CULTIVAR DESCRIPTION

Alvena hard red spring wheat

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Knox, R. E., DePauw, R. M., Clarke, F. R., Clarke, J. M., McCaig, T. N. and Fernandez, M. R. 2008. **Alvena hard red spring wheat.** Can. J. Plant Sci. **88**: 513–518. Based on 38 replicated trials over 3 yr, Alvena, hard red spring wheat (*Triticum aestivum* L.) expressed significantly higher mean grain yield than the checks. It was significantly earlier maturing than AC Barrie and significantly more resistant to lodging than Katepwa. Wheat protein concentration of Alvena was similar to the mean of the checks and flour protein concentration was significantly higher than the check mean. Amylograph viscosity was significantly lower than the mean of the checks. Alvena meets the end-use quality and Canadian Grain Commission's kernel visual distinguishability specifications of the Canada Western Red Spring wheat market class. Alvena expressed moderate resistance to prevalent races of loose smut and stem rust, intermediate resistance to prevalent races of leaf rust and common bunt, and moderate susceptibility to fusarium head blight.

Key words: *Triticum aestivum* L., cultivar description, grain yield, maturity, disease resistance

Knox, R. E., DePauw, R. M., Clarke, F. R., Clarke, J. M., McCaig, T. N. et Fernandez, M. R. 2008. **Le blé roux vitreux de printemps Alvena**. Can. J. Plant Sci. **88**: 513–518. Au terme de 38 essais avec réplication en trois ans, la variété de blé roux vitreux de printemps (*Triticum aestivum* L.) Alvena a donné un rendement grainier sensiblement plus élevé que la moyenne obtenue avec les variétés témoins. Le cultivar arrive à maturité sensiblement plus tôt que AC Barrie et résiste nettement mieux à la verse que Katepwa. Alvena se caractérise par une teneur en protéines similaire à la teneur moyenne des cultivars témoins, mais donne une farine significativement plus protéinée. La viscosité à l'amylographe était sensiblement plus faible que la moyenne des cultivars témoins. Alvena respecte les spécifications de qualité liées à la destination finale du grain et celles de la Commission canadienne des grains pour la différenciation visuelle de la classe commerciale « blé roux de printemps de l'Ouest canadien ». Alvena résiste modérément aux races courantes de charbon nu et de rouille de la tige; la variété démontre aussi une résistance intermédiaire aux races courantes de rouille de la feuille et de carie du blé, mais est modérément sensible à la brûlure de l'épi causée par le fusarium.

Mots clés: *Triticum aestivum* L., description de cultivar, rendement grainier, précocité, résistance à la maladie

Alvena, a hard red spring wheat (*Triticum aestivum* L.), was developed at the Semiarid Prairie Agricultural Research Centre (SPARC), Agriculture and Agri-Food Canada (AAFC), Swift Current, SK. It received registration No. 6183 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 2006 Nov. 10.

Pedigree and Breeding Method

Alvena derives from the cross BW711/AC Intrepid made in 1998 at the Semiarid Prairie Agricultural Research Centre of Agriculture and Agri-Food Canada, Swift Current, SK. BW711 (DePauw et al. 1997) derives from the cross of BW90*3/BW553. AC Intrepid (DePauw et al. 1999) derives from the cross Laura/RL4596//CDC Teal. One hundred and ninety-nine doubled haploid lines were generated using the maize pollen method (Knox et al. 2000). In 2000, seed of individual doubled haploid lines was inoculated with common bunt [*Tilletia laevis* Kühn in Rabenh., and *T. caries* (DC.) Tul. & C. Tul.] races L1, L16, T1, T6, T13 and T19 (Hoffmann and Metzger 1976). The seed was planted in 1.5-m-long rows, which were 23 cm apart, with every second row planted with CDC Kestrel winter wheat, which is susceptible to leaf and stem rust. An irrigated leaf rust (*Puccinia triticina* Eriks.) and stem rust (*P. graminis* Pers.:Pers. f.sp. *tritici* Eriks. & E. Henn.) epiphytotic nursery was established by planting genotypes susceptible to prevalent races of leaf and stem rust in every 12th plot and needle inoculating a sample of plants in each row with representative rust races. The leaf rust races used in this nursery were representative of those found the previous year (McCallum and Seto-Goh 2006). Stem rust races used were: QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2005). Spikes were selected from the disease-resistant

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doubled haploid lines that matured early and had strong stems of acceptable height. The seed from each head was grown out in 2-m rows near Christchurch, New Zealand. Agronomic performance was assessed on 78 doubled haploid lines, which were grown in four row plots 3 m long and replicated twice in nurseries near Swift Current and Regina, SK. Grain protein concentration was measured by using near infrared reflectance (NIR) spectroscopy on an equally proportioned composite of grain across replicates from each location (Williams 1979). Reaction to prevalent races of leaf and stem rust was assessed in an epiphytotic nursery near Glenlea, MB. Remnant seed from the yield trials was used to assess grain quality and kernel characteristics. Selected doubled haploid lines were screened for reaction to loose smut and common bunt. The above procedure resulted in an experimental doubled haploid line B9861&DW016* being identified, which met all of the selection criteria at each stage of selection.

