CULTIVAR DESCRIPTION

Cerveza barley

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Key words: Malting barley, *Hordeum vulgare* L., cultivar description, yield, disease resistance, malting quality

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Mots clés: Orge brassicole, *Hordeum vulgare* L., description de cultivar, rendement, résistance à la maladie, qualité brassicole

Cerveza is a doubled-haploid (DH) hulled two-row spring malting barley (*Hordeum vulgare* L.) cultivar developed at the Agriculture and Agri-Food Canada (AAFC) Brandon Research Centre, Brandon, MB. It received registration No. 6846 from the Variety Registration Office, Plant Products Division, Canadian Food Inspection Agency (CFIA) on 2010 Jun. 28. Plant Breeders' Rights for Cerveza (certificate No. 4213) were granted by the Plant Breeders' Rights Office, CFIA on 2011 Nov. 17.

Pedigree and Breeding Methods

Cerveza was developed from the cross TR251/Newdale//TR253/Newdale made in 1998 in the greenhouse at the AAFC Brandon Research Centre, Brandon, MB. TR251 is an advanced breeding line from AAFC Brandon that was selected from the cross TR229//AC Oxbow/ND7556, where TR229 was developed from the AC Oxbow/Manley cross and ND7556 was a breeding line with spot blotch resistance [*Cochliobolus sativus* (Ito & Kurib.) Drechs. ex Dast.] from North Dakota State University, Fargo, ND. Newdale is a two-row malting barley cultivar that showed a significant advance in grain yield when it was evaluated in the Western Cooperative Two-row Barley Registration Test (Legge et al. 2008). TR253, another advanced breeding line from AAFC Brandon, was developed from the cross TR238//TR236/TR234 with all parents from AAFC Brandon. TR238 was developed from the cross Wpg843-234/Manley//AC Oxbow/Manley, where Wpg843-234 was a breeding line

Abbreviations: **DH**, doubled-haploid; **DON**, deoxynivalenol; **ELISA**, enzyme-linked immunosorbent assay; **FHB**, fusarium head blight

developed by the AAFC Cereal Research Centre (CRC), Winnipeg, MB, from the cross Ellice/SM80489 with SM80489 being a breeding line from the University of Saskatchewan, Saskatoon, SK. TR236 was selected for net blotch resistance (*Pyrenophora teres* Drechs.) from the cross Wpg8419-24-2-1//Oxbow/Manley, where Wpg8419-24-2-1 is another breeding line from the CRC with the pedigree SM80489/CI9214. TR234 was developed from the cross Ellice/S7729//ND7556, where S7729 is a breeding line from the University of Saskatchewan.

Cerveza was produced by anther culture in the DH laboratory at the AAFC Brandon Research Centre following methods previously described for Norman barley except that no fusarium mycotoxins were included in the induction medium (Legge et al. 2011). Briefly, two seeds of the F_1 generation were planted in each of five pots containing PRO-MIX general purpose growing medium in a growth room at the Brandon Research Centre on 1999 Jul. 13. This comprised the first relay with two more relays being planted at weekly intervals. The anther culture treatment from the F_1 plants of this cross produced 297 green DH plants, which were transplanted into pots containing PRO-MIX growing medium in the greenhouse, grown to maturity and harvested by April 2000. One of these became BM9831D-290, which was planted as a single row in the field at Brandon in 2000. It was selected on the basis of height, maturity, lodging resistance, general appearance, and field disease reaction with spot blotch being the predominant disease. However, it was not harvested due to severe sprouting as a result of wet conditions before harvest. Reserve seed from the greenhouse was used to grow BM9831D-290 as a bulk increase in the 2000–2001 winter nursery at Southern Seeds Technology, Leeston, New Zealand. BM9831D-290 was grown as a single plot in a preliminary yield test with repeated checks at Brandon in 2001. Selection was based on the same criteria plus yield, heading date, kernel plumpness, test weight, kernel weight, kernel brightness, hull peeling and preliminary malting quality analyses (i.e., grain protein concentration, alpha amylase activity, diastatic power, fine grind extract, soluble protein concentration, and ratio of soluble to total protein concentration) conducted at the CRC, Winnipeg, MB. It was also evaluated at Brandon for reaction to spot blotch and net-form net blotch (*P. teres* Drechs. f. *teres* Smedeg.) in the irrigated leaf disease nursery, and to fusarium head blight (FHB) incited by *Fusarium graminearum* Schwabe on a 0–5 scale based on visual symptoms in the irrigated FHB nursery (Legge et al. 2004). BM9831D-290 was advanced to a replicated preliminary yield test at Brandon in 2002 where it was evaluated for the same traits as the previous year plus suitability for straight-cutting, advanced malting quality analyses (i.e., same traits as for preliminary analyses plus wort viscosity), and reaction to stem rust (*Puccinia graminis* Pers.), scald [*Rhynchosporium secalis* (Oud.) J.J. Davis], and spot-form net blotch (*P. teres* Drechs. f. *maculata* Smedeg.). Deoxynivalenol (DON) concentration was assessed by harvesting and threshing the row from the FHB nursery at Brandon, grinding a 20-g sample of the grain and sending a 1-g subsample to the Eastern Cereal and Oilseed Research Centre (ECORC), Ottawa, ON, for analysis using the enzyme-linked immunosorbent assay (ELISA) technique. BM9831D-290 was grown in an advanced yield test at six locations in western Canada in 2003 (Brandon, Hamiota and Wawanesa, MB; Saskatoon and Melfort, SK; and Lacombe, AB) where it was evaluated for the same traits as in 2002 plus reactions to loose smut [*Ustilago nuda* (Jens.) Rostr.], covered smut [*U. hordei* (Pers.) Lagerh.], false loose smut (*U. nigra* Tapke.), and common root rot [*C. sativus* (Ito & Kurib.) Drechs. ex Dast.], but DON concentration was not determined. Malting quality was determined at two locations (Brandon and Wawanesa) for the same traits as in the previous year plus malt beta-glucan concentration. BM9831D-290 was grown again in an advanced yield test at six locations in western Canada in 2004 (same locations as for 2003 except Melfort was replaced with Wakaw, SK) where it was

