CULTIVAR DESCRIPTION

Peace hard red spring wheat

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Key words: *Triticum aestivum* L., hard red spring wheat, cultivar description, yield, *Lr34*, Ug99

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Mots clés: *Triticum aestivum* L., description de cultivar, rendement, *Lr34*, résistance aux maladies, Ug99

Peace, a hard red spring wheat (*Triticum aestivum* L.), was developed at the Cereal Research Centre (CRC), Agriculture and Agri-Food Canada, Winnipeg, MB. It received restricted registration No. 5861 from the Variety Registration office of the Canadian Food Inspection Agency on 2004 Apr. 24. Peace is adapted to the wheat-growing regions of the Canadian prairies and meets the end-use quality requirements of the Canada Western Red Spring wheat class.

Pedigree and Breeding Method

Peace derives from a cross between BW165 and RL4660, where BW165 is a common bunt resistant line with the pedigree Pacific*2/BW553 and RL4660 derives from the cross BW87/Katepwa. Pacific and BW87 are sister hard red spring wheat breeding lines developed at the Cereal Research Centre (CRC) of Agriculture and Agri-Food Canada and have the parentage: BW15/BW38//BW40/RL4353. BW553 is hard red spring wheat line with common bunt resistance developed at the Semiarid Prairie Agricultural Research Centre of Agriculture and Agri-Food Canada and has the parentage: Seln70-3524/8*Neepawa. The cross was made at the Cereal Research Centre of Agriculture and Agri-Food Canada in 1991 and given the designation: 91B05. The F_1 seed was grown in both the CRC New Zealand winter nursery and the greenhouse in 1992. F_2 seed was grown in space planted plots at Glenlea, MB, in 1993 and the spikes from the best plants were selected. F_3 heads were grown in hill plots in

Abbreviation: **CPS**, Canadian Short Process

the 1993–1994 California winter nursery of the CRC in 1993. F_4 families were grown in head row plots in 1994 at Glenlea, MB, and selected for agronomic desirability including straw strength and disease (leaf and stem rust) resistance. The best F_4 lines were selected and increased as F_5 rows in the CRC California winter nursery in 1995. Selected F_4 lines were evaluated for their enduse quality in the Central Quality Laboratory of the CRC in the winter 1994–1995. Agronomically desirable lines with suitable end use quality were harvested and yield tested in the F_6 daylength sensitive test at Glenlea and Portage la Prairie, MB, in 1995. Heads from the agronomically superior lines were sent to the 1995–1996 CRC New Zealand winter nursery for increase. The best F_7 lines were harvested and yield tested as F_8 lines at four locations (Beaverlodge, AB; Scott and Melfort, SK; and Glenlea, MB) in 1996. Sixteen lines from the 91B05 cross were evaluated in the 1997 Central Bread Wheat A1 test and one of these (91B05-CC1D$) was designated RL4904 and entered in the Parkland 'B' Test in 1998. RL4904 was evaluated in the Parkland Cooperative Test (1999–2001) under the designation PT416. The Parkland Cooperative Test check cultivars used for comparisons were: Neepawa (Campbell 1970), Roblin (Campbell and Czarnecki 1987b) (1999 and 2000) and AC Barrie (McCaig et al. 1996) and AC Splendor (Fox et al. 2007) (1999–2001). CDC Teal (Hughes and Hucl 1993) and Katepwa (Campbell and Czarnecki 1987a) were not included because these cultivars were only added to the Parkland Cooperative Test as checks in 2001. Data for the cultivar Lovitt (DePauw et al. 2004) were included to permit comparisons because this cultivar was evaluated in the Parkland Cooperative Test at the same time as Peace. The variables measured and the protocols followed in the Parkland Cooperative Test have been described by Graf and Fox (2000). Each year the data were analyzed using the S506 statistical program developed by the Statistical Research Services, AAFC. This program treats station-years independently, so that the LSD values for multi-location and multi-year comparisons are based on genotype × environment interactions.

End use quality was evaluated by the Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB, using the American Association of Cereal Chemists methods. These quality evaluations were conducted on a 10–12 kg composite sample that was generated each year from the six to nine sites of the Parkland Cooperative Test with the highest grades and suitable grain protein content.

