

## Stettler hard red spring wheat

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DePauw, R. M., Knox, R. E., Clarke, F. R., Clarke, J. M. and McCaig, T. N. 2009. **Stettler hard red spring wheat**. *Can. J. Plant Sci.* **89**: 945–951. Based on 34 replicated trials over 3 yr, Stettler, a doubled haploid hard red spring wheat (*Triticum aestivum* L.), expressed significantly higher grain yield than all checks except Superb. Wheat and flour protein concentration were significantly greater than all of the checks except Lillian. It matured significantly later than AC Barrie and Katepwa but earlier than Superb. Stettler was significantly shorter than all of the checks except Superb and was more resistant to lodging than Katepwa and Laura. Stettler had high grain volume weight and intermediate kernel weight relative to the checks, and meets the end-use quality specifications of the Canada Western Red Spring wheat market class. Stettler expressed resistance to prevalent races of stem rust, common bunt and loose smut, with moderate susceptibility to prevalent races of leaf rust and fusarium head blight.

**Key words:** *Triticum aestivum* L., cultivar description, grain yield, protein, disease resistance, doubled haploid

DePauw, R. M., Knox, R. E., Clarke, F. R., Clarke, J. M. et McCaig, T. N. 2009. **Le blé roux vitreux de printemps Stettler**. *Can. J. Plant Sci.* **89**: 945–951. Au terme de 34 essais avec réplication effectués en trois ans, le cultivar de blé roux vitreux de printemps (*Triticum aestivum* L.) à double haploïdie Stettler s'est caractérisé par un rendement sensiblement plus élevé que celui des variétés témoins sauf Superb. La concentration de protéines dans le grain et la farine était significativement plus élevée chez Stettler que chez tous les cultivars témoins sauf Lillian. Stettler parvient à maturité sensiblement plus tard qu'AC Barrie et Katepwa, mais plus tôt que Superb. Stettler a une paille significativement plus courte que celle des autres variétés hormis Superb et résiste mieux à la verse que Katepwa et Laura. Le grain de Stettler a une plus grande densité apparente que celui des témoins et un poids intermédiaire. Il respecte les exigences qualitatives pour l'usage final de la classe Blé roux de printemps de l'Ouest canadien. Stettler résiste aux races régnantes de la rouille de la tige, de la carie commune et du charbon nu, et est modérément sensible aux races régnantes de la rouille des feuilles et de la brûlure de l'épi par *Fusarium*.

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

Stettler, 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. 6516 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 2008 Oct. 16.

### Pedigree and Breeding Method

Stettler derives from the cross Prodigy/Superb designated B9962 made in 1999 at the Semiarid Prairie Agricultural Research Centre of Agriculture and Agri-Food Canada, Swift Current, SK. Prodigy derives from the cross of Columbus/BW85//Stoa (Graf et al. 2003). Superb derives from the cross Grandin\*2/AC Domain (Townley-Smith and Humphreys 2000). One hundred and sixty-eight F<sub>1</sub>-derived doubled haploid lines (B9962&) were generated using the maize pollen method (Knox et al. 2000) and given incrementing alpha (female parent) numeric (doubled haploid derivative) designations after the "&". In 2001, seed of individual doubled

haploid lines was inoculated with common bunt [*Tilletia laevis* Kühn in Rabenh., and *T. tritici* (Bjerk.) G. Wint. in Rabenh.] 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 (Fowler 1997), 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 doubled haploid lines that matured early and had strong stems of acceptable height. The

seed from each spike was grown out in 2-m rows near Irwell, New Zealand. Agronomic performance was assessed on 97 doubled haploid lines, which were grown in four-row plots 3 m long and replicated twice in nurseries near Swift Current, SK, and Regina, SK, in 2002. Grain protein concentration was measured by near infrared reflectance (NIR) spectroscopy (Williams 1979) on an equally proportioned composite of grain across replicates from each location. Reactions to prevalent races of leaf and stem rust were 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 a mixture of races T2, T9, T10, and T39 of loose smut [*Ustilago tritici* (Pers.) Rostr.] (Nielsen 1987), and races L1, L16, T1, T6, T13 and T19 of common bunt. The experimental doubled haploid line B9962&AR12 met all of the selection criteria at each stage of selection.