Table 1. Grain yield (kg ha^{-1}) for Cerveza and check cultivars, Western Cooperative Two-row Barley Registration Test, 2006 and 2007

		Soil zone			
Cultivar	Class	Black (east)[z]	Brown[y]	Black and Grey (west)[x]	Overall
Means for 2006					
Harrington	Malting	5516	5188	4286	5065
Xena	Feed	6784	6423	5345	6266
AC Metcalfe	Malting	5942	5400	4458	5334
CDC Kendall	Malting	5735	5460	4435	5290
Cerveza	Malting	6666	5967	4883	5914
$LSD^{w}_{0.05}$		672	590	543	328
No. of tests		5	7	4	16
Means for 2007					
CDC Copeland	Malting	5508	4780	5109	5084
Xena	Feed	5549	5659	5656	5629
AC Metcalfe	Malting	5187	5214	4807	5071
Cerveza	Malting	5873	5393	4981	5384
$LSD^{w}_{0.05}$		381	367	559	279
No. of tests		4	6	5	15
Overall means (2006–2007)					
Xena	Feed	6235	6071	5518	5958
AC Metcalfe	Malting	5607	5314	4652	5207
Cerveza	Malting	6313	5702	4938	5658
$LSD^{w}_{0.05}$		375	305	406	201
No. of tests		9	13	9	31

[z]Black Soil Zone (east): Brandon and Glenlea (2006), MB; Indian Head, Melfort, and Regina, SK.
[y]Brown Soil Zone: Beiseker, Lethbridge and Trochu (2006), AB; Harris (2006), Saskatoon, Scott (2007), Swift Current and Watrous, SK.
[x]Black and Grey Soil Zone (west): Beaverlodge, Calmar, Fort Vermilion, and Lacombe, AB; Dawson Creek (2007), BC.
[w]Least significant difference among cultivar means at the 5% probability level, where each test was treated as one replication.

evaluated for the same traits as in 2003. The same two sites were also evaluated for malting quality.

In 2005, BM9831D-290 was advanced to the Eastern Prairie Barley Test grown at eight locations in western Canada (Brandon, Hamiota, Morden and Glenlea, MB; Saskatoon, Harris, Melfort and Indian Head, SK). The Glenlea and Morden sites were lost due to excessive moisture and unfavourable conditions. The same traits were evaluated as in previous years, except that beta-glucan concentration was not determined for the three locations (i.e., Harris, Saskatoon and Indian Head) that were used for malting quality analysis. BM9831D-290 was advanced in 2006 to the Western Cooperative Two-row Barley Registration Test, where it was evaluated for 2 yr as TR06294. TR06294 was also evaluated in the 2007 and 2008 Collaborative Malting Barley Trials conducted at the pilot-scale level by the malting and brewing industry as part of the registration recommending process under the auspices of the Prairie Recommending Committee for Oat and Barley. Cerveza was evaluated in the Two-Row Barley Registration and Recommendation Test in Quebec and in the Maritimes in 2007–2009.