Area of Adaptation

Peace is adapted to the shorter-season wheat-growing areas of the prairie provinces.

Performance

Peace is a red-seeded, hollow-stemmed wheat with end use quality similar to current wheat cultivars of the CWRS class. Agronomic performance data for Peace are summarized in Table 1. Peace was not significantly ($P < 0.05$) higher yielding than the check cultivars in the Parkland Cooperative test. On average, Peace matured a day earlier than AC Barrie but was 2 d later than AC Splendor over 3 yr of testing. Over 2 yr of testing (1999–2000), Peace was a day later than both Neepawa

Table 1. Agronomic data for Peace and check cultivars based on data collected in the Parkland Wheat Cooperative test (1999, 2000 and 2001)

	Yield (kg ha^{-1})				Maturity (d)							
Cultivar	Zone 1[z]	Zone 2[y]	Zone 3[x]	Overall mean	Zone 1	Zone 2	Zone 3	Overall Mean	Height (cm)	Lodging[w] (1–9)	Test weight (kg hL^{-1})	Seed mass (mg)
Three-year means (1999–2001)												
AC Barrie	3818	3879	4380	3931	99	114	125	108	93	2.0	79.8	37.6
AC Splendor	3852	3737	4354	3876	95	111	122	105	94	2.2	78.7	36.7
Lovitt	3820	4019	4644	4035	98	113	123	107	96	2.2	79.2	34.3
Peace	3909	3798	4526	3952	97	113	123	107	94	2.2	79.3	36.4
LSD ($P < 0.05$)[v]	830	807	1337	514	6	9	12	5	6	1.1	1.1	1.6
Station years	13	15	5	33	9	12	2	23	30	13	33	33
Two-year means (1999–2000)												
AC Barrie	3825	4070	3977	3968	103	115	–	110	97	2.1	79.2	37.0
AC Splendor	3971	3956	4027	3971	99	112	–	107	98	2.2	78.3	36.5
Lovitt	3791	4244	4363	4096	102	114	–	109	98	2.1	78.6	34.2
Neepawa	3500	3775	4263	3741	100	114	–	108	100	3.0	78.1	33.7
Roblin	3613	3839	4073	3789	100	113	–	108	95	1.7	77.9	35.1
Peace	3863	3949	4070	3934	101	114	–	109	97	2.1	78.7	35.7
LSD ($P < 0.05$)[v]	807	973	1988	590	9	10	–	6	7	2	1	2
Station years	10	12	2	24	6	9	–	15	20	9	24	24

[z]Zone 1 Saskatchewan site: Kernen, Lake Lenore, Melfort, Loon Lake and Kelvington (2001).
[y]Zone 2 Alberta sites: Beaverlodge, Fort Vermillion, Neapolis, Edmonton (1999), Lacombe (1999, 2000), Breton (1999) and Clive (2000, 2001).
[x]Zone 3 British Colombia sites: Fort St. John and Dawson Creek (1999, 2001).
[w]Lodging scale: 1 = vertical; 9 = flat.
[v]LSD of means was based on the checks and Peace, and calculated using SAS software (Version 9.2).

Table 2. Seedling and adult plant reactions and ratings of Peace and check cultivars to leaf and stem rust in the Parkland Wheat Cooperative test (1999, 2000 and 2001)

	Leaf rust[z]										
				Seedling leaf rust ratings							
	Field ratings			12-3 MBDS	74-2 MGBJ		77-2 TJBJ		128-1 MBRJ		185-1 MBDS
Cultivar	1999	2000	2001	2001	2000	2001	2000	2001	2000	2001	2000
AC Barrie	80 MRMS	50 MRMS	50 MRMS	11+	3+	2-2=	3+	2+-	11-	;1-1=	11-
AC Splendor	30 MRMS	25 MR	20 MRMS	1+22+c	1+	;11-2	11+	;2+-c	22-	;1-2=c	11-
Lovitt	20 RMR	tr	5 MR	;1-1=	;1-	;	;1-	;1-1=	;1-	;	;1-
Neepawa	80 S	60 S	–	–	3+	–	3+	–	3+	–	3
Roblin	20 MS-S	40 MRMS	–	–	3	–	3+	–	3+	–	3+
Peace	30 MRMS	15 MR	5 MR	23	23	;1-2-2=	;1-?	;2-2=	3+	2-2=	3+