B9861&DW016* was evaluated in the Western Bread Wheat A_3 test in 2001, Western Bread Wheat B test in 2002, and as PT213 in the Parkland Wheat Cooperative tests from 2003 to 2005. The check cultivars in the Parkland Wheat Cooperative tests were AC Barrie, Katepwa, AC Splendor and CDC Teal for the 3 test years 2003 to 2005, and AC Intrepid for 2003 and 2004. The variables measured and the protocols followed in the Parkland Wheat Cooperative test have been described by Fox and McCallum (2006). The PROC MIXED procedure was used to analyze the data for each year and to perform a combined analysis over environments using a mixed model with environments and replications considered random and genotypes considered fixed (SAS Institute, Inc. 1999).

PT213 was also assessed for reaction to several diseases from 2003 to 2005. Leaf and stem rust seedling infection types were assessed using stem rust races: QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2005), and leaf rust races: MBDS (12-3), MBRJ (128-1), MGBJ (74-2), 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 fusarium head blight (FHB) caused by *Fusarium graminearum* Schwabe [teleomorph *Gibberella zeae* (Schwein. Petch)] was assessed in artificially inoculated field tests conducted annually near Glenlea and Carman, MB (Gilbert and Woods 2006). Fusarium head blight failed to develop in 2004 in the nursery near Glenlea. To determine 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 (Menzies et al. 2003). To determine 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, Alberta (Fox and McCallum 2006).

A sample of grain of the checks from all locations was submitted to the Canadian Grain Commission to determine grain grade and protein concentration. End-use suitability was determined on a composite sample made up from sites with grain samples representative only of the top hard red spring wheat grades. The quantity of grain from a location was adjusted to achieve a final composite protein content approximating that of the average for the crop. A consistent quantity of grain within a location for all treatments was used to make up the composite. All end-use suitability analyses were performed by personnel at the Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB, following protocols of the American Association of Cereal Chemists. Determination of kernel attributes and eligibility to meet grades of the CWRS market class was done by personnel of the Inspection Division, Canadian Grain Commission.

Performance

Each year Alvena produced significantly more grain than AC Splendor and Katepwa (Table 1). In 2003 and 2004 Alvena yielded significantly more than CDC Teal. In 2004 and 2005 Alvena yielded significantly more than AC Barrie. Based on 38 replicated tests over 3 yr (2003 to 2005), Alvena yielded significantly more grain ($P \leq 0.05$) than all of the checks, 9.2% more than AC Splendor and Katepwa, 6.0% more than CDC Teal, and 6.1% more than AC Barrie. This increased average yield was more consistent in the Parkland Region than in the Peace River Region. Based on 26 tests over 2 yr, Alvena yielded significantly more grain than all of the checks except AC Barrie and AC Intrepid (Table 1). Grain yield of Alvena exceeded AC Splendor by 8.7%, and produced 8.6% more grain than Katepwa, 6.8% more than CDC Teal, and 4.8% more than AC Barrie (Table 1).

Alvena matured 1.6 d ($P \leq 0.05$) earlier than AC Barrie, 1 d earlier than CDC Teal, similar to Katepwa, and 0.6 d later than AC Splendor (Table 2, mean 29 tests). The plant height of Alvena averaged 2.5 cm shorter than Katepwa and similar to the other check cultivars. The straw strength of Alvena as measured by lodging score was significantly stronger than Katepwa, slightly less than AC Barrie and AC Splendor, and similar to CDC Teal. The test weight of Alvena was similar to AC Barrie and slightly less than the other checks. The seed size of Alvena was slightly less than all of the checks.