B9962&AR12 was evaluated in the Western Bread Wheat A<sub>3</sub> test in 2003, the Western Bread Wheat B test in 2004, and as BW867 in the Western Bread Wheat Cooperative (WBWC) tests from 2005 to 2007. Annually the WBWC consisted of 25 experimental lines and five check cultivars grown in 5 × 6 lattice design with three replications at up to 13 locations. The check cultivars in the WBWC tests were AC Barrie (McCaig et al. 1996), Katepwa (Campbell and Czarnecki 1987), Laura (DePauw et al. 1988) and Superb (Townley-Smith and Humphreys 2000) for the 3 test years 2005 to 2007. AC Abbey (DePauw et al. 2000) was a check in 2005 and was replaced by Lillian (DePauw et al. 2005) in 2006. The variables measured and protocols followed in the WBWC test have been described by Fox and McCallum (2006). The PROC MIXED procedure was used to analyze the data annually and to perform a combined analysis over years using a mixed model with environments and replications considered random and genotypes considered fixed (SAS Institute, Inc. 2003).

Response to several diseases was assessed in specialized disease nurseries from 2005 to 2007. 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), TDBJ (70-1), and TBBJ (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 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 inoculate seed subsequently grown out in a greenhouse (Menziez 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, AB (Fox and McCallum 2006).

A sample of grain of the checks from each location 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 concentration approximating that of the average for the crop. A consistent quantity of grain within a location for all experimental lines 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

Stettler generally exhibited significantly greater grain yield in each zone than most checks, except in 2007 (Table 1). Based on 34 trials over 3 yr, Stettler had significantly greater grain yield than all checks except Superb. It yielded 15.2% more than Katepwa, 11% more than AC Barrie and Laura, and 2.7 % more than Superb. Based on 23 trials, Stettler yielded 13.5% more than Lillian. Stettler had significantly ( $P \leq 0.05$ ) greater protein concentration than all of the checks except Lillian (Table 2). Stettler was significantly ( $P \leq 0.05$ ) later maturing than Katepwa and AC Barrie, and intermediate to Laura and Superb. Stettler was significantly ( $P \leq 0.05$ ) shorter than AC Barrie, Katepwa, Lillian and Laura and taller than Superb, the shortest stature check. Stettler expressed straw strength similar to AC Barrie and Superb and significantly ( $P \leq 0.05$ ) stronger than Katepwa and Laura. Stettler had kernel mass similar to that of AC Barrie, significantly ( $P \leq 0.05$ ) smaller than Superb and larger than Katepwa and Laura. Stettler had heavy volume weight equivalent to AC Barrie and significantly heavier than the other checks.

### Other Characteristics

**SPIKE:** Parallel sided, medium density, erect to inclined attitude at maturity, medium glaucosity, white chaff colour at maturity, medium length awns; glumes are glabrous with medium width, short length, square to

**Table 1. Grain yield of Stettler compared with the check cultivars in the Western Bread Wheat Cooperative test from 2005 to 2007**

Entry	Yield (kg ha <sup>-1</sup> )												
	Zone 1 <sup>z</sup>			Zone 2			Zone 3			Means <sup>y</sup>			
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005–2007
AC Barrie	3367	2663	2586	3738	3299	3453	6123	5547	4605	4138	3685	3497	3760
Katepwa	3069	2425	2400	3600	3430	3294	6064	5004	4110	4000	3644	3282	3622
Laura	3194	2009	2283	3868	3690	3281	5944	5526	4374	4184	3889	3296	3749
Lillian		2165	2435		3371	3239		5032	4166		3583	3258	
Superb	3660	2529	2966	4049	3543	3834	7094	5619	4474	4567	3857	3799	4064
Stettler	4067	2915	2635	4353	3873	3644	7139	6087	4197	4834	4220	3574	4174
LSD <sub>0.05</sub> <sup>x</sup>	259	317	379	264	263	201	691	284	882	241	251	208	228
No of tests	1	1	2	8	7	9	2	2	2	11	10	13	34

<sup>z</sup>Locations: Zone 1: Stewart Valley, Swift Current; Zone 2: Beiseker, Goodale, Indian Head, Irricana, Kernen, Kindersley, Lethbridge, Neapolis, Regina, Scott, Watrous; Zone 3: Lacombe, Melfort.