	Stem rust[y]								
				Seedling stem rust ratings					
	Field ratings			C10 TMRT	C63 RKQS	C53 TPMK	C57 RTHJ	C25 QTHS	C20 RHTS
Cultivar	1999	2000	2001	2001[x]					
AC Barrie	5 MR	0 R	2 R	;1+	;1=	;1=	12+	12+	0;
AC Splendor	tr	0 R	tr R	0;	0;	;1	12	13	0;
Lovitt	tr	tr R	tr R	;1+	;1-	;1-	13	12+	0;
Neepawa	5 R	tr R	–	0;	;	;	0;	;1+	0;
Roblin	tr	0 R	–	;1+	;1	;1	12+	12+	0;
Peace	tr	0 R	tr R	0;	;1	;1-	;1-	;1-	0;

[z]Caused by *Puccinia triticina* Eriks. Inoculum was a composite of all leaf rust races increased from collections made the previous year (Kolmer 2001; McCallum and Seto-Goh 2002, 2003). Ratings indicate percent severity and pustule type, respectively.
[y]Caused by *Puccinia graminis Pers.* f. sp. *tritici* Eriks. & E. Henn. Races used include TMRT, RKQS, TPMK, RTHJ, QTHS and RHTS (Roelfs and Martens 1988; Fetch 2003). Ratings indicate percent severity and pustule type, respectively.
[x]Stem rust seedling reactions only determined in 2001.

Table 3. Common bunt, loose smut and Fusarium head blight reactions of Peace and check cultivars in the Parkland Wheat Cooperative test (1999, 2000 and 2001)

	Common bunt[z]			Loose smut[y]			Fusarium head blight VRI (%)[x]
Cultivar	1999	2000	2001	1999	2000	2001	2001
AC Barrie	32 S	23 I	5 MR	0 R	3 R	0 R	16 MR
AC Splendor	29 MS	25 I	7 MR	0 R	11 R	0 R	35 MS
Lovitt	35 S	27 MS	13 I	0 R	18 MR	0 R	36 MS
Neepawa	18 I	35 S	–	0 R	0 R	–	–
Roblin	30 S	41 S	–	0 R	9 R	–	–
Peace	0 R	5 R	0 R+	33 MR	6 R	0 R	38 MS

[z]Caused by *Tilletia tritici* (Bjerk) Wint. and T. laevis Kühn. The inoculum used was a composite of races T1, T6, T13 and T19 of *T. tritici* and L1, L16 of *T. laevis* mixed (vol/vol) in a 1:1:1:1:2:2 ratio (Gaudet and Puchalski 1989a), and represents the virulence spectrum of bunt isolates in western Canada (Gaudet and Puchalski 1989b). Rating indicates percent infection and relative classification.
[y]Caused by *Ustilago tritici* (Pers.) Rostr. Races include T2, T9, T10 and T39 (Nielsen 1987; Menzies et al. 2003).
[x]Caused by *Fusarium graminearum* Schwabe. Visual rating index = (% severity × % incidence)/100.

and Roblin. Peace has straw strength and test weight similar to the checks. Peace has large seeds similar to AC Barrie and AC Splendor and significantly larger than Lovitt over 3 yr of testing and significantly larger than Neepawa over 2 yr of testing.

Other Characteristics

SPIKE: Oblong shape, erect attitude, medium density and length, slight waxy bloom, white colour at maturity, short apical white awnlettes.

KERNEL: hard, light red colour, medium size, narrow width, ovate shape, rounded cheek, short and small to medium-sized brush hairs, small oval shaped germ, mid-wide and shallow crease.