In long-season environments, grain yield and time to maturity are correlated positively, while grain yield and protein concentration are negatively correlated

Table 1. Grain yield of Alvena compared with the check cultivars in the Parkland[z] Wheat Cooperative test from 2003 to 2005

	Yield (kg ha^{-1})								
	2003	2004[y]	2005	2003–2005			2003–2004		
	Mean[x]	Mean	Mean	Peace River	Parkland	Mean	Peace River	Parkland	Mean
AC Barrie	3756	3603	4696	3480	4131	3967	2991	3976	3692
AC Intrepid[w]	3858	3776	–				3077	4140	3835
AC Splendor	3639	3437	4646	3312	4045	3856	2740	3892	3561
CDC Teal	3654	3486	4876	3527	4120	3971	2911	3912	3623
Katepwa	3713	3449	4626	3524	3954	3855	2953	3808	3565
Alvena	3876	3848	5043	3668	4399	4209	3036	4215	3871
LSD[v]	144	239	258	349	264	154	240	335	207
No. tests	13	13	12	12	26	38	8	18	26

[z]Locations for the 3 yr: in the Peace River Region: Beaverlodge, Dawson Creek, Fort St John, Fort Vermilion; and locations in the Parkland Region: Clive, Ellerslie, Kernen, Kelvington, Killam, Lacombe, Lake Lenore, Loon Lake, Melfort, Neapolis, Russell.
[y]RCB design used in 2004, whereas in 2003 and 2005 a lattice design was used.
[x]Means were computed by the PROC MIXED procedure.
[w]AC Intrepid was not grown as a check cultivar in 2005.
[v]Least significant difference, $P \leq 0.05$, includes variation from the genotype by environment interaction.

(DePauw et al. 2007). Physiological features of modern cultivars like AC Barrie, AC Cadillac, AC Elsa and AC Intrepid, that expressed either a combination of higher grain protein concentration and higher grain yield or higher grain yield with earlier maturity, run counter to expected correlations (Wang et al. 2002, 2007, 2008). On average, Alvena had significantly higher grain yield, and grain and flour protein concentration than Katepwa (Tables 1 and 4) with a similar time to maturity as Katepwa (Table 2). The 3-yr mean wheat protein concentration of Alvena was similar to the mean of the checks, and the flour protein concentration was significantly higher than the mean of the checks.

Other Characteristics

SPIKE: Parallel sided, medium density, erect to nodding attitude at maturity, medium to strong glaucosity, white at maturity; apically awnleted; glumes are glabrous, with straight and slightly sloping shoulder, medium to very narrow width shoulder, slightly curved and straight beak shape, very short to short beak length.

KERNEL: Colour is medium red, oval to ovate, medium size, short, midwide, angular cheek shape, midlong

Table 2. Agronomic characteristics of Alvena compared with the check cultivars in the Parkland[z] Wheat Cooperative test from 2002 to 2005

	Maturity (d)					Height (cm)		Lodging[y] (1 to 9)		Volume weight (Kg hL^{-1})		Seed mass (mg)	
	2003	2004[z]	2005	2003–2005	2003–2004[z]	2003–2005	2003–2004[z]	2003–2005	2003–2004[z]	2003–2005	2003–2004[z]	2003–2005	2003–2004[z]
AC Barrie	91.9	110.1	113.5	106.1	103.2	91.9	88.0	2.9	3.1	78.2	78.2	35.3	34.7
AC Intrepid[x]	91.2	108.4			102.1		89.4		2.7		78.2		34.7
AC Splendor	90.7	107.6	110.8	103.9	101.3	91.8	86.9	3.0	2.9	78.3	78.5	35.1	34.5
CDC Teal	91.4	109.1	113.2	105.5	102.4	91.4	88.0	2.4	2.6	78.5	78.4	34.9	34.6
Katepwa	91.2	108.7	112.6	104.7	101.7	94.2	90.0	3.5	3.6	78.4	78.3	35.3	34.5
Alvena	91.0	108.4	112.0	104.5	101.6	91.7	87.6	2.6	2.4	78.2	78.0	34.2	33.9
LSD[w]	0.8	1.6	1.2	1.1	1.6	1.9	2.1	0.9	1.1	0.8	1.1	1.2	1.7
No. tests	7	10	12	29	17	37	26	9	7	62	25	37	25

[z]RCB design used in 2004, whereas in 2003 and 2005 a lattice design was used. Data analyzed using PROC MIXED procedure.
[y]Straw strength rated on a scale of 1 indicating that all plants in plot are erect to 9 indicating that all plants in a plot are lying horizontal.
[x]AC Intrepid was not grown as a check cultivar in 2005.
[w]Least significant difference, $P \leq 0.05$, includes variation from the genotype by environment interaction.

