CULTIVAR DESCRIPTION

Goodeve hard red spring wheat

R. M. DePauw[1], R. E. Knox[1], J. B. Thomas[2], M. Smith[2], J. M. Clarke[1], F. R. Clarke[1], T. N. McCaig[1], and M. R. Fernandez[1]

[1]Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, Swift Current, Saskatchewan, Canada S9H 3X2 (e-mail: ron.depauw@agr.gc.ca); and [2]Agriculture and Agri-Food Canada, Cereal Research Centre, 195 Dafoe Rd., Winnipeg, Manitoba, Canada R3T 2M9. Received 20 December 2008, accepted 9 May 2009.

DePauw, R. M., Knox, R. E., Thomas, J. B., Smith, M., Clarke, J. M., Clarke, F. R., McCaig, T. N. and Fernandez, M. R. 2009. **Goodeve hard red spring wheat.** Can. J. Plant Sci. **89**: 937–944. Goodeve, hard red spring wheat (*Triticum aestivum* L.) expressed resistance to the insect orange blossom wheat midge *Sitodiplosis mosellana* (Géhin) that was conferred by the *Sm1* gene on chromosome 2BS and selected with the DNA marker WM1. Goodeve had significantly higher grain yield than all checks except Superb, was significantly earlier maturing than AC Barrie, Laura and Superb, had significantly shorter straw than Katepwa and Laura, and had significantly less lodging than Katepwa and Laura. Goodeve has an awnless spike with white chaff colour. Goodeve had higher grain protein concentration, brighter flour colour, longer farinograph dough development time and higher farinograph water absorption than the mean of the checks. Goodeve meets the end-use quality specifications of the Canada Western Red Spring (CWRS) wheat market class. Goodeve expressed resistance to prevalent races of stem rust and loose smut, moderate resistance to leaf rust, moderate susceptibility to common bunt and susceptibility to fusarium head blight.

Key words: *Triticum aestivum* L., cultivar description, orange blossom wheat midge resistance, grain yield

DePauw, R. M., Knox, R. E., Thomas, J. B., Smith, M., Clarke, J. M., Clarke, F. R., McCaig, T. N. et Fernandez, M. R. 2009. **Le blé roux vitreux de printemps Goodeve**. Can. J. Plant Sci. **89**: 937–944. Le blé roux vitreux de printemps Goodeve (*Triticum aestivum* L.) résiste à la cécidomyie orangée du blé *Sitodiplosis mosellana* (Géhin) grâce au géne *Sm1* situé sur le chromosome 2BS, sélectionné grâce au marqueur génétique WM1. Goodeve se caractérise par un rendement grainier sensiblement plus élevé que celui des variétés témoins sauf Superb; le cultivar parvient à maturité significativement plus tôt qu'AC Barrie, Laura et Superb, sa paille est sensiblement plus courte que celle de Katepwa et de Laura, et la variété est significativement moins sensible à la verse que Katepwa et Laura. Goodeve posséde des épillets mutiques de couleur paille. Son grain est plus protéiné, sa farine, plus claire, et sa pâte prend plus de temps à se développer au farinographe tout en absorbant plus d'eau que la moyenne des variétés témoins. Goodeve respecte les exigences qualitatives pour l'usage final de la classe Blé roux de printemps de l'Ouest canadien. La variété résiste aux races régnantes de la rouille de la tige et du charbon nu, est modérément sensible à la carie et est sensible à la brûlure de l'épi causée par *Fusarium*.

Mots clés: *Triticum aestivum* L., description de cultivar, résistance à la cécidomyie orangée du blé, rendement grainier

BW841, 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. 6342 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 2007 Oct. 27 and at that point was named "Goodeve".