Performance

Cerveza is widely adapted to western Canada, and outyielded the malting check cultivar AC Metcalfe (Legge et al. 2003) by 9% across all soil zones over 2 yr of evaluation in the Western Cooperative Two-row Barley Registration Test (Table 1). In these trials, it was about 6 cm shorter than AC Metcalfe, similar in lodging resistance, and one day later in heading and maturing (Table 2). Cerveza had higher kernel weight, lower test weight and similar kernel plumpness to AC Metcalfe. Thus, Cerveza has an acceptable combination of agronomic traits when compared with AC Metcalfe over 2 yr, with high yield being its most noteworthy trait. When compared over 1 yr with CDC Copeland, which was included as a new malting check cultivar in 2007, Cerveza was 6% higher yielding, had 7 cm shorter straw and was generally similar for all other agronomic traits. On average over 2 yr, Cerveza yielded 5% less than the

Table 2. Agronomic trait data for Cerveza and check cultivars, Western Cooperative Two-row Barley Registration Test, 2006 and 2007

Cultivar	Days to heading	Days to maturity	Height (cm)	Lodging (1–9)[z]	Test weight (kg hL^{-1})	1000-kernel weight (g)	Plump (%)[y]
Means for 2006							
Harrington	58.0	86.1	81.0	6.0	64.5	42.6	88.0
Xena	57.8	87.5	83.6	4.8	67.0	49.8	93.4
AC Metcalfe	58.4	86.9	83.1	5.7	66.2	44.7	89.9
CDC Kendall	59.2	86.0	80.8	6.8	65.4	43.4	92.7
Cerveza	59.5	87.1	77.7	5.3	64.4	46.0	87.1
$LSD^{x}_{0.05}$	0.9	0.9	1.5	3.5	0.9	1.3	4.4
No. of tests	13[w]	13[v]	14[u]	2[t]	13[s]	13[r]	10[q]
Means for 2007							
CDC Copeland	59.0	90.0	87.0	4.5	63.3	43.8	88.0
Xena	56.6	90.3	85.6	3.8	66.2	47.2	89.0
AC Metcalfe	56.6	89.2	85.9	4.2	65.2	42.7	87.8
Cerveza	58.3	90.6	79.9	4.7	64.0	44.9	87.8
$LSD^{x}_{0.05}$	0.8	0.9	2.1	1.2	0.9	1.2	3.1
No. of tests	11[w]	13[v]	14[u]	2[t]	13[s]	12[r]	11[q]
Overall means (2006– 2007)							
Xena	57.2	88.9	84.6	4.3	66.6	48.6	91.1
AC Metcalfe	57.6	88.0	84.5	4.9	65.7	43.7	88.8
Cerveza	58.9	88.9	78.8	5.0	64.2	45.5	87.4
$LSD^{x}_{0.05}$	0.6	0.7	1.2	1.6	0.6	0.8	2.6
No. of tests	24[w]	26[v]	28[u]	4[t]	26[s]	25[r]	21[q]

[z]1 = no lodging; 9 = completely lodged.
[y]Kernel plumpness (%) as determined over a 6/64-inch (238-mm) slotted screen.
[x]Least significant difference among cultivar means at the 5% probability level, where each test was treated as one replication.
[w]Locations: Brandon, MB; Indian Head, Melfort (2006), Regina (2006), Saskatoon, Swift Current and Watrous, SK; Beaverlodge, Beiseker, Calmar, Fort Vermilion, Lacombe (2007), Lethbridge and Trochu (2006), AB.
[v]Locations: Brandon and Glenlea (2006), MB; Indian Head, Melfort (2007), Regina, Swift Current, and Watrous, SK; Beaverlodge, Beiseker, Calmar, Fort Vermilion, Lacombe, Lethbridge and Trochu (2006), AB; Dawson Creek (2007), BC.
[u]Locations: Brandon and Glenlea (2006), MB; Indian Head, Melfort, Regina, Saskatoon, Scott (2007), Swift Current and Watrous, SK; Beiseker, Calmar, Fort Vermilion, Lacombe, Lethbridge and Trochu (2006), AB; Dawson Creek (2007), BC.
[t]Locations: Melfort, SK; Lethbridge, AB.
[s]Locations: Brandon, MB; Harris, Indian Head, Regina, Saskatoon and Watrous, SK; Beaverlodge, Beiseker, Calmar, Fort Vermilion, Lacombe, Lethbridge and Trochu (2006), AB; Dawson Creek (2007), BC.
[r]Locations: Brandon, MB; Harris, Indian Head, Regina, Saskatoon and Watrous, SK; Beaverlodge, Beiseker, Calmar, Fort Vermilion, Lacombe, Lethbridge and Trochu (2006), AB.
[q]Locations: Brandon, MB; Harris, Indian Head, Regina (2007), Saskatoon and Watrous, SK; Beiseker, Calmar, Lacombe, Lethbridge and Trochu (2006), AB; Dawson Creek (2007), BC.

