

Jake hard red spring wheat

D. Spaner, M. Iqbal, A. Navabi, K. Strenzke, and B. Beres

Abstract: Jake hard red spring wheat (*Triticum aestivum* L.) was developed using a modified bulk breeding method at the University of Alberta, Edmonton, AB. Jake is an awned, hollow-stemmed line with high yield potential, medium tall plants, and medium maturity. During the three years (2015–2017) of evaluation in the Parkland Wheat Cooperative test, Jake yielded 6% higher than the mean of all of the checks, and matured 0.7 and 1.7 d later than Parata and Splendor but 2.9 d earlier than Glenn. Jake was 91.2 cm tall, shorter than AC Splendor (95.8 cm), but similar in height to Glenn (91.8 cm) and Parata (92 cm). The lodging score of Jake (2.2) was lower than Parata (3.1) and AC Splendor (3.1), but similar to Glenn. The test weight of Jake (80.8) was higher than AC Splendor (78.3), similar to Parata (80.5), but lower than Glenn (82.5). The grain weight of Jake (35.6 g) was similar to Parata (35.6 g), but lower than Glenn (36.7 g) and AC Splendor (37.4 g), while the NIR Protein of Jake (15.9%) was higher than Glenn (15.5%) and similar to the other checks. Jake was moderately resistant to resistant to leaf, stem, and stripe rusts, and moderately resistant to common bunt during the 3 yr of testing. The reaction of Jake to Fusarium head blight was variable and ranged from moderately susceptible to moderately resistant, with DON values similar to Carberry and Glenn. Three years of end-use quality evaluation has indicated that Jake is acceptable for the CWRS class.

Key words: *Triticum aestivum* L., Canada western red spring, rust resistance, lodging resistance, cultivar description.

Résumé : Le blé roux de printemps Jake (*Triticum aestivum* L.) est une variété élaborée à l'Université de l'Alberta, à Edmonton (Canada), au moyen d'une méthode modifiée d'hybridation massive. Jake est une lignée de blé barbu à tige creuse au rendement potentiel élevé. Le plant a une taille moyenne et parvient à maturité en un temps moyen. Au cours des trois années (2015–2017) qu'a duré son évaluation, lors des essais coopératifs sur le blé de Parkland, le rendement de Jake a dépassé le rendement moyen des témoins de 6% et est parvenu à maturité 0,7 et 1,7 jour plus tard que Parata et Splendor, et 2,9 jours avant Glenn. Jake avait une paille de 91,2 cm, soit plus courte que celle d'AC Splendor (95,8 cm), mais semblable à celle de Glenn (91,8 cm) et de Parata (92 cm). La cote de résistance à la verse de Jake (2,2) était inférieure à celle de Parata (3,1) et d'AC Splendor (3,1), quoique similaire à celle de Glenn. Son poids spécifique (80,8) dépassait celui d'AC Splendor (78,3), ressemblait à celui de Parata (80,5), mais était inférieur à celui de Glenn (82,5). Le grain de Jake (35,6 g) pèse autant que le grain de Parata (35,6 g), mais est plus léger que celui de Glenn (36,7 g) et d'AC Splendor (37,4 g). Toutefois, la concentration de protéines de Jake (15,9%), déterminée par spectroscopie dans le proche infrarouge, est supérieure à celle de Glenn (15,5%) et semblable à celle des autres variétés témoins. Jake résiste modérément ou résiste à la rouille des feuilles, à la rouille de la tige et à la rouille jaune. Au cours des trois années d'essai, le cultivar a résisté modérément à la carie. Sa réaction à la fusariose de l'épi varie de modérément sensible à modérément résistant, avec une concentration de DON similaire à celle notée chez Carberry et Glenn. Les trois années d'évaluation de la qualité selon l'usage final permettent de classer Jake dans la catégorie CWRS. [Traduit par la Rédaction]

Mots-clés : *Triticum aestivum* L., blé roux de l'Ouest canadien, résistance à la rouille, verse, description de cultivar.

