM (56-1), MJB (10-3), TBD (U3-1), TDG (36-3), TDT, TGBJ (82-1), and TJB (77-2) (Kolmer and Liu 1997). Field leaf and stem rust reactions, using the same races as for the seedling tests, were measured in an epiphytotic nursery near Glenlea, MB. Reaction to Fusarium head blight (caused by *Fusarium* spp.) was assessed in artificially inoculated tests conducted near Winnipeg, MB. To determine the loose smut reaction type, a mixture of the prevalent races T2, T9, T10 and T39 were artificially injected into florets at anthesis. A mixture of common bunt races L1, L16, T1, T6, T13, and T19 were used to inoculate the seed which was planted about mid-April near Lethbridge. The race designations are those described by Green (1965) and Roelfs and Martens (1988) for stem rust, Hoffmann and Metzger (1976) for

Table 3. Agronomic performance of AC Abbey compared with check cultivars, based on data from the Western Bread Wheat Cooperative test, 1994–1997

Name	Maturity – days			Height	Lodging	Test weight	Kernel weight
	Zone 1[z]	Zone 2	Mean[y]	(cm)	(1–9)[x]	kg hL^{-1}	(mg)
Neepawa	99.2	101.1	100.9	100	2.3	80.2	32.7
Laura	99.5	103.3	102.9	98	3.2	80.3	32.9
AC Elsa	98.5	101.4	101.1	95	2.3	80.4	33.4
AC Eatonia	99.5	102.5	102.2	97	3.6	80.8	33.4
AC Abbey	97.9	100.5	100.2	89	2.2	80.4	34.3
SE[w]			0.3	0.3	0.2	0.1	0.2
# Tests	4	32	36	42	20	46	46

[z]Zone 1, locations in the Brown soil zone of Saskatchewan and Alberta; zone 2, locations in the Dark Brown and Black soil zones of Saskatchewan and Alberta.
[y]All means are weighted by the number of tests within a zone.
[x]Rated as 1 = all plants vertical; 9 = all plants horizontal.
[w]Standard error of a mean using the cultivar-by-test interaction mean square.

common bunt, and Nielsen (1987) for loose smut. Response to leaf spots [caused by *Pyrenophora tritici-repentis*. (Died.) Drechs., Stagonospora blotch caused by *Phaeosphaeria nodorum* (E. Muller) Hedjaroude and Septoria blotch caused by *Mycosphaerella graminicola* (Fuckel) J. Schrot. in Cohn] was scored in tests grown near Swift Current, Indian Head, Saskatoon, and Regina, SK. following the procedures described by Fernandez et al. (1996). Stem solidness was rated using a scheme described by DePauw and Read (1982).

Performance

AC Abbey has stem solidness similar to Leader, and less than Lancer and AC Eatonia (Table 1). In the Western Bread Wheat Cooperative test 1994 to 1997, AC Abbey yielded 7.8% more than the wheatstem sawfly check, AC Eatonia, in Zone 1 (Table 2) and 9.6% more in Zone 2. It also yielded 3.3% more than Neepawa in Zone 1 and 2.9% more in Zone 2. Overall, AC Abbey yielded 1% less than Laura and 4.7% less than AC Elsa, which are not relevant wheatstem sawfly checks. It matured about 2 d earlier than AC Eatonia (Table 3), was shorter than all of the checks (8 cm shorter than AC Eatonia), and had stronger straw than AC Eatonia and Laura.

Other Characteristics

SPIKES. Oblong to fusiform, mid-dense, mid-long, inclined to slightly nodding, and awned; glumes mid-wide, mid-long, glabrous, white; glume shoulders are primarily square, some tending to oblique and some tending to rounded, mid-wide; glume beak is mid-long and acuminate.

KERNEL. Red, medium size, mid-wide to wide, mid-long, ovate to oval; cheeks angular to slightly rounded; brush mid-size, with short hairs; embryo mid-size, oval.

SHATTERING. Resistant, similar to AC Eatonia.

DISEASE REACTION. Resistant to common bunt (Table 4); moderately resistant to leaf rust and stem rust, similar to AC Eatonia; more susceptible than AC Eatonia to loose smut and leaf spots under field conditions. AC Abbey is susceptible to Fusarium head blight.

PHOTOPERIOD RESPONSE: Insensitive.