Table 3. Malting quality trait data[z] for Cerveza and check cultivars, Western Cooperative Two-row Barley Registration Test, 2006 and 2007[y]

Cultivar	Kernel plumpness (%)[x]	1000-kernel weight (g)	Grain protein (g hg^{-1})[xw]	Germination energy		Steep-out Moisture (%)[x]	Malt hull peeling (%)[x]
				4 mL (%)	8 mL (%)		
Means for 2006							
Harrington	88.7	43.0	11.5	100	99	–	10.0
AC Metcalfe	91.7	44.8	11.7	99	94	–	6.7
CDC Kendall	92.9	42.4	11.8	99	96	–	5.1
Cerveza	86.5	45.1	11.5	100	96	–	5.4
$LSD^{p}_{0.05}$	5.0	1.5	0.7	1	3	–	8.2
No. of tests	3	3	3	3	3	–	2
Means for 2007							
CDC Copeland	94.1	43.1	10.2	97	96	46.6	5.7
AC Metcalfe	92.8	42.3	10.7	98	96	46.9	4.8
Cerveza	92.3	44.1	10.9	96	96	46.5	5.2
$LSD^{p}_{0.05}$	3.8	3.2	0.9	4	3	1.7	7.0
No. of tests	3	3	3	3	3	3	2
Overall means (2006–2007)							
AC Metcalfe	92.2	43.6	11.2	99	95	46.9	5.8
Cerevza	89.4	44.6	11.2	98	96	46.5	5.3
$LSD^{p}_{0.05}$	3.7	2.0	0.5	2	2	3.4	3.6
No. of tests	6	6	6	6	6	3	4[o]

Cultivar	Fine grind extract (g hg^{-1})[xv]	Soluble protein (g hg^{-1})[xv]	Soluble to total protein (%)[xu]	Diastatic power (°L)[wt]	Alpha amylase (DU)[ws]	Beta- glucan (mg L^{-1})[r]	Wort viscosity (cps)[wq]	Friability (%)[x]
Means for 2006								
Harrington	80.0	4.87	43.1	107	58.3	111	1.44	94.1
AC Metcalfe	80.4	4.85	41.9	126	61.9	64	1.42	90.5
CDC Kendall	80.0	4.93	41.9	145	61.0	51	1.41	94.7
Cerveza	81.3	4.62	40.9	97	57.8	70	1.42	97.4
$LSD^{p}_{0.05}$	0.6	0.41	2.9	16	6.0	49	0.02	8.4
No. of tests	3	3	3	3	3	3	3	2
Means for 2007								
CDC Copeland	81.1	4.62	45.6	105	52.0	80	1.43	98.4
AC Metcalfe	81.7	4.78	46.7	123	68.0	87	1.42	99.4
Cerveza	82.0	4.50	42.0	110	62.6	123	1.42	97.7
$LSD^{p}_{0.05}$	0.3	0.10	3.8	5	4.1	93	0.01	5.2
No. of tests	3	3	3	3	3	3	3	2
Overall means (2006–2007)								
AC Metcalfe	81.1	4.81	44.3	125	64.9	76	1.42	94.9
Cerveza	81.7	4.56	41.5	103	60.2	97	1.42	97.5
$LSD^{p}_{0.05}$	0.5	0.17	2.8	12	1.7	37	0.01	8.2
No. of tests	6	6	6	6	6	6	6	4[o]

[z]Malting quality characteristics determined by industry at the micro-malting level using procedures similar to the Grain Research Laboratory (GRL), Canadian Grain Commission, Winnipeg, MB (Mather et al. 1997).
[y]Locations (company lab): 2006 – Beiseker, AB (GRL), Harris, SK (GRL), and Brandon, MB (Anheuser-Busch Inc.); 2007 – Beiseker, AB (GRL), Harris, SK (GRL), and Beaverlodge, AB (Anheuser-Busch Inc.).
[x]Expressed as % by the malting and brewing industries.
[w]On a grain dry matter basis.
[v]On a malt dry matter basis.
[u]Ratio of soluble protein to total protein concentration.
[t]Degrees Lintner.
[s]Dextrinizing unit measure of alpha amylase activity.
[r]On a malt extract basis, expressed as ppm by the malting and brewing industries.
[q]Centipoise, international viscosity units used by the malting and brewing industries.
[p]Least significant difference among cultivar means at the 5 % probability level, where each test was treated as one replication.
[o]Data not collected in 2006 for Brandon, MB (Anheuser-Busch Inc.) and in 2007 for Beaverlodge, AB (Anheuser-Busch Inc.); mean of four tests.

feed cultivar Xena (Table 1). During its 2 yr in the Western Cooperative Two-row Barley Registration Test, Cerveza had a desirable malting quality profile with consistently higher malt extract and lower soluble protein concentration than AC Metcalfe (Table 3). It had lower diastatic power and alpha amylase activity than AC Metcalfe, but was at least equal to CDC Copeland. The malt beta-glucan concentration of Cerveza was not significantly different from any of the checks, and was intermediate to the low check CDC

Copeland and the high check Harrington. It was generally similar to AC Metcalfe in all other traits including resistance to hull peeling. Although minor differences in the malting traits of Cerveza relative to AC Metcalfe and CDC Copeland were noted during the 2 yr of pilot-scale testing by industry in the Collaborative Barley Quality Trial, Cerveza continued to have higher malt extract and lower soluble protein concentration, but enzyme activity was closer to AC Metcalfe than CDC Copeland (Table 4). It also continued to have slightly higher malt beta-glucan concentration relative to the checks, although only significantly higher than CDC Copeland. In contrast to the cooperative test results, hull peeling of the malt was higher for Cervaza than the checks, but this appeared to be due to one very high value at the Neapolis site in 2007 and it was not significant due to the high error (LSD) associated with this trait. Market development is currently underway for Cerveza, so commercial acceptance by the malting and brewing industry is not known at this time.