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D. Spaner, M. Iqbal, and K. Strenzke. Agricultural, Food & Nutritional Science, 4-10 Ag/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada.

A. Navabi.* Agricultural, Food & Nutritional Science, 4-10 Ag/Forestry Centre, University of Alberta, Edmonton, AB T6G 2P5, Canada; Department of Plant Agriculture, University of Guelph, Guelph, 50 Stone Road E. Guelph, ON N1G 2W1, Canada.

B. Beres.† Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, 5403-1st Avenue South, Lethbridge, AB T1J 4B1, Canada.

Corresponding author: D. Spaner (email: dspaner@ualberta.ca).

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*Deceased.

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Introduction

Jake, a hard red spring wheat (*Triticum aestivum* L.) cultivar, was developed at the University of Alberta, Edmonton, AB, and is well adapted to the wheat-growing regions of Western Canada. Jake is a medium-maturing, medium tall, high-yielding cultivar with good lodging resistance. It has end-use quality suitable for the Canada Western Red Spring (CWRS) class. It has good resistance against leaf, stem, and stripe rusts, common bunt, and loose smut. Jake was issued registration no. 8626 by the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency (CFIA), Ottawa, ON, on 22 Mar. 2019.

Pedigree and Breeding Methods

Jake derives from a cross between CWRS wheat line PT764 (McKenzie/Alsen//BW297) and the registered wheat cultivar CDC Stanley that was made at the University of Alberta during 2009–2010. Jake was developed using a modified bulk breeding method. The F₁ seeds from the final cross were planted in a greenhouse to obtain the F₂ generation. The F₂ generation was planted in the field in six 2-m-long rows in Edmonton in 2010. The row was harvested, bulked, and 25 g of seed were sent to New Zealand (NZ) and planted as F₃ long rows (2 m × 25 m) during the 2010–2011 winter season (in Canada), where plants were selected based on plant height, maturity, and disease resistance. Two hundred heads were harvested, bulked, and planted as the F₄ generation in long rows in Edmonton during 2011. Seventy heads were selected from the F₄ generation and were individually threshed and planted as F₅ headrows in NZ during 2011–2012. From these headrows, 44 were selected based on plant type, lodging, maturity, and disease resistance. These lines were tested in an un-replicated preliminary yield trial in 2012 under organic management in Edmonton; in leaf, bunt, and leaf spot nurseries in Edmonton, and in a stripe rust nursery in Lethbridge, AB. Based on agronomic, disease, and end-use quality data, one line (UAW1002*F6MBK05) was selected and subsequently evaluated in a replicated multi-location advanced yield trial (organic) in 2013 in Edmonton. This line was subsequently evaluated in the Parkland Cooperative B test as entry number 9 in 2014, and then as PT782 in the Parkland Cooperative tests in 2015, 2016, and 2017.

Evaluation in the Parkland Cooperative tests followed protocols described by the Prairie Recommending Committee for Wheat, Rye, and Triticale (PRCWRT 2013). Agronomic performance was evaluated in a multi-environment trial conducted during 2015–2017 in 36 environments. The trials were conducted using a rectangular lattice design with three replications per environment. The data for the test were analyzed for individual years and combined in a mixed model design in SAS (SAS Institute Inc., Cary, NC), with environments

and replications as random effects and genotype as a fixed effect. Response to stem rust (*Puccinia graminis* Pers.:Pers. f. sp. *tritici* Erikss. & E. Henn.) was assessed at the seedling stage and in the field using seven stem rust races (TPM, RHT, TMR, RKQ, QTH, RTH, and MCC). For leaf rust (*Puccinia triticina* Erikss.) assessment, representative leaf rust races from previous years were used at both the seedling and adult plant stages. Field evaluation of leaf and stem rust was conducted annually in epiphytotic nurseries in Brandon and Morden, MB. Resistance to Fusarium head blight (FHB) [*Fusarium graminearum* Schwabe; teleomorph *Gibberella zeae* (Schwein.) Petch] was assessed by inoculation of field nurseries at Carmen and Morden, MB, and Ottawa, ON, with a macroconidial suspension (Gilbert and Woods, 2006). Loose smut resistance was assessed by injecting prevalent races of *Ustilago tritici* (Pers.) Rostr. into the florets of plants at anthesis in the field and subsequently growing the inoculated seed in the greenhouse (Menzies et al. 2003). Response to common bunt was evaluated by inoculating seed with prevalent races of common bunt and planting in mid-April of each year in Lethbridge following the protocols of Gaudet and Puchalski (1989).