Disease Resistance: Assessments were made of the resistance to four obligate pathogens at several points in the breeding process. Races of stem rust [*Puccinia graminis* Pers.:Pers. f.sp. *tritici* Eriks. & E. Henn.] used were QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2005). Races of leaf rust (*Puccinia triticina* Eriks.) to determine the field resistance of adult plants differed over time. This epidemic mixture was a representative mixture of isolates of races collected in the previous year (e.g., McCallum and Seto-Goh 2006). Seedling leaf rust reactions were recorded for five races: MBDS (isolate 12–3), MBRJ (isolate 128–1), MGBJ (isolate 74–2), TDBJ (isolate 70–1), and TJBJ (isolate 77–2) (McCallum and Seto-Goh 2006). Rust inoculations in the field at Swift Current were made by needle inoculation of a water suspension of rust spores into the leaf whorl of young plants of highly susceptible genotypes planted in spreader rows seeded at frequent and regular intervals throughout the nursery. Consequently, the reactions of experimental lines represent secondary and cumulative later infections of the subsequent epiphytotic. Seedling rust inoculations were made by suspending the spores in a light drying oil and spraying it on the plants. The

inoculated plants were incubated for 12 h in a mist chamber and rated for infection response 12 to 14 d after inoculation. Races of common bunt used were L1 and L16 (*Tilletia laevis* Kühn in Rabenh.) and T1, T6, T13 and T19 [*T. tritici* (Bjerk.) G. Wint. in Rabenh.] (Hoffmann and Metzger 1976); breeding material was inoculated by coating the seed with a mixture of bunt spores from all six races and scoring for infection between flowering and maturity. Races of loose smut [*Ustilago tritici* (Pers.) Rostr.] used were T2, T9, T10 and T39 (Nielsen 1987). These races were inoculated by needle injecting a spore mixture in water into florets of the line prior to flowering and growing the resulting seed to maturity to score infection.

Pedigree and Breeding Method

Goodeve derives from the cross 94B43-BLW4/AC Intrepid made in 1998 at the Cereal Research Centre of Agriculture and Agri-Food Canada, Winnipeg, MB. The male parent, AC Intrepid (DePauw et al. 1999), derives from the cross Laura/RL4596//CDC Teal. RL4596 has the pedigree Columbus/BW63//BW47/BW552 where: BW63 derives from a complex backcross of Neepawa containing *Lr11, Lr13, Lr14b, Lr22a* and *Lr30* (Dyck 1993); BW47 derives from Neepawa*6/Pompe; BW552 is derived from Seln 70–3524/8*Neepawa where Sel 70–3524 is a soft white line expressing the gene *Bt10*, which confers resistance to prevalent races of common bunt. The female parent 94B43-BLW4 derives from the cross BW174*2/Clark in which Clark (Ohm et al. 1988) is the source of the gene *Sm1*, which confers resistance to orange blossom wheat midge (OBWM) [*Sitodiplosis mosellana* (Géhin)] (Barker and McKenzie 1996). BW174 has the pedigree Columbus*2//Saric 70/Neepawa/3/Columbus*5//Saric 70/Neepawa. The *Sm1* gene has been localized to chromosome 2BS (Thomas et al. 2005). A DNA marker, WM1, produces a single 233 base pair fragment at a locus linked ($\sim$1.3cM) to *Sm1*; this marker is present in most resistant lines but also present in many susceptible genotypes (Thomas et al. 2005). 94B43-BLW4 expressed resistance to OBWM but was recombinant for the WM1 fragment (i.e., lacked the marker) while AC Intrepid was susceptible and the WM1 fragment could be amplified. Four plants of 94B43-BLW4 were tested to confirm the absence of the WM1 amplicon and express a high level of preharvest sprouting resistance; these were pollinated with AC Intrepid to generate four F_1 populations designated B9818A through B9818D. F_2 seeds were spaced at 13 cm (within a row) by 46 cm (between rows) in a nursery at the Semiarid Prairie Agricultural Research Centre, AAFC near Swift Current, SK. Inoculated diseases included common bunt, leaf rust and stem rust. About 100 plants per sub population with favourable phenotypes (medium-short, upright straw and an absence all three inoculated diseases) were selected and threshed as a bulk. About 2000 F_3 seeds of each subpopulation were space-planted near Lincoln, New Zealand. About 200 disease free short, strong-stemmed F_3 plants from each sub population were selected and again threshed in bulk. Diseases present from endemic pathogens included leaf rust, yellow rust (*Puccinia striiformis* Westend. f. sp. *tritici*) and leaf spotting diseases such as tan spot 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. F_4 seed from each subpopulation was again inoculated with common bunt and space-planted in a leaf and stem rust epiphytotic nursery near Swift Current, SK. About 200 disease-free, strong-stemmed, and early-maturing individuals were selected from each subpopulation, threshed and selected for kernel characteristics. In F_5, seed of 92, 125, 149, and 95 lines from the four subpopulations were grown in a contra season nursery of 2 m rows near Lincoln, NZ. From the four sub populations, 86, 65, 93, and 55 lines were selected on the basis of time to maturity, plant height and straw strength and were harvested individually. Remnant F_5 seed of the selections were tested with the WM1 marker resulting in 41, 35, 35 and 19 individuals being identified which did not express the amplicon. The proportion failing to express the amplicon (130 out of 299) fit the expected ratio of 7/16. Since the null amplicon was now in coupling with *Sm1* in 94B43-BLW4, lines exhibiting the WM1 fragment were discarded. In the F_6 generation, seed of 34, 27, 26, and 18 lines were grown in four-row plots planted on 5 m centres with 23 cm spacing between rows with two replications near Swift Current and Indian Head, SK, to assess agronomic performance. Grain protein concentration was measured using near infrared reflectance (NIR) spectroscopy (Williams 1979) on a composite of replicates within each location. End-use suitability, volume weight, seed size and kernel attributes suitable for the CWRS market class were assessed on the grain samples. In the F_7 generation, four, four, seven, and three families (three to five lines per family) were grown out near Irwell, NZ. Families were selected on the basis of grain quality and kernel attributes assayed on remnant seed from the F_6 yield trial. Experimental lines within acceptable families were selected on the same basis as in F_5. In the F_6:F_8 generation, seven lines from two families were evaluated in replicated trials near Swift Current and Indian Head following a protocol similar to that of the F_6 generation. In the F_6 and F_8 generations, reaction to leaf and stem rust was used as a selection criterion by assessing response to the rusts in an epiphytotic nursery near Glenlea, MB. Selected F_8 lines were screened for resistance to mixtures of races of loose smut and common bunt. This overall procedure identified the experimental line B9818B-323C as meeting all selection criteria at each generation. This designation has the following meaning: "B9818" refers to the cross; "B" after the cross name identifies the second subpopulation;