Cerveza performed well in Quebec and the Maritimes (Tables 6 and 8). In Quebec, it yielded higher than AC Siruis and Sunderland, but less than Island. In the Maritimes, it yielded higher than AC Queens, but less than Island. Note that all check cultivars in both tests were feed barley. Cerveza was low in test weight and seed weight in both Quebec and the Maritimes (Tables 6 and 8). Cerveza is recommended for use in Quebec and the Maritimes because of its high yield and malting quality potential.

Table 4. Pilot-scale malting quality trait data[z] for Cerveza and check cultivars, Collaborative Malting Barley Trials, 2007 and 2008[y]

Cultivar	Kernel plumpness (%)[x]	1000-kernel weight (g)	Grain protein (g hg^{-1})[xw]	Germination energy		Steep-out Moisture (%)[x]	Friability (%)[x]
				4 mL (%)	8 mL (%)		
AC Metcalfe	95.7	46.8	11.9	95	88	45.2	73.2
CDC Copeland	96.6	47.2	11.1	97	92	45.0	83.2
Cerveza	94.9	47.7	11.3	95	88	45.3	75.8
$LSD^{o}_{0.05}$	1.1	1.2	0.7	2	5	0.4	8.1
No. of tests	9	8[n]	9	8[n]	8[n]	9	7[m]

Cultivar	Malt protein (g hg^{-1})[xv]	Fine grind extract (g hg^{-1})[xv]	70°C coarse grind extract (g hg^{-1})[xv]	Fine-coarse difference (g hg^{-1})[xv]	Soluble protein (g hg^{-1})[xv]	Soluble to total protein (%)[xu]
AC Metcalfe	11.7	80.9	79.4	1.3	4.92	42.3
CDC Copeland	11.2	81.3	79.7	1.4	4.89	44.0
Cerveza	11.2	82.2	80.4	1.6	4.79	43.3
$LSD^{o}_{0.05}$	0.8	0.7	0.8	0.9	0.13	3.0
No. of tests	9	9	7[l]	7[l]	9	9

Cultivar	Diastatic power (°L)[wt]	Alpha amylase (D.U.)[ws]	Beta glucan (mg L^{-1})[r]	Wort viscosity (cps)[wq]	Peeled and Broken	
					Barley (%)[xp]	Malt (%)[xp]
AC Metcalfe	153	69.0	227	1.52	2.1	4.9
CDC Copeland	130	59.8	182	1.51	2.0	3.4
Cerveza	145	69.8	271	1.53	2.0	6.9
$LSD^{o}_{0.05}$	16	3.5	48	0.05	1.0	5.0
No. of tests	9	9	9	9	9	8[k]

[z]Malting quality characteristics determined by industry using procedures similar to the Grain Research Laboratory (GRL), Canadian Grain Commission, Winnipeg, MB (Mather et al. 1997).
[y]Locations (company lab): 2007 – Beiseker, AB (ADM Malting Canada), Lacombe, AB (Prairie Malt Ltd.), Neapolis, AB (Anheuser-Busch Inc.), Saskatoon, SK (GRL); 2008 – Beiseker, AB (GRL), Lacombe, AB (Rahr Malting Co.), Neapolis, AB (Prairie Malt Ltd.), Saskatoon, SK (Malteurop Canada), Watrous, SK (GRL).
[x]Expressed as % by the malting and brewing industries.
[w]On a grain dry matter basis.
[v]On a malt dry matter basis.
[u]Ratio of soluble protein to total protein concentration.
[t]Degrees Lintner.
[s]Dextrinizing unit measure of alpha amylase activity.
[r]On a malt extract basis, expressed as ppm by the malting and brewing industries.
[q]Centipoise, international viscosity units used by the malting and brewing industries.
[p]Percentage of peeled and broken barley and malt, respectively, as measured by industry.
[o]Least significant difference among cultivar means at the 5% probability level, where each test was treated as one replication.
[n]Data not collected in 2008 for Lacombe, AB (Rahr Malting Co.).
[m]Data not collected in 2007 for Neapolis, AB (Anheuser-Busch Inc.) and in 2008 for Lacombe, AB (Rahr Malting Co.).
[l]Data not collected in 2007 for Lacombe, AB (Prairie Malt Ltd.) and in 2008 for Neapolis, AB (Prairie Malt Ltd.).
[k]Data not collected in 2007 for Beiseker, AB (ADM Malting Canada).