Table 3. Disease reactions of Alvena and check cultivars in the Parkland Wheat Cooperative Trials from 2003–2005

	Leaf rust[z]			Stem rust[z]		
	2003	2004	2005	2003	2004	2005
AC Barrie	60 MRMS	48 MSS	63 S	25 MRMS	7 RMR	15 MRMS
AC Intrepid[y]	23 MRMS	8 MR	–	15 MRMS	Tr R	–
AC Splendor	28 RMS	11 MR	60 MS	10 RMR	Tr R	5 RMR
CDC Teal	5 MRMS	3 MR	33 I	15 MRMS	Tr R	20 MRMS
Katepwa	50 MSS	55 MSS	63 MS	7 RMR	5 RMR	10 MRMS
Alvena	35 MRMS	23 MRMS	52 MS	10 MRMS	3 R	15 MRMS
	Bunt[z]			Loose Smut[z]		
	2003	2004	2005	2003	2004	2005
AC Barrie	6 I	25 I	27 I	29MR	29 MR	43 I
AC Intrepid	4 MR	11 R		27MR	27 MR	
AC Splendor	7 I	10 R	5 MR	5R	5 R	27 MR
CDC Teal	1 VR	45 I	35 I	30MR	30 MR	25 MR
Katepwa	4 MR	19 I	40 I	10R	10 R	16 MR
Alvena	4 MR	31 I	18 MR-I	13 R	16 MR	12 MR
	FHB[x] Glenlea			FHB[x] Carman		
	2003	2004[w]	2005[w]	2003	2004	2005[w]
AC Barrie	23 I	NA	NA	28 I	9 MR	NA
AC Intrepid	38 MS	NA	NA	37 MS	49 S	NA
AC Splendor	46 S	NA	NA	44 MS	22 I	NA
CDC Teal	71 S	NA	NA	64 S	50S	NA
Katepwa	23 I	NA	NA	24 I	19 I	NA
Alvena	51 S	NA	NA	32 I	18 I	NA

[z]Percent infection and type of reaction: Tr, trace; R, resistant; VR, very resistant; MR, moderately resistant; I, intermediate resistant; MS, moderately susceptible; S, susceptible.
[y]AC Intrepid was not grown as a check cultivar in 2005.
[x]Disease index = (% infected spikelets *% infected spikes)/100. Response category: I, intermediate resistant; MR, moderately resistant; MS, moderately susceptible; S, susceptible.
[w]Due to excessive wet growing conditions data not available (NA).

brush hairs, midwide crease, shallow to mid-deep crease; embryo is midsize to large and oval.

SHATTERING: Resistant to seed shelling caused by wind.
DISEASE REACTIONS: Moderately resistant to loose smut and stem rust; an intermediate reaction to leaf rust and common bunt; moderately susceptible to fusarium head blight (Table 3).

END-USE SUITABILITY: Based on 3 yr of testing in the Parkland Wheat Cooperative test (Table 4), Alvena was rated equal to the check cultivars for grain quality by the Quality Evaluation Team of the Prairie Registration Recommending Committee for Grain. Most end-use suitability traits of Alvena, including wheat and flour protein concentration were similar to the mean of the checks, although Alvena had significantly lower flour color and flour ash content. Averaged over 3 yr, Alvena also had significantly lower amylograph viscosity although the Hagberg falling number was not significantly different from the mean of the checks. Alvena is eligible for all grades of the CWRS market class.

Maintenance and Distribution of Pedigreed Seed:

The 120 Breeder Lines originate from random single plants selected from the doubled haploid line and grown out as 144 Breeder-Lines in 3-m rows in isolation near Swift Current in 2004 and again as 15-m rows near Indian Head in 2005. Approximately 236 kg of Breeder Seed is available. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, Saskatchewan, Canada S0G 2K0. Application for Plant Breeders' Rights has been filed. The variety will be added to the OECD list of Cultivars. Alvena has been released for distribution and multiplication to SeCan Association, 501–300 March Rd. Kanata, Ontario, Canada K2K 2E2. Toll free: 1-800-764-5487, Fax: (613) 592-9497, e-mail: seed@secan.com.

Table 4. Averages of end-use suitability[z] traits of Alvena and check-cultivars in the Parkland Wheat Co-operative tests from 2003 to 2005

	Wheat protein (%)		Flour protein (%)		Flour yield (%)		Flour colour Agtron	
	2003–2004	2003–2005	2003–2004	2003–2005	2003–2004	2003–2005	2003–2004	2003–2005
AC Barrie	14.9	14.5	14.3	13.8	76.5	76.1	78.5	78.5
AC Intrepid[y]	14.2		13.8		74.6		80.0	
AC Splendor	15.0	14.6	14.5	14.1	75.1	75.0	79.0	80.3
CDC Teal	14.6	14.3	14.2	13.9	75.3	74.9	78.0	79.2
Katepwa	14.5	14.0	13.9	13.4	74.8	74.4	76.6	77.4
Mean of Checks	14.7	14.3	14.1	13.7	75.2	75.0	78.4	79.1
Alvena	14.6	14.3	14.2	13.8	75.0	74.8	77.8	77.7
SD[x]	0.05	0.05	0.05	0.05	0.34	0.34	0.9	0.9