End-use quality analyses were done at the Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB, following standard protocols of the American Association of Cereal Chemists (AACC 2000). The Canadian Grain Commission first determined the grain grade and protein concentration for the check cultivars at all test locations, and then devised a common site-blending formula for the checks and candidate cultivars to develop composite samples. Grain samples from test locations with serious down-grading factors were not included in the composites.

Plant descriptive characteristics were recorded from a three-replicate trial conducted in a randomized complete block design at the University of Alberta Research Farm, Edmonton, during 2017 and 2018. This trial included the reference cultivars Alsen (Frohberg et al. 2006), Go Early (Spaner et al. 2017), and McKenzie (Graf et al. 2003). All characteristics were recorded as prescribed in the objective description form of the Variety Registration Office, CFIA.

Performance

Over 3 yr of testing in the Parkland Wheat Cooperative trials (2015–2017), Jake yielded 6% higher than the mean of the combined check cultivars, with significantly ($P < 0.05$) higher yield than all checks (Table 1). Jake matured 2.9 d earlier ($P < 0.05$) than Glenn but 1.7 d later than Splendor (Table 1). Jake was 91.2 cm tall; significantly ($P < 0.05$) shorter than AC Splendor (95.8 cm), but similar in height to Glenn (91.8 cm) and Parata (92 cm). The lodging score of Jake (2.2) was significantly ($P < 0.05$) lower than Parata (3.1) and AC Splendor (3.1), but similar to Glenn (Table 1). The test weight of Jake (80.8) was greater ($P < 0.05$) than AC Splendor (78.3),

Table 1. Agronomic data for Jake and check cultivars in the Parkland Wheat Cooperative Tests, 2015–2017.

Cultivar	Yield (kg ha ⁻¹)	Yield ^a (%Chk)	Maturity (d)	Height (cm)	Lodging score (1–9)	Test weight (kg hl ⁻¹)	Grain weight (g 1000 ⁻¹)	NIR protein (%)
Glenn	4685	101.4	101.6	91.8	2.0	82.5	36.7	15.5
Parata	4758	103.0	98.0	92.0	3.1	80.5	35.6	15.7
Splendor	4414	95.6	97.0	95.8	3.1	78.3	37.4	15.7
Jake	4904	106.2	98.7	91.2	2.2	80.8	35.6	15.9
LSD ^b (0.05)	138		0.8	1.5	0.4	0.4	0.7	0.3
Site-years	35		32	35	17	35	35	35

^aPercent of mean of checks.

^bLSD, least significant difference.

similar to Parata (80.5), but lower than Glenn (82.5). The grain weight of Jake (35.6 g) was similar to Parata (35.6 g) but significantly lower than Glenn (36.7 g) and AC Splendor (37.4 g), while the near-infrared (NIR) spectroscopy protein of Jake (15.9%) was higher than Glenn (15.5%) and similar to other check cultivars (Table 1).

Other Characteristics

Botanical description

At the seedling stage, Jake has erect to semi-erect growth habit, glabrous lower leaf blade and sheath, and light green leaves. Jake has light to medium green flag leaves with glabrous blades and sheaths, without waxiness on the flag leaf blade and sheath. The flag leaf of Jake is rectilinear to slightly curved, upright in attitude, lacks anthocyanin coloration of the auricles, and has glabrous auricle margins. Jake has a hollow straight culm neck, which is glabrous and lacks waxiness. Jake has a white stem at maturity. Jake has fusiform, medium dense awned spikes that are erect and white at maturity. The lower glume of Jake has 60% squared, 30% sloping, and 10% elevated shoulders, is glabrous, and has a moderately curved/acuminate beak. The lowest lemma beak of Jake is straight to slightly curved. The chaff color of Jake is white at maturity. The kernels of Jake are hard, medium red, small to medium in size, length, and width, oval to ovate/broad elliptical, with rounded to slightly angular cheeks. It has a small to medium kernel brush with short to mid-long brush hairs. The kernel crease is narrow to mid-wide and shallow to mid-deep. Jake has a mid-size oval germ.