DISEASE REACTION: Leaf and stem rust reactions were evaluated as part of the cooperative testing in an epiphytotic nursery. Peace was generally moderately resistant to leaf rust (*Puccinia triticina* Eriks.) and resistant to stem rust (*Puccinia graminis* f. sp. *tritici*) (Table 2a, b). DNA marker testing using the Indel *Lr34* marker (Dakouri et al. 2010) indicated that Peace carries the leaf rust resistant gene *Lr34* (data not shown). Following its release, Peace was shown to possess resistance to the highly virulent family of Ug99 stem rust races (Hiebert et al. 2011). Peace is resistant to common bunt [*Tilletia laevis* Kuhn in Rabenh., and *T. caries* (DC.) Tul.& C. Tul.], and moderately resistant to loose smut [caused by *Ustilago tritici* (Pers.) Rostr.] (Table 3). The highly resistant reaction to common bunt (Table 3) combined with a positive test (data not shown) for the *Bt10* DNA marker (Laroche et al. 2000) strongly suggest that Peace carries the common bunt resistance gene *Bt10*. Peace would have obtained this gene from its maternal grandparent BW533, which has been previously documented to carry *Bt10* (Depauw et al. 1998). Peace was moderately susceptible to Fusarium head blight (caused by *Fusarium graminearium* Schawbe) similar to AC Splendor (Table 3).

Leaf and stem rust seedling infection types were assessed by plant pathologists at CRC. The reaction data are summarized in Table 2. The 20–50 leaf rust races used for field evaluations near Glenlea, MB, were those multiplied from field survey collections made the previous year in western Canada (Kolmer 2001; McCallum and Seto-Goh 2002, 2003). Stem rust races used for field evaluations, conducted near Glenlea, MB, for 1 or more years were: QTHS, RHTS, RKQS, RTHJ, TMRT and TPMK (Roelfs and Martens 1988; Fetch 2003). To determine the reaction to loose smut, a mixture of the prevalent races T2, T9, T10 and T39 (Menzies et al. 2003) was injected into florets at anthesis of plants grown in growth cabinets. A mixture of the common bunt [*Tilletia laevis* Kuhn in Rabenh. and *T. caries* (DC.) Tul.& C. Tul.] races L1, L16, T1, T6, T13 and T19 (Gaudet and Puchalski 1989a, b) were used to inoculate the seed planted in mid-April of each year near Lethbridge, AB. Race designations are described by Roelfs and Martens (1988) for stem rust, Nielsen (1987) for loose smut, and Hoffman and Metzger (1976) for common bunt. Screening for the reaction to Fusarium head blight was conducted near Glenlea, MB. Screening was carried as outlined in Gilbert and Woods (2006).

END-USE SUITABILITY: Peace is eligible for all grades of the Canada Western Red Spring wheat class. End-use quality test results are summarized in Table 4. Peace has significantly larger kernels than Lovitt and Neepawa. Grain and flour protein concentrations were similar to the checks. Hagberg falling numbers were similar to AC Barrie, AC Splendor and Lovitt, but significantly higher than Neepawa and Roblin. Flour yield was significantly lower than AC Barrie, but similar to other check cultivars. Over 3 yr of testing, Peace showed significantly higher farinograph absorption than AC Barrie and Lovitt, but was not significantly different from AC Splendor. Over 2 yr of testing, Peace showed significantly higher farinograph dough development time than Lovitt and Neepawa, but had significantly shorter farinograph

Table 4. End use quality data for Peace and check cultivars based on data from the Parkland Wheat Cooperative test (1999, 2000 and 2001)[z]

Cultivar	Test weight (kg hL^{-1})	Kernel weight (mg)	Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylo-graph (BU)	Flour yield (%)	Flour ash (%)	Agtron colour (%)	Starch damage (%)	Particle size index (%)
Three-year means (1999–2001)												
AC Barrie	82.9	39.4	15.3	14.8	0.5	393	693	76.3	0.42	79	6.6	56
AC Splendor	81.5	38.2	15.3	14.9	0.5	372	603	75.2	0.42	79	6.3	56
Lovitt	82.4	34.3	14.9	14.4	0.5	402	658	76.2	0.41	80	6.5	56
Peace	82.4	37.7	15.2	14.7	0.5	398	620	74.9	0.42	78	6.4	55
LSD ($P<0.05$)[y]	0.3	1.6	0.5	0.6	0.3	34	90	0.9	0.02	1.4	0.2	1.9
Station years	3	3	3	3	3	3	3	3	3	3	3	3
Two-year means (1999–2000)												
AC Barrie	82.7	38.9	14.9	14.4	0.5	380	638	76.3	0.42	79.5	6.5	56
AC Splendor	81.4	37.7	15.0	14.6	0.4	355	573	75.3	0.42	78.5	6.3	56
Lovitt	82.3	34.3	14.5	14.0	0.5	393	655	75.9	0.42	79.5	6.5	56
Neepawa	81.6	33.9	14.3	13.8	0.5	313	350	74.3	0.41	78.0	6.8	55
Roblin	82.7	35.6	15.0	14.6	0.4	325	430	74.6	0.39	76.5	5.4	58
Peace	82.2	37.3	14.9	14.4	0.5	395	585	74.7	0.43	77.5	6.3	55
LSD ($P<0.05$)[x]	1.2	1.9	0.8	0.8	0.4	42	146	1.4	0.03	4.1	0.5	2.3
Station years	2	2	2	2	2	2	2	2	2	2	2	2