Table 5. Disease reactions for Cerveza and check cultivars, Western Cooperative Two-row Barley Registration Test, 2006 and 2007

	Ustilago Smuts				Net Blotch				Spot Blotch			
	(% infected)[z]			Sask[y]	Inoculated[x]			Melf[w]	Bran[v]	Melf[w]	Sask[u]	Inoc.[t]
Cultivar	*nuda*	*hordei*	*nigra*	*U. hordei*	102	858	857	(1–9)	(1–9)	(1–9)	(1–9)	1903
2006												
Harrington	29	10.0	22.5	S	10	10	9	7.5	7.5	4.5	6.5	7
Xena	81	3.0	40.0	S	10	10	3	2.0	7.0	5.0	5.0	6
AC Metcalfe	0	3.0	7.5	R	9	10	5	4.5	5.5	3.5	4.5	6
CDC Kendall	81	3.5	26.5	MR	5	9	3	1.5	6.5	4.0	4.8	6
Cerveza	0	0.5	6.0	R	2	9	2	1.5	1.5	3.0	1.0	2
2007												
CDC Copeland	94	0.5	0.0	MR	6	9	5	2.0	4.5	5.0	5.5	6
Xena	89	0.0	0.0	S	9	10	5	1.0	5.0	4.5	4.5	7
AC Metcalfe	0	0.0	0.0	R	9	9	5	3.5	5.0	3.5	3.5	6
Cerveza	0	0.0	0.0	MR	6	9	2	1.0	2.5	1.8	2.0	3

		Stem Rust[r]	Scald				Fusarium head blight	
	Common Root Rot			Field[p]		*Septoria*[o]		
Cultivar	(% infected)[s]	MCCF SeedlingIT	Inocul.[q] 1493	Edmon	Laco	1998	FHB[n] (0–5)	DON[m] (mg kg^{-1})
2006								
Harrington	89	3-2	S	1.5	6.5	S	2.3	5.9
Xena	89	0;1	S	2.5	7.0	S	1.3	3.7
AC Metcalfe	89	0;1	S	0.5	6.0	S	2.3	5.6
CDC Kendall	87	3-2	S	2.0	4.0	S	2.5	5.4
Cerveza	88	0;	S	1.5	6.0	S	2.2	5.6
2007								
CDC Copeland	96	0;	S	3.0	9.0	–	1.8	1.9
Xena	57	0;	S	2.0	8.5	–	2.2	1.7
AC Metcalfe	80	0;	S	2.0	8.5	–	2.2	5.9
Cerveza	68	0;	S	3.0	8.5	–	3.5	1.3

[z]Infected plants (%) as determined in smut tests conducted at the Agriculture and Agri-Food Canada (AAFC) Cereal Research Centre (CRC), Winnipeg, MB.
[y]Covered smut (*U. hordei*) rating determined at the Crop Development Centre (CDC), University of Saskatchewan, Saskatoon, SK; S = susceptible, MR = moderately resistant, R = resistant.
[x]Seedlings inoculated with *Pyrenophora teres* f. *teres* isolates WRS102 and WRS858 (net-form net blotch), and *P. teres* f. *maculata* isolate WRS857 (spot-form net blotch) from the CRC, Winnipeg, MB; 1 = resistant, 10 = susceptible.
[w]Rated for net-form net blotch (*P. teres* f. *teres*) and spot blotch (*Cochliobolus sativus*) reactions in the leaf disease nursery at AAFC, Melfort, SK, on a 1–9 scale (1 = resistant, 9 = susceptible).
[v]Rated for spot blotch (*C. sativus*) reactions in the irrigated leaf disease nursery at AAFC, Brandon, MB, on a 1–9 scale (1 = resistant, 9 = susceptible).
[u]Rated for reaction to spot blotch (*C. sativus*) in the CDC irrigated nursery, Saskatoon, SK, on a 1–9 scale (1 = resistant, 9 = susceptible).
[t]Seedlings inoculated with *C. sativus* isolate WRS1903 from the CRC, Winnipeg, MB; 1 = resistant, 9 = susceptible.
[s]Percentage of plants infected in the common root rot (*C. sativus*) nursery at AAFC, Lacombe, AB.
[r]Reaction to stem rust (*Puccinia graminis*) race MCCF to detect the *Rpg1* stem rust resistance gene in seedling tests at the CRC, Winnipeg, MB, where IT = infection type.
[q]Seedlings inoculated with *Rhynchosporium secalis* isolate WRS1493 from the CRC, Winnipeg, MB; S = susceptible.
[p]Field ratings for scald (*R.secalis*) reactions on a 0–9 scale where 0 = no disease, 9 = susceptible; Edmon = University of Alberta scald nursery, Edmonton, AB; Laco = AAFC, Lacombe, AB, scald nursery.
[o]Seedlings inoculated with *Septoria passerinii* isolate WRS1998 from the CRC, Winnipeg, MB; S = susceptible.
[n]Mean fusarium head blight (*Fusarium graminearum*) reaction rated visually on a 0–5 scale (0 = no symptoms, 5 = susceptible) in the irrigated FHB nursery at AAFC, Brandon, MB; mean for each year calculated from three replications.
[m]Deoxynivalenol (DON) concentration determined by the enzyme-linked immunosorbent assay (ELISA) technique at the Eastern Cereal and Oilseed Research Centre (ECORC), Ottawa, ON, using a composite sample of three replications for each test.