"323" identifies an F_4: F_5 line; "C" identifies an F_6: F_7 selection from family "323".

B9818B-323C was evaluated in the Western Bread Wheat'A_4' test in 2003, and entered in the Western Bread Wheat Cooperative (WBWC) tests from 2004 to 2006 as BW841. 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; 10 to 11 locations per year produced data sets that had coefficients of variation less than 15% for grain yield. 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 for the 3 test years 2004 to 2006. AC Abbey (DePauw et al. 2000) was a check from 2004 to 2005 and was replaced by Lillian (DePauw et al. 2005) in 2006. The variables measured and the protocols followed in the Western Bread Wheat Cooperative 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 as random effects and genotypes considered as fixed (SAS Institute, Inc. 2003).

Goodeve was assessed annually for reaction to several diseases from 2004 to 2006 (Fox and McCallum 2006). These diseases included individual reactions of seedlings to races of leaf and stem rust, and adult plant resistance to leaf rust and stem rust in spray-inoculated nurseries near Glenlea. Reaction to loose smut was recorded from greenhouse-grown plants grown from inoculated seed from field-grown plants. Reaction to common bunt was recorded in the field at Lethbridge, AB, from plants grown from inoculated seed sown in cool soil (by mid April). 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 did not develop in the 2004 Glenlea nursery.

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 resembling the top hard red spring wheat grades. The quantity of grain from each location was adjusted to achieve a composite protein content approximating the average of the crop. A consistent quantity of grain within a location for all experimental lines and checks 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.