	Farinograph				Canadian short process (150 ppm ascorbic acid)						
Cultivar	Absorption (%)	Dough development time (min)	Mixing tolerance index (BU)	Stability index (min)	Loaf volume (cm^3)	Loaf appearance	Crumb structure	Crumb colour	Absoption (%)	Mixing energy (W h kg^{-1})	Mixing time (min)
Three-year means (1999–2001)											
AC Barrie	66.7	6.25	32	9.0	1096	7.5	6.2	7.8	71	16.9	11.7
AC Splendor	68.4	7.08	17	13.8	1118	7.6	6.1	8.0	72	16.7	12.1
Lovitt	66.8	5.75	28	9.2	1093	7.6	6.2	8.0	71	16.0	11.3
Peace	68.3	6.33	18	11.2	1077	7.8	6.0	7.5	70	16.2	10.9
LSD ($P<0.05$)[y]	1.0	0.8	4.4	2.9	83	0.4	0.3	0.4	2.0	4.6	2.2
Station years	3	3	3	3	3	3	3	3	3	3	3
Two-year means (1999–2000)											
AC Barrie	66.6	6.25	33	9.0	1075	7.6	6.2	7.9	71	17.0	12.3
AC Splendor	68.2	6.88	18	12.8	1120	7.6	6.1	8.1	71	14.6	11.3
Lovitt	66.9	5.50	30	9.0	1083	7.8	6.1	8.0	71	14.1	10.6
Neepawa	66.7	4.75	30	7.3	1118	7.7	5.9	7.6	69	11.0	8.1
Roblin	66.6	7.50	18	17.8	1135	7.8	6.1	8.0	69	16.7	13.0
Peace	68.3	6.50	20	10.3	1085	7.8	6.0	7.5	70	16.1	11.3
LSD ($P<0.05$)[y]	2.0	0.8	6.1	6.6	101	0.4	0.3	0.5	2.3	2.9	1.9
Station years	2	2	2	2	2	2	2	2	2	2	2

[z]End-use quality testing was performed by the Grain Research Laboratory of the Canadian Grain Commission on a composite generated each year from the Parkland Cooperative test.
[y]LSD of means was based on the checks and Peace, and calculated using SAS software (Version 9.2).

dough development time than Roblin. Farinograph stability was significantly shorter than Roblin, but otherwise similar to other check cultivars. In contrast to farinograph absorption, Canadian Short Process (CPS) absorption for Peace was not significantly different from the check cultivars, while CPS mixing energy was similar to the checks over 3 yr of testing, Peace required significantly greater CPS mixing energy than AC Splendor, Lovitt and Neepawa over 2 yr of testing (1999–2000). CPS mixing time was not significantly different from the check means over 3 yr of testing, but was significantly longer than Neepawa over 2 yr of testing.

Maintenance and Distribution of Pedigreed Seed

The breeder lines were derived from 250 spikes taken at random from a rogued F_{13} test plot. The spikes were grown in isolation as rows in Lincoln, New Zealand, in the winter of 2001–2002. From the rows harvested in Lincoln, 155 long row plots were grown at Indian Head, SK, in 2002. Peace breeder seed was generated from a bulk of 151 breeder's lines. Breeder seed is maintained by the AAFC Seed Increase Unit, Indian Head, SK. Distribution and multiplication of pedigree seed stocks is the responsibility of Canterra Seeds, 1475 Chevrier Blvd., Winnipeg, Manitoba, Canada R3T 1Y7.

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