Other Characteristics

PLANT: Erect to semi-erect juvenile growth; whitish coleoptile with very thin green strip at tip and short to medium elongation; medium green leaves with slight waxy bloom, green lower leaf sheath, glabrous sheath and blade; intermediate to upright flag leaf, long length, medium to wide width, white to purple auricles, glabrous sheath, blade and auricles, and pronounced waxy sheath; medium green stem with slight to pronounced waxy bloom, thin to medium thickness, slight stem

Table 6. Grain yield and agronomic trait data for Cerveza and check cultivars (all checks are feed barley cultivars), Quebec Two-Row Barley Registration and Recommendation Test, 2007 to 2009

Cultivar	Grain yield (kg ha^{-1})	Test weight (kg hL^{-1})	Seed weight (mg)	Height (cm)	Lodging (0–9)[z]	Maturity (d)
AC Sirius	5221	68	44	82	3.7	89
Island	5772	69	48	85	2.9	90
Sunderland	5446	69	46	77	3.1	90
Cerveza	5555	64	42	77	3.3	93
$LSD^{y}_{0.05}$	250	1	1	2	0.6	1
No. of tests[x]	22	22	22	22	22	22

[z]0 = no lodging, 9 = severe lodging.
[y]Least significant difference among cultivar means at the 5% probability level, where each test was treated as one replication.
[x]Tested in Quebec at: seven locations (Normandin, Hébertville, Sainte-Rosalie, Printendre, Saint-Simon, Saint-Augustin, and La Pocatière) in 2007; eight locations (Normandin, Hébertville, Sainte-Rosalie, Princeville, Saint-Simon, Saint-Augustin, La Pocatière, and Causapscal) in 2008; and eight locations (Normandin, Hébertville, Sainte-Rosalie, N-D-de-St-Hyacinthe, Princeville, Saint-Augustin, La Pocatière, and Causapscal) in 2009.

Table 7. Disease ratings for Cerveza and check cultivars, Quebec Two-Row Barley Registration and Recommendation Test, 2007 to 2009

Cultivar	Foliar diseases[z] (0–9)[y]	Leaf rust (0–9)[y]	Deoxynivalenol[x] (mg kg^{-1})
AC Sirius	6.8	0.5	31
Island	6.5	6.0	25
Sunderland	7.0	0.0	31
Cerveza	5.7	0.0	28
No. of tests	22	1	9

[z]Natural mixtures of net blotch, spot blotch and scald.
[y]Visual disease ratings determined for yield plots, where 0 = no disease, 9 = severe disease.
[x]Artificial inoculation tests were conducted by S. Rioux at Saint-Mathieu-de-Beloeil in 2007–2009; by A. Comeau and F. Langevin, Soils and Crops Research and Development Centre, Agriculture and Agri-Food Canada, at Lévis in 2007–2009, and by D. Pageau at Normandin Farm, Agriculture and Agri-Food Canada, in 2007–2009. Deoxynivalenol (DON) concentration of artificial inoculation tests was determined by the enzyme-linked immunosorbent assay (ELISA) technique at the Eastern Cereal and Oilseed Research Centre (ECORC), Ottawa, ON.

exertion, 5 nodes, straight to slightly curved neck, and closed cup with V-shaped collar.

SPIKE: Two-row type, slightly tapering to parallel shape, medium density, long in length, erect to semi-erect attitude, with medium glaucosity; rough lemma awns longer than the spike with green tips, with a few barbs on lateral veins; glumes medium to long in length with short to medium long hairs confined to a band, rough awns with green to slightly purplish tips shorter to longer in length than the glumes; first segment of rachis short to medium long with very weak to strong curvature, rachis edges strongly pubescent; sterile spikelet with weakly divergent attitude; median spikelet with longer glume and awn than grain.

KERNEL: Covered (hulled), medium length and width, colourless aleurone, short to medium long rachilla with long hairs, a few abnormal rachillas, green lateral lemma nerves, clasping lodicules, no hairs on ventral furrow, and predominantly horseshoe depression basal marking.

QUALITY: Very good malting quality (Tables 3 and 4).