<sup>y</sup>Means are based on LS means procedure of SAS software.

<sup>x</sup>Least significant difference,  $P \leq 0.05$ , includes the appropriate genotype by environment interaction variation.

rounded shoulder of medium width, and short beak length.

**KERNEL:** Hard red type, medium red colour, small to medium size kernel, oval kernel shape, angular cheek shape, midlong brush hairs, midsize germ, round shape of germ, medium wide crease of shallow to medium depth.

**SHATTERING:** Resistant to spike shelling seeds caused by wind.

**DISEASE REACTIONS:** Resistant to stem rust, common bunt and loose smut (Table 3); moderately susceptible to leaf rust and fusarium head blight.

**END-USE SUITABILITY:** Based on 3 yr of testing in the Western Bread Wheat Cooperative test Stettler was rated equal to the check cultivars for gain quality by the Quality Evaluation Team of the Prairie Recommending Committee for Wheat, Rye and Triticale (Table 4). Stettler had higher protein concentration than the

**Table 2. Agronomic characteristics of Stettler compared with the check cultivars in the Western Bread Wheat Cooperative test from 2005 to 2007**

Entry	Maturity (d)		Height (cm)		Lodging <sup>z</sup> (1–9)	
	2006–2007 <sup>y</sup>	2005–2007	2006–2007	2005–2007	2006–2007	2005–2007
AC Barrie	94.4	100.4	98.2	97.8	2.2	2.5
Katepwa	93.5	98.9	102	101.5	3.2	3.5
Laura	96.3	102.0	100.8	100.8	3.4	4.1
Lillian	94.9		96.8		2.9	
Superb	96.8	102.5	89.3	89	2.1	2.6
Stettler	95.7	101.7	91.8	91.6	2.0	2.7
LSD <sup>x</sup>	1.7	1.3	2.3	1.8	1.1	0.7
No. tests	21	32	25	36	7	12

  

Entry	Volume weight (kg hL <sup>-1</sup> )		Kernel mass (mg)		Protein concentration (%)	
	2006–2007	2005–2007	2006–2007	2005–2007	2006–2007	2005–2007
AC Barrie	79.0	78.9	29.7	32.4	15.4	15.1
Katepwa	77.8	77.6	30.0	30.5	15.2	14.8
Laura	78.2	78.0	29.6	30.0	15.5	15.1
Lillian	77.2		32.9		16.6	
Superb	78.5	78.2	35.4	35.9	15.0	14.6
Stettler	79.0	78.9	31.0	31.8	16.0	15.5
LSD <sub>0.05</sub> <sup>x</sup>	0.7	0.6	1.9	1.0	0.4	0.4
No. tests	24	35	24	35	24	35

<sup>z</sup>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.

<sup>y</sup>Means are based on LS means procedure of SAS software.

<sup>x</sup>Least significant difference,  $P \leq 0.05$ , includes the appropriate genotype by environment interaction.

Table 3. Disease reactions of Stettler and check cultivars in the Western Bread Wheat Cooperative Trials from 2005 to 2007