Response to Orange Wheat Blossom Midge

To confirm the presence of antibiosis to OBWM due to the wheat gene *Sm1* in Goodeve, a standardized cage test was conducted (Lamb et al. 2000). The bioassay included Goodeve and two controls: AC Barrie (susceptible) and Key 97–24 (antibiotic resistant) in a randomized complete block design using replicate cages set up on different days. The age of spikes to be infested (days since first emergence from the flag leaf sheath) was controlled because spike age affects attractiveness to ovipositing OBWM females in the laboratory (Lamb et al. 2003). Tillers with visible spikelets as the flag leaf sheath opened were tagged with the current date below the flag leaf. When a replicate cage was set up, plants were included if they had spikes tagged 5 to 8 d previously and untagged tillers were cut off at the base. Each cage contained four to six plants per wheat line, with one to three spikes per plant. After two nights of exposure to ovipositing OBWM females, plants were returned to the greenhouse and spikes were covered with glassine pollination bags to maintain humidity. The plants were then left in a greenhouse for 3 wk to allow larvae to complete development. Each spike was dissected under a stereomicroscope and the number of live second and third instars and dead larvae recorded. Any living first instars were included with dead larvae because they would not complete development if they were still first instars after 3 wk.

Statistical analyses were carried out using procedures of SAS (SAS Institute, Inc. 2003). Differences were considered significant at $P \leq 0.05$. Differences among wheat lines in the proportion of third instars and proportion of dead larvae were analyzed using the Generalized Linear Models Procedure (PROC GENMOD, Logit model). Comparisons of the test line with the antibiotic control and the susceptible control were made using CONTRAST statements.

Goodeve exhibited the typical resistance response to wheat midge infestation by plants with the *Sm1* gene tested in the laboratory (Lamb et al. 2000a). Most of the larvae found on Goodeve were dead or moribund, whereas larvae on the susceptible cultivar AC Barrie had mostly completed development (Figs. 1 and 2). Goodeve had a significantly lower proportion of third instar larvae ($\chi^2 = 1507.3$, $P < 0.0001$) and higher proportion of dead larvae ($\chi^2 = 1403.4$, $P < 0.0001$) than the susceptible control, AC Barrie. Also, Goodeve had a significantly higher proportion of third instar larvae ($\chi^2 = 10.7$, $P = 0.0011$) and lower proportion of dead larvae ($\chi^2 = 10.3$, $P = 0.0014$) than the antibiotic control, Key 97–24 which derives from the cross HW Alpha/Monon (McKenzie et al. 2002). It is not unusual for low numbers of larvae to complete development on antibiotic wheat plants in the cages, probably due to the artificiality of the cabinet environment. However, the significant difference in larvae survival between Goodeve and Key 97–24 may also suggest differences in gene

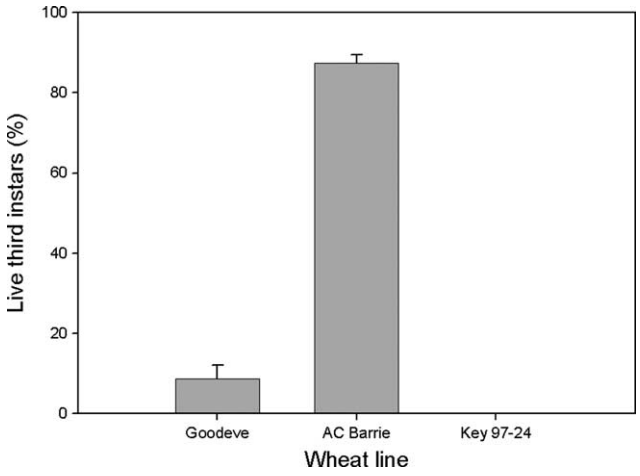

Fig. 1. Percent and SE of live third instar wheat midge larvae 3 wk after onset of infestation of wheat spikes in the laboratory.

expression or presence of other factors that contribute to reduced midge survival.