DISEASE REACTION: Resistance to loose smut, covered smut, and false loose smut; moderate resistance to spot blotch and spot-form net blotch; moderately resistant to moderately susceptible to common root rot, FHB and stem rust (carries the *Rpg1* gene but susceptible to race Pgt-QCCJ); moderately susceptible to net-form net blotch; susceptible to scald and speckled leaf blotch (*Septoria passerinii* Sacc.) (Table 5). Overall, Cerveza has a superior disease resistance package when compared with the checks, including resistance to the smuts, spot-form net blotch and spot blotch (Tables 5, 7, and 9). Its spot blotch resistance is particularly noteworthy.

Table 8. Grain yield and agronomic trait data for Cerveza and check cultivars (all checks are feed barley cultivars), Maritime Two-Row Barley Registration and Recommendation Test, 2007 to 2009

Cultivar	Grain yield (t ha^{-1})	Test weight (kg hL^{-1})	Seed weight (mg)	Height (cm)	Lodging (0–9)[z]	Heading (d)	Maturity (d)	Straw yield (t ha^{-1})
AC Queens	4.26	65	45	94	2.7	60	99	3.3
Island	4.61	65	45	93	2.7	60	99	3.0
Cerveza	4.55	59	38	84	2.2	62	100	2.9
$LSD^{y}_{0.05}$	0.31	1	2	3	1.3	1	5	0.4
No. of tests[x]	11	11	11	11	9	11	3	2

[z]0 = no lodging, 9 = severe lodging.
[y]Least significant difference among cultivar means at the 5% probability level, where each test was treated as one replication.
[x]Tested at Harrington, PE, Hartland, NB, and Truro, NS, in 2007; and at Harrington, Hartland, Truro, and Canning, NS, in 2008–2009.

Table 9. Disease ratings for Cerveza and check cultivars, Maritime Two-Row Barley Registration and Recommendation Test, 2007 to 2009

Cultivar	Net blotch (0–9)[z]	Scald (0–9)[z]	Powdery mildew (0–9)[z]	Deoxynivalenol (mg kg^{-1})[y]
AC Queens	3.9	3.1	3.7	1.1
Island	3.6	3.1	3.0	0.8
Cerveza	1.9	2.2	3.9	1.2
No. of tests	9	7	2	3

[z]Visual disease ratings determined for yield plots, where 0 = no disease, 9 = severe disease.
[y]Deoxynivalenol (DON) concentration of yield plots was determined by the enzyme-linked immunosorbent assay (ELISA) technique at the Eastern Cereal and Oilseed Research Centre (ECORC), Ottawa, ON.

Maintenance of Pedigreed Seed Stocks

Breeder Seed will be maintained by the AAFC Seed Increase Unit, Experimental Farm, Box 760, Indian Head, Saskatchewan, Canada S0G 2K0. Initial Breeder Seed was produced in 2008 by the Seed Increase Unit at Indian Head from a bulk of 199 lines (seven generations after initial DH plant was produced) derived from single plant selections originally made at the AAFC Brandon Research Centre in 2006 from the same increase used to provide seed for evaluation of Cerveza in the Western Cooperative Two-row Barley Registration Test. Distribution and multiplication of other classes of Pedigreed seed will be handled by Mastin Seeds, R.R. #1, Sundre, Alberta, Canada T0M 1X0.

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Legge, W. G., Haber, S., Harder, D. E., Menzies, J. G., Noll, J. S., Tekauz, A., Thomas, P. L., Turkington, T. K. and Bizimungu, B. 2008. Newdale barley. Can. J. Plant Sci. **88**: 717–723.

Legge, W. G., Metcalfe, D. R., Haber, S., Harder, D. E., Noll, J. S., Tekauz, A. and Thomas, P. L. 2003. AC Metcalfe barley. Can. J. Plant Sci. **83**: 381–384.

Legge, W. G., Therrien, M. C., Tucker, J. R., Banik, M., Tekauz, A., Somers, D., Savard, M. E., Rossnagel, B. G., Lefol, E., Voth, D., Zatorski, T., Harvey, B. L. and Scoles, G. 2004. Progress in breeding for resistance to fusarium head blight in barley. Can. J. Plant Pathol. **26**: 436–442.

Legge, W. G., Tucker, J. R., Bizimungu, B., Tekauz, A., Noll, J. S., Fetch Jr., T. G., Menzies, J. G., Haber, S., Savard, M. E., Vigier, B. J., Choo, T. M., Martin, R. A., Turkington, T. K., Rossnagel, B. G. and Harvey, B. L. 2011. Norman barley. Can. J. Plant Sci. **91**: 1105–1113.

Mather, D. E., Tinker, N. A., LaBerge, D. E., Edney, M., Jones, B. L., Rossnagel, B. G., Legge, W. G., Briggs, K. G., Irvine, R. B., Falk, D. E. and Kasha, K. J. 1997. Regions of the genome that affect grain and malt quality in a North American two-row barley cross. Crop Sci. **37**: 544–554.