Disease resistance

Jake was rated as resistant to the prevalent stem and stripe rust races, moderately resistant to resistant to common bunt, and intermediate to resistant to leaf rust races during the 3 yr of testing (Table 2). Based on a Visual Rating Index (VRI) of Fusarium head blight (FHB), Jake was rated moderately resistant (MR) in one, moderately susceptible (MS) in four, and susceptible (S) in one environment (Table 3). Based on a combined rating of incidence, severity, and deoxynivalenol (DON) content of FHB, Jake was rated as intermediate in Morden in 3 yr of testing, and MS in Carmen in only 1 yr (Table 3).

The DON values of Jake were in the range of Carberry and Glenn (Table 3). The overall rating of Jake for FHB was MS.

End-use quality

Three years of end-use quality evaluation conducted by the Canadian Grain Commission, Grain Research Laboratory, indicated that Jake is acceptable for all grades of the CWRS wheat class (Table 4). Grain and flour protein of Jake was similar to or higher than the check cultivars (Table 4). Protein loss on milling was significantly lower ($P < 0.05$) than AC Splendor, Carberry, and Glenn, but similar to Parata. Falling number of Jake was significantly ($P < 0.05$) higher than Glenn but lower than Parata. Amylograph peak viscosity and flour yield of Jake was in the range of the checks. Starch damage was higher than AC Splendor but lower than Carberry and Glenn. Farinograph absorption, dough development time, and stability of Jake were similar to the checks except for stability, which was higher than Carberry. Extensogram area and R_{max} values of Jake were higher than all checks except Glenn. Canadian short process/lean no time absorption and loaf volume of Jake were similar to the checks. Mixing time was longer than AC Splendor, less than Glenn, but similar to Carberry and Parata. Mixing energy was lower than Glenn but similar to the other checks (Table 4).

Maintenance and Distribution of Pedigreed Seed

Breeder seed of Jake derives from 150 heads picked from a seed increase plot of Parkland B in 2014 at Edmonton. The 150 heads were grown in headrows in Edmonton in 2016. Of these, 45 rows were discarded due to non-uniformity and (or) the presence of off-types and 105 headrows (about 100–200 g of seed per row) were harvested separately. From each headrow, 25 g seeds was planted into 15 m rows at Edmonton in 2017. Nine (9) rows were eliminated due to non-uniformity and (or) the presence of off-types. Ninety six (96) uniform rows were harvested and bulked to produce approximately 100 kg of breeder seed. Breeder seed of Jake will be maintained by the University of Alberta's Cereal Breeding Program, Edmonton, AB.

Table 2. Reaction of Jake to stripe, stem, and leaf rust and common bunt in Parkland Wheat Cooperative Tests, 2015–2017.