END-USE SUITABILITY: Based on four years of testing in the Western Bread Wheat Cooperative Test, AC Abbey was rated equal to Neepawa for grain quality (Table 5), and it is eligible for grades of Canada Western Red Spring.

Maintenance and Distribution of Pedigreed Seed

Breeder Seed consists of 129 Breeder Lines. They were selected from F_6-derived F_{11} random single plants, and were grown in isolation near Swift Current in 1995 and again as 15-m rows near Indian Head in 1996. Breeder Seed will be maintained by the Seed Increase Unit, Research Farm, Indian Head, Saskatchewan, Canada S0G 2K0. Plant Breeders' Rights have been filed. AC Abbey has been released for distribution and multiplication to Canterra Seeds Ltd., 43 Scurfield Blvd., Winnipeg, Manitoba, Canada. R3Y 1G4.

Appreciation is expressed to K. R. Preston and B. Morgan, Grain Research Laboratory, Canadian Grain Commission, Winnipeg and J. S. Noll, Cereal Research Centre, AAFC, Winnipeg, for end-use suitability analysis; J. Gilbert for assessing reaction to *Fusarium* head blight and leaf spots, J. G Menzies for determining reaction to loose smut, and D. E Harder and J. A. Kolmer, for assessing reaction to stem and leaf rust, all from the Cereal Research Centre, AAFC, Winnipeg; D. A Gaudet, and B. J Puchalski, Research Centre, AAFC, Lethbridge, AB, for assessing reaction to common bunt; and C. W. B. Lendrum, G. McClare, and H. L Campbell, Semiarid Agricultural Research Centre, AAFC, Swift Current, R. A Ferguson, Research Farm, AAFC, Regina, Saskatchewan, and D. A. Green, and D. T. Gehl, Research Farm, AAFC, Indian Head, Saskatchewan, for their expert technical assistance in developing AC Abbey. The financial assistance from the Producer Check-off on wheat administered by the Western Grains Research Foundation is gratefully acknowledged. Financial support from western Canadian producer wheat levy, collected by the Canadian Wheat Board, and administered by the Western Grains Research Foundation is gratefully acknowledged.

Table 4. Disease reactions of AC Abbey and check cultivars, based on data from Western Bread Wheat Cooperative tests 1994–1997

	Field rust[z] reaction								Common bunt[z]				Loose smut[z,y]				Common root rot[x]			
	Leaf				Stem															
Entry	1994	1995	1996	1997	1994	1995	1996	1997	1994	1995	1996	1997	1994	1995	1996	1997	1994	1995	1996	1997
Neepawa	30MR	70MRMS	50MRMS	40MRMS	10RMR	40RMR-5MS	5RMR	5MR	14 I	12 I	4 R	17 I	6R	8R	0R	0R	22	0	5	11
Laura	10M	TR	5M	10M	5R	20RMR	1R	1RMR	43 S	24 S	23 I	46 S	52S	82HS	36HS	87HS	10	0	0	7
AC Elsa	20M	TR	5M	10M	5R	30RMR	4R	1R	8 I	6 I	27 I	25 I	17MR	6R	24MR	24MR	19	0	3	8
AC Eatonia	30MR	30M	20M	30M	15RMR	40MR-MS	1R	5MR	2 R	1 R	3 R	12 R	0MS	19MR	0S	22MR	14	0	12	16
AC Abbey	30MR	TR	10M	40MS	5R	30RMR	4RMR	3MR	2 R	2 R	11 R	19 I	0MR	47MS	25MS	56S	36	0	13	19

	Leaf spots[w]								
	1994		1995		1996		1997	FHB[u]	
Entry	SC[v]	St	SC	Reg	SC	IH	SC	1995	1997
Neepawa	7.5	8.5	8.2	9.3	7.8	8.0	6.9	52	48
Laura	9.0	3.5	9.3	9.3	9.0	9.8	7.0	57	64
AC Elsa	7.3	2.0	7.0	7.3	8.0	7.0	7.0	75	83
AC Eatonia	7.5	5.0	7.8	9.3	7.8	7.5	6.8	57	84
AC Abbey	8.8	8.0	9.8	10.0	9.3	10.0	7.3	75	81

[z]Percent infection and type of reaction: T, trace: VR, very resistant; R, resistant; MR, moderately resistant; I, intermediate resistant; MS, moderately susceptible; S, susceptible; HS, highly susceptible.
[y]Ratings are based on data from current and previous years, some of which are not shown.
[x]Percentage of plants with moderate to large lesions on the subcrown internode.
[w]Rated at the milk dough stage, using a scale of 0–11 except Saskatoon 1994 where a 0–9 scale was used. 0 = no symptoms and 9 or 11 = all leaves heavily infected.
[v]SC = Swift Current, SK; IH = Indian Head, SK; St = Saskatoon, SK; and Reg = Regina, SK.
[u]Fusarium head blight index = (% infected spikelets * % infected spikes)/100.