Entry	Field leaf rust <sup>z</sup>						Field stem rust						Stripe rust				
	2005		2006		2007		Glenlea		Nolette		Glenlea		Winnipeg	Regina	Neapolis		
							2005	2005	2006			2006	2006	2006	2007		
AC Barrie	58 <sup>y</sup>	MS <sup>x</sup>	47	MS	72	S	5 <sup>w</sup>	RMR <sup>x</sup>	7	RMR	10	I	30	I	7 <sup>v</sup>	5 <sup>u</sup>	8 <sup>u</sup>
Katepwa	50	MS	40	MS	52	MS	7	RMR	5	RMR	3	MR	20	I	8	2.7	6
Laura	0	R	0	R	0	R	5	RMR	2	R	5	RMR	10	R	7	3	5
Lillian			6	R	0	R			2	R	15	I	15	I	4	1.1	3
Superb	70	S	67	S	83	S	5	RMR	5	R	7	MR	40	I	5	1.4	6
Stettler	45	MS	35	I	42	MS	10	RMR	3	R	7	RMR	15	RMR	5	0.9	4
Entry	Bunt						Loose smut										
	2005		2006		2007		2005		2006		2007						
AC Barrie	43	I <sup>x</sup>	17	I	4	VR	43	I <sup>x</sup>	68	MS	12	R					
Katepwa	29 <sup>t</sup>	I	9	MR	4	VR	16	MR	16	MR	32	MR					
Laura	82	VS	50	VS	51	VS	39	I	51	MS	37	I					
Superb	15	MR	2	VR	14	MR-I	40	I	13	MR	10	R					
Lillian			4	VR	13	MR			42	I	11	R					
Stettler	10	MR	2	VR	6	R	6	R	0	R	13	R					
Entry	Fusarium head blight disease index																
	Carman <sup>r</sup>			Glenlea <sup>r</sup>			Ottawa <sup>q</sup>			Charlottetown <sup>r</sup>		Mean <sup>p</sup> Disease Index					
	2005	2006	2007	2007	2006	2005	2006	2007	2005	2006	2005	2006	2005	2006	2007		
AC Barrie	21	I <sup>x</sup>	33	MS	19	34	MS	28	MR	30	40	25	40	14	32	29	25
Katepwa	46	S	25	I	17	18	MR	36	I	40	32	28	47	15	45	27	22
Laura	34	MS	22	I	13	25	I	43	MS	13	77	32	65	21	44	40	23
Lillian			64	S	65	73	S	65	S		77	72		18		56	70
Superb	19	I	23	I	4	40	MS	44	MS	40	42	20	48	14	38	31	21
Stettler	39	S	21	I	15	48	S	39	I	35	58	22	44	16	40	33	28
LSD <sub>0.05</sub>	9.4		8.9		8.6	23		25		16	12	8.8	10.2	3.3	18	15	15
CV	16		25		22.	44		30		19	10	22	19	10	30	33	34

**Table 3** (Continued)

Entry	Field leaf rust <sup>z</sup>					Field stem rust			Stripe rust			
	2005		2006		2007	Glenlea	Nolette		Glenlea	Winnipeg	Regina	Neapolis
	Deoxynivalenol (ppm)					FDK <sup>a</sup> (w:w)						
	Charlotte-town	Carman	Charlotte-town	Glenlea	Carman	Charlottetown						
2005	2005	2006	2007	2007	2005	2006						
AC Barrie	3	6	4.0 <sup>o</sup>	4	1.7	3.8	9	10				
Katepwa	1	6	1.7	5	1.9	3.5	6	20				
Laura	3	6	0.5	6	2.7	5.7	11	34				
Lillian				11	3.8	6.3		27				
Superb	3	8	4.9	9	4.8	10.9	11	25				
Stettler	3	9	2.3	6	4.1	12.3	10	30				
LSD <sub>0.05</sub>	NA-bulk	6		4	NA-bulk	NA-bulk	15	11				
CV	NA	32		34	NA	NA	73	37				

<sup>z</sup>Leaf rust scores are an average of Winnipeg, MB, and Portage la Prairie MB, data.

<sup>y</sup>Leaf rust rating scale based on severity and percent leaf area affected: 0–30 R, 11–30 MR, 31–39 I, 40–60 MS, >60 S.

<sup>x</sup>Disease response category: R = resistant, RMR = resistant/moderately resistant, MR = moderately resistant, MRMS is equal to I = intermediate in reaction, MS = moderately susceptible, S = susceptible, and VS = very susceptible.