Performance and Adaptation

In 2005 and 2006, Goodeve had significantly higher ($P \leq 0.05$) grain yield than all of the checks except Superb in 2005 (Table 1) and occasionally Laura in Zone 2 in 2005 and 2006, whereas in 2004, Goodeve had similar grain yield to all the checks with only Superb higher. Based on 31 trials over 3 yr, Goodeve had grain yield similar to Superb and significantly higher ($P \leq 0.05$) than the other checks. The average grain yield of Goodeve was 11.4% more than Katepwa, 6.9% more than Laura, 8.2% more than AC Barrie. There were genotype by year interactions, with Superb expressing higher grain yield relative to some of the other checks in the moist, long growing season of 2004 and it was relatively lower yielding in the dry, hot kernel filling stage of 2006 while Goodeve tended to be more stable. Averaged over 31 trials from 2004 to 2006, Goodeve matured 4.4 d earlier ($P \leq 0.05$) than Superb, 2.9 d earlier ($P \leq 0.05$) than Laura, 1.8 d earlier ($P \leq 0.05$) than AC Barrie, and similar to Katepwa (Table 2). Goodeve had shorter ($P \leq 0.05$) stature than Katepwa, Laura, and AC Barrie and taller ($P \leq 0.05$) than Superb. Lodging scores of Goodeve were less ($P \leq 0.05$) than Katepwa and Laura, and similar to AC Barrie and Superb. The grain volume weight of Goodeve was equivalent to most checks but was less ($P \leq 0.05$) than that of AC Barrie. Goodeve had a larger ($P \leq 0.05$) seed size than Katepwa and Laura, equivalent to AC Barrie and smaller than Superb.

Fig. 2. Percent and SE of dead plus first instar wheat midge larvae 3 wk after onset of infestation of wheat spikes in the laboratory.

Other Characteristics

SPIKE: Parallel sided, medium density, erect to inclined attitude at maturity, medium to strong glaucosity, white chaff colour at maturity, awnlets present; glumes are glabrous with narrow to medium width, long to very long length, sloping to straight shoulder width, very narrow to narrow shoulder width, and straight 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, mid-wide to wide crease, shallow to mid-deep crease.

SHATTERING: Resistant to spike shelling caused by wind.

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

END-USE SUITABILITY: Based on 3 yr of testing in the Western Bread Wheat Cooperative test Goodeve 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). Goodeve had grain and flour protein concentration higher than the mean of the checks. The flour colour was brighter than Katepwa and Superb. The farinograph dough development time was longer than Katepwa and AC Barrie. Goodeve had higher farinograph absorption than AC Barrie but the kernel texture was softer than most checks. Goodeve exhibited higher Hagberg Falling number values than Laura and Superb. Hagberg Falling numbers are used to measure the level of alpha amylase in the grain which is activated under wet weather prior to harvest. High Hagberg Falling numbers are indicative of some tolerance to wet weather prior to harvest.

Table 1. Grain yield of Goodeve compared with the check cultivars in the Western[z] Bread Wheat Cooperative test from 2004 to 2006

	Yield (kg ha^{-1})												
	Zone 1			Zone 2			Zone 3			Mean[y]	Mean	Mean	Mean
Entry	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004	2005	2006	2004–2006
Katepwa	4412	3069	2425	3935	3600	3430	5780	6064	5004	4352	4000	3645	3999
Superb	5585	3660	2529	4427	4049	3543	6460	7094	5619	4949	4567	3857	4461
Laura	4565	3194	2009	4101	3868	3690	5485	5944	5526	4424	4184	3889	4166
AC Barrie	4945	3367	2663	4007	3738	3299	6112	6123	5547	4522	4138	3685	4116
AC Abbey[x]	4904	3026		3843	3473		6079	5979		4396	3888		
Lillian			2165			3371			5032			3582	
Goodeve	4694	3720	3102	4002	4083	3774	6250	7152	6309	4521	4608	4214	4453
LSD[w]	344	259	317	318	264	263	894	691	684	301	241	251	247
no. tests	1	1	1	7	8	7	2	2	2	10	11	10	31

[z]Locations for the 3 yr: Zone 1: Stewart Valley, Swift Current; Zone 2: Beiseker, Goodale, Indian Head, Irricana, Kernen, Kindersley, Lethbridge, Neapolis, Regina, Scott, Watrous; Zone 3: Lacombe, Melfort
[y]Means were computed by the PROC MIXED procedure.
[x]AC Abbey discontinued and Lillian added as a check in 2006.
[w]Least significant difference, $P \leq 0.05$, includes the appropriate genotype by environment interaction variation.