	Flour ash (%)		Amylograph viscosity (BU)		Hagberg falling no. (s)		Starch damage (megazm)	
	2003–2004	2003–2005	2003–2004	2003–2005	2003–2004	2003–2005	2003–2004	2003–2005
AC Barrie	0.42	0.42	528	518	368	365	7.4	7.7
AC Intrepid	0.42		385		330		7.3	
AC Splendor	0.45	0.45	510	483	365	367	6.9	7.1
CDC Teal	0.42	0.43	470	500	355	373	7.3	7.5
Katepwa	0.43	0.44	423	385	355	362	7.8	8.2
Mean of Checks	0.43	0.44	463	459	355	363	7.3	7.6
Alvena	0.42	0.43	343	347	340	358	6.9	7.2
SD	0.01	0.005	5	5	15	15	0.08	0.08

	Farinograph							
	Absorption (%)		DDT[w] (min.)		MTI[v] (BU)		Stability (min.)	
	2003–2004	2003–2005	2003–2004	2003–2005		2004–2005	2003–2004	2003–2005
AC Barrie	66.5	67.4	6.9	6.5		22.5	12.3	11.2
AC Intrepid	68.3		6.6				16.1	
AC Splendor	68.0	68.1	7.9	7.8		20.0	22.8	19.0
CDC Teal	66.5	67.5	7.1	7.6		22.5	14.1	14.6
Katepwa	67.7	68.2	5.8	6.0		30.0	8.6	8.9
Mean of Checks	67.3	67.9	6.9	6.9		24.4	14.8	13.6
Alvena	67.2	68.3	7.1	7.1		30.0	18.0	14.9
SD	0.17	0.17	0.4	0.4		2.6	1.4	1.4

	Canadian short process (150 ppm ascorbic acid)					
	Loaf volume (cc)		Mixing time (min.)		Absorption (%)	
	2003–2004	2003–2005	2003–2004	2003–2005	2003–2004	2003–2005
AC Barrie	1118	1105	4.5	4.0	71.0	71.0
AC Intrepid	1130		3.7		72.0	
AC Splendor	1163	1148	4.3	4.0	73.0	72.3
CDC Teal	1183	1165	4.5	4.2	71.5	71.3
Katepwa	1138	1103	3.8	3.6	71.5	71.3
Mean of Checks	1146	1128	4.2	3.9	71.6	71.4
Alvena	1110	1090	4.1	3.7	71.5	71.3
SD	45	45	0.3	0.3	NA[u]	NA

[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]AC Intrepid was included as a check for end-use suitability in 2003 and 2004 only.
[x]SD is the 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 GRL, CGC.
[w]DDT is the farinograph dough development time.
[v]MTI is farinograph mixing tolerance index expressed in Brabender Units (BU). MTI was not reported in 2003.
[u]NA, SD was not available.

Financial support from the producer check-off on wheat collected by the Canadian Wheat Board and administered by the Western Grains Research Foundation is gratefully acknowledged. Appreciation is expressed to the following: N. Edwards and E. Lysenko (Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB) and J. S. Noll and D. Niziol (Cereal Research Centre, AAFC, Winnipeg) for end-use suitability analysis; N. Woodbeck (Inspection Division, Canadian Grain Commission) for kernel attribute analysis; A. Brule-Babel (University of Manitoba) and J. Gilbert (CRC, AAFC, Winnipeg) for assessing reaction to fusarium head blight and leaf spots; J. G. Menzies (CRC, AAFC, Winnipeg) for determining reaction to loose smut; and T. Fetch and B. McCallum (CRC, AAFC, Winnipeg) for assessing reaction to stem rust; D. A Gaudet and T. Despins (Lethbridge Research Centre, AAFC, Lethbridge, AB) for assessing reaction to common bunt; D. T. Gehl, Research Farm (AAFC, Indian Head, SK) for production of Breeder Seed; and G. McClare, D. Dahlman, H. L Campbell and M. Poppy (SPARC, AAFC, Swift Current, SK) R. A. Ferguson (Research Farm, AAFC, Regina, SK) and O. Thompson (Research Farm, AAFC, Indian Head, SK) for their expert technical assistance in conducting and analyzing field trials.

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