<sup>w</sup>Percent of the stem infected with stem rust based on modified Cobb scale.

<sup>v</sup>Seedling stripe rust assessment performed in Winnipeg using an isolate from U of M plots.

<sup>u</sup>Stripe rust ratings scored on field plots at Regina, SK, and Neapolis, AB, using a 1 = resistant to 9 = susceptible scale.

<sup>t</sup>Percentage of plants with common bunt symptoms.

<sup>s</sup>Percentage of plants with loose smut.

<sup>r</sup>Fusarium head blight disease index = (percentage of infected heads × percentage of diseased florets on infected heads)/100.

<sup>q</sup>Percentage of spikes with FHB symptoms.

<sup>p</sup>Calculated using LS means procedure of SAS software.

<sup>o</sup>Standard deviation of DON analysis performed on 1 g flour samples from 2 of the 3 reps grown at Carman.

<sup>n</sup>Fusarium damaged kernels on a weight of damaged kernels to total seed weight basis.

**Table 4. Averages of end-use suitability<sup>z</sup> traits of Stettler and check cultivars in the Western Bread Wheat Cooperative test from 2005 to 2007**

	Wheat protein (%)	Flour protein (%)	Protein loss	Hagberg falling no. (s)	Amylograph viscosity (BU)	Flour yield (%)	Flour ash (%)	Flour color (Agtron)	Starch damage (megazm)	Particle size index
AC Barrie	14.2	13.6	0.7	395	703	76.5	0.43	82.8	7.4	56.9
Katepwa	14.2	13.5	0.7	385	533	74.5	0.44	81.0	7.8	57.2
Laura	14.3	13.5	0.7	368	545	74.4	0.43	84.7	6.8	56.9
Superb	13.7	13.0	0.6	370	655	75.7	0.44	74.0	8.0	54.2
Mean of checks	14.1	13.4	0.7	380	609	75.3	0.44	80.6	7.5	56.3
Stettler	14.7	14.2	0.5	375	543	74.7	0.43	76.6	7.4	54.4
SD <sup>y</sup>	0.05	0.05		15	5	0.34	0.005	0.9	0.08	0.9

  

	Farinograph				Canadian short process (150 ppm ascorbic acid)		
	Absorption (%)	DDT <sup>x</sup> (min)	MTI <sup>w</sup> (BU)	Stability (min.)	Loaf volume (cc)	Absorption (%)	Mixing time (min.)
AC Barrie	65.2	8.4	15.0	15.3	1142	69.0	4.8
Katepwa	66.6	5.8	23.3	9.8	1122	68.0	3.5
Laura	67.3	10.2	16.7	23.8	1140	69.3	4.3
Superb	67.7	8.3	16.7	20.3	1088	69.3	4.5
Mean of checks	66.7	8.1	17.9	17.3	1123	68.9	4.3
Stettler	67.8	7.1	16.7	13.5	1088	70.7	4.1
SD	0.2	0.4	2.6	1.4	45	NA <sup>v</sup>	0.3

<sup>z</sup>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.

<sup>y</sup>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.

<sup>x</sup>DDT is the farinograph dough development time.

<sup>w</sup>MTI is farinograph mixing tolerance index expressed in Brabender units (BU).

<sup>v</sup>NA, not available.

checks, high farinograph absorption, but not due to high levels of starch damage, and intermediate gluten strength relative to the checks. The flour colour of Stettler was not as bright as the mean of the checks, which was due to higher protein concentration than the checks.

#### Maintenance and Distribution of Pedigreed Seed

The 129 Breeder Lines originate from random single plants of the doubled haploid line B9962&AR12 grown out as 144 Breeder-Lines in 3-m-long rows in isolation near Swift Current in 2006 and again as 15-m rows near Indian Head in 2007. Approximately 390 kg of Breeder Seed was produced. 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. Stettler has been released for distribution and multiplication to SeCan Association, 501 – 300 March Rd. Kanata, Ontario, Canada K2K 2E2. Phone: 1-800-764-5487. Fax: (613) 592-9497. E-mail: seed@secan.com.

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