Maintenance and Distribution of Pedigreed Seed

The 126 Breeder-Lines originate from F_6:F_{10} random single plants grown out as 144 Breeder-Lines in 3-m-long rows in isolation near Swift Current in 2005 and again as 15-m rows near Indian Head in 2006. Approximately 372 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. Goodeve has been released for distribution to FarmPure Genetics Inc., 426 McDonald St., Regina, Saskatchewan, Canada S4N 6E1. Phone (306) 791 1045, Fax: (306) 791 1046.

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Table 2. Agronomic characteristics of Goodeve compared with the check cultivars in the Western Bread Wheat Cooperative test, 2004 to 2006

	Maturity (d)	Height (cm)	Lodging[z] (1 to 9)	Grain volume weight (kg hL^{-1})	Seed mass (mg)
	2004–2006	2004–2006	2004–2006	2004–2006	2004–2006
Katepwa	104.5	100.8	3.4	78.3	31.7
Superb	108.8	89.0	2.1	78.6	37.2
Laura	107.3	100.0	4.3	78.2	30.7
AC_Barrie	106.2	97.0	2.2	79.4	33.4
Goodeve	104.4	94.4	2.1	78.4	34.1
LSD[y]	1.3	1.7	0.8	0.6	1.0
No. tests	31	34	15	32	32

[z] Straw strength rated on a scale of 1 (all plants in plot erect) to 9 (all plants lying horizontal).
[y]Least significant difference, $P \leq 0.05$, includes the appropriate genotype by environment interaction variation.

Table 3. Disease reactions of Goodeve and check cultivars in the Western Bread Wheat Cooperative Trials from 2004 to 2006

	Field leaf rust[z]						Field stem rust[z]							
	Glenlea						Glenlea						Nolette	
Entry	2004[y]		2005[y]		2006[y]		2004		2005		2006		2006	
Katepwa	53	MSS	50	MS	40	MS	5	RMR	7	RMR	5	RMR	3	MR
Superb	23	MSS	70	S	67	S	t	R	5	RMR	5	R	7	MR
Laura	2	R	0	R	0	R	t	R	5	RMR	2	R	5	RMR
AC Barrie	47	MSS	58	MS	47	MS	t	R	5	RMR	7	RMR	10	I
AC Abbey	40	MSS	67	S			10	RMR	5	RMR				
Lillian					6	R					2	R	15	I
Goodeve	10	MR	48	MS	23	MR	3	R	5	RMR	1	R	7	MR

	Bunt[x]						Loose smut[w]					
Entry	2004		2005		2006		2004		2005		2006	
Katepwa	24	I	29	I	9	MR	11	MR	16	MR	16	
Superb	28	I	15	MR	2	VR	36	I	40	I	13	
Laura	68	S+	82	VS	50	VS	60	MS	39	I	51	MS
AC Barrie	36	I	43	I	17	I	48	I	43	I	68	MS
AC Abbey	16	I−	38	I			45	I	50	I		
Lillian					4	VR					42	I
Goodeve	65	S+	40	I	57	VS	25	MR	3	R	3	R

	Fusarium head blight index[v]																
	Carman[u]						Glenlea	Ottawa			Charlottetown			Lévis QC.	Mean[t]	Mean[t]	Mean[t]
Entry	2004		2005		2006		2006	2004	2005	2006	2004	2005	2006	2004	2004	2005	2006
Katepwa	33	MS	46	S	25	I	35 I	22	40	32	55	47	15	54	41	44	27
Superb	43	S	19	I	23	I	44 MS	37	40	42	45	48	17	57	45	36	31
Laura	37	S	34	MS	22	I	43 MS	38	13	77	56	65	24	59	47	37	41
AC Barrie	32	MS	21	I	33	MS	28 MR	22	30	40	30	40	10	50	33	30	28
AC Abbey	71	S	63	S				68	65		63	48		73	68	59	
Lillian					64	S	65 S			77			20				56
Goodeve	51	S	57	S	25	I	49 MS	27	38	60	77	55	11	55	52	50	36
LSD	4.4		4.4		8.9					9.7			6.5				