Table 5. End-use suitability[z] traits of AC Abbey and check cultivars, averages for the Western Bread Wheat Cooperative test 1994–1997

	Wheat protein (%)	Flour protein (%)	Flour yield (%)	Flour color (KJ)	Ash (%)	Wheat amylase[y] (EU)	Amylograph viscosity (BU)	Hagberg falling no. (s)	Starch damage Farrand units	Farinograph				Canadian short process		
										Absorption (%)	DDT[x] (min)	MTI[x] (BU)	Stability (min)	LV[x] (cc)	Time (min)	Absorption (%)
Neepawa	13.7	13.1	75.7	−2.1	0.41	5.5	608.8	384	33	65.7	4.88	27.5	9.0	1349	7.1	70.0
Laura	13.7	13.1	75.5	−2.8	0.42	5.5	646.3	364	26	65.4	8.00	16.3	21.4	1398	9.6	69.0
AC Eatonia	14.1	13.6	77.0	−1.9	0.41	8.5	702.5	358	30	64.4	4.19	27.5	8.3	1381	6.2	68.5
AC Elsa	14.1	13.4	76.6	−2.6	0.43	4.3	660.0	395	31	66.2	6.88	16.3	18.3	1370	8.5	70.3
AC Abbey	13.5	13.0	76.9	−2.8	0.43	4.7	757.5	384	27	65.5	5.50	18.8	13.9	1465	7.6	69.5

[z]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 to 10 locations each year.
[y]Assessed for 1994–1996.
[x]DDT is the Farinograph dough development time; MTI is Farinograph mixing tolerance index; and LV is loaf volume.

DePauw, R. M. and McLeod, J. G. 1987. Report on Western Bread Wheat Cooperative Tests, 1986. *In* Minutes, 42nd Ann. Meeting, Expert Committee on Grain Breeding, Edmonton, AB.

DePauw, R. M. and Read, D. W. L. 1982. The effect of nitrogen and phosphorus on the expression of stem solidness in Canuck wheat at four locations in S.W. Saskatchewan. Can. J. Plant Sci. **62**: 593–598.

DePauw, R. M. and Townley-Smith, T. F. 1988. Patterns of response for genotype grain yield and protein content in seven environments. Pages 993–997 *in* T. E. Miller and R. M. D. Koebner, eds. 7th International Wheat Genetics Symposium. Cambridge, UK.

DePauw, R. M., Townley-Smith, T. F., McCaig, T. N., Clarke, J. M., McLeod, J. G. and Knox, R. E. 1989. HY355 white spring wheat. Can. J. Plant Sci. **69**: 1245–1250.

Fernandez, M. R., Clarke, J. M., DePauw, R. M. and Lefkovitch, L. P. 1996. Comparison of durum and common wheat cultivars for reaction to leaf spotting fungi in the field. Plant Dis. **80**: 793–797.

Green, G. J. 1965. Stem rust of wheat, rye, and barley in Canada in 1964. Can. Plant Dis. Surv. **45**: 23–29.

Hoffmann, J. A. and Metzger, R. J. 1976. Current status of virulence genes and pathogenic races of the wheat bunt fungi in the northwestern USA. Phytopathology **66**: 657–660.

Kolmer, J. A. and Liu, J. Q. 1997. Physiologic specialization of *Puccinia recondita* f. sp. *tritici* in Canada in 1995. Can. J. Plant Pathol. **19**: 166–170.

Nielsen, J. 1987. Races of *Ustilago tritici* and techniques for their study. Can. J. Plant Pathol. **9**: 91–105.

Roelfs, A. P. and Martens, J. W. 1988. An international system of nomenclature for *Puccinia graminis* f. sp. *tritici*. Phytopathology **78**: 525–533.

Williams, P. C. 1979. Screening wheat for protein and hardness by near infrared reflectance spectroscopy. Cereal Chem. **56**: 169–172.