[z] Severity based on modified Cobb scale. Pustule type: R = resistant, MR = moderately resistant, I = intermediate in reaction, MS = moderately susceptible, and S = susceptible with borderline classes as combined ratings e.g., RMR.
[y] Rating: 0–10 = R, 11–30 = MR, 31–39 = I, 40–60 = MS, >61 = S.
[x] Bunt: Seed was inoculated to excess with a 1:1 composite of the bunt species *Tilletia tritici* and *T. laevis* in a 1:1:1:1:2:2 mixture of the races T-1, T-6, T-13, T-19, L-1, L-16.
Rating 2004: Rating: <7.3 = R; 7.3–14.9 = MR; 14.9–22.5 = I−; 22.5–37.7 = I; 37.7–45.3 = I+; 45.3–52.9 = S−;52.9–60.5 = S; >60.5 = S+.
Rating 2005: <4.22 = R;4.22–14.58 = MR; 14.58–24.94 = I−; 24.94–45.66 = I; 45.66–56.02 = I-MS; 66.38–76.74 = S; >60.5 = S; >76.74 = VS.
Rating 2006: <5.09 = VR;5.09–8.46 = R;8.46–11.8 = MR;11.83–15.2 = MI; 15.2–21.9 = I; 21.94–25.3 = HI; 25.31–28.7 = MS;28.68–32.1 = S; >32.05 = VS.
[w] Loose smut: Races T2, T9, T10, and T39. Rating: <10 = R; <30 = MR; <50 = I; <70 = MS; >70 = S.
[v] Disease Index = (% infected heads x% diseased florets on infected heads)/100.
[u] Carman 2004: FHB average over 3 replications: <6 = R, 6.1–15.0 = MR, 15.1–25.0 = I, 25.1– 35.0 = MS, >35.1 = S. Carman 2005: FHB average over 3 replications: Rating R <4.0; MR = 4.1–14.0; I = 14.1–24.0; MS = 24.1–34.0; S >34.1. LSD = 4.38. Carman 2006 FHB average over 3 replications: Rating scale: R <5; MR = 5.1–15; I = 15.1–30; MS = 30.1–45; S >45.1.
[t] Mean of Carman, Ottawa, Levis and Charlottetown FHB Indices.

Table 4. Averages of end-use suitability[z] traits of Goodeve and checks cultivars in the Western Bread Wheat Cooperative tests from 2004 to 2006

	Wheat protein (%)	Flour protein (%)	Protein loss	Hagberg falling no. (s)	Amylograph viscosity (BU)	Flour yield (%)	Flour ash (%)	Flour colour Agtron	Starch damage (megazm)	Particle size index
AC Barrie	14.0	13.5	0.6	412	695	76.8	0.42	84.7	7.3	56
Katepwa	14.0	13.3	0.7	398	573	74.6	0.42	83.5	7.8	56
Laura	14.0	13.4	0.6	373	563	74.7	0.41	87.0	6.8	57
Superb	13.4	12.8	0.6	372	657	75.8	0.43	76.7	8.1	54
Mean of checks	13.9	13.3	0.6	389	622	75.5	0.42	83.0	7.5	56
Goodeve	14.5	13.9	0.6	413	677	74.7	0.41	86.7	6.6	58
SD[y]	0.05	0.05		15	5	0.34	0.01	0.9	0.08	0.9

	Farinograph				Canadian short process (150 ppm ascorbic acid)		
	Absorption (%)	DDT[x] (min)	MTI[w] (BU)	Stability (min.)	Loaf volume (cc)	Mixing time (min.)	Absorption (%)
AC Barrie	65.2	7.8	16.7	13.4	1132	4.8	70.0
Katepwa	66.8	5.8	25.0	10.7	1107	3.7	69.7
Laura	66.9	9.8	16.7	28.8	1128	4.3	70.0
Superb	67.7	8.5	11.7	26.1	1085	4.6	70.3
Mean of checks	66.6	8.0	17.5	19.8	1113	4.4	70.0
Goodeve	67.6	9.3	18.3	20.0	1130	4.1	71.3
SD	0.17	0.4	2.6	1.4	45	0.3	NA[v]

[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]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.
[x]DDT is the farinograph dough development time.
[w]MTI is farinograph mixing tolerance index expressed in Brabender units (BU).
[v] NA, standard deviation was not available.

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