Year	Entry	Stripe rust		Stem rust		Leaf rust		Bunt		Leaf spot		Loose smut					
		Lethbridge		Creston		Sev.	Rate	Sev.	Rate	Mean	Rate	Melfort		Swift Curr.		%Inf. ^b	Rate
		Sev. ^a	Rate	Sev.	Rate							Score	Rate	Score	Rate		
2015	Splendor	10	MR	—	—	7	R	38	I	9.5	MR	9	MS	—	—	14.9	MR
2016	Splendor	45	MS	85	S	5	R	32	I	10	MR	8.3	MS	10	S	—	—
2017	Splendor	80	S	20	MR	5	R	30	M	4	MR	2.7	—	—	—	—	—
2015	Glenn	15	I	—	—	10	MR	17	MR	8.8	MR	8.3	MS	—	—	4.44	R
2016	Glenn	15	MR	25	I	10	R	28	MR	3	R	8	I	10	S	—	—
2017	Glenn	40	MS	1	R	10	MR	27	MR	15	I	2.3	—	—	—	—	—
2015	Parata	10	MR	—	—	7	R	53	MS	13	MR	11	S	—	—	10.6	MR
2016	Parata	15	MR	5	R	5	R	1.7	R	3.5	R	10.3	S	10	S	—	—
2017	Parata	15	MR	1	R	5	R	6	MR/M	0	R	5.7	—	—	—	—	—
2016	Carberry	10	MR	5	R	5	R	3.7	R	2	R	10.7	S	10	S	—	—
2017	Carberry	T	R	1	R	10	MR	1	R/MR	1	MR	3	—	—	—	—	—
2015	Jake	2	R	—	—	5	R	33	I	8.3	MR	7.7	I	—	—	0	R
2016	Jake	5	R	5	R	5	R	1	R	2.3	R	7	I	7.5	I	—	—
2017	Jake	2	R	1	R	5	R	3.3	R/MR	3	MR	2	—	—	—	—	—

Note: R = resistant; MR = moderately resistant; I = intermediate; MS = moderately susceptible; S = susceptible; —, not available.

^aSeverity.

^bPercent infection.

Table 3. Reaction of Jake to Fusarium head blight in Parkland Wheat Cooperative Tests, 2015–2017.

Year	Entry	Morden							Carmen							Ottawa				
		Mean INC ^a	Mean SEV ^b	VRI ^c	Rate	DON ^d	ISD ^e	Rate	Mean INC	Mean SEV	VRI	Rate	FDK ^f	DON	ISD	Rate	Mean INC	Mean SEV	Index	Rank
													%							
2015	Splendor	8.3	6.8	57	MS	45.9	30.6	MS	86.7	28.3	25	I	—	22.0	15.5	—	100	76.7	77.0	18
2016	Splendor	9.8	5.7	56	MS	29.5	20.8	I	73.3	23.3	17	I	—	13.6	10.1	—	100	72	72.0	26
2017	Splendor	8.8	6.7	59	S	17.2	13.4	I	83.3	70.0	59	S	18.7	12.7	38.3	MS	100	62	62.0	28
2015	Glenn	8.7	7.3	64	MS	29.3	20.8	I	68.3	13.3	9	MR	—	15.0	10.6	—	100	58	58.0	8
2016	Glenn	9	2.5	23	R	20.5	14.6	R	63.3	16.7	11	MR	—	20.8	14.1	—	100	47	47.0	17
2017	Glenn	6.8	3.2	22	MR	10.8	8.5	MR	53.3	13.3	8	MR	6.3	7.0	17.7	MR	97	33	32.3	23
2015	Parata	9.7	9	87	S	23.8	18.0	I	78.3	23.3	18	I	—	13.0	9.8	—	100	87	87.0	22
2016	Parata	9.3	4.2	39	MR	36.8	24.8	MS	66.7	18.3	12	MR	—	31.2	20.4	—	97	23	23.0	3
2017	Parata	7.5	3.3	25	MR	13.1	10.0	MR	68.3	30.0	20	I	8.0	11.3	26.7	I	88	25	22.3	13
2016	Carberry	9.5	3	29	MR	26.0	18.1	MR	70	28.3	20	I	—	42.0	27.2	—	100	45	45.0	16
2017	Carberry	6.3	2.2	14	MR	12.1	9.0	MR	71.7	20.0	15	MR	9.0	10.0	24.3	I	98	35	34.4	25
2015	Jake	9	7.2	65	MS	34.2	23.7	I	88.3	40	36	MS	—	19.0	14.0	—	100	75	75.0	16
2016	Jake	9.5	4.5	43	MR	28.8	20.1	I	81.7	35	29	MS	—	31.5	21.2	—	100	73	73.0	27
2017	Jake	8.5	5.5	46	MS	17.7	13.4	I	81.7	53.3	44	S	11.7	11.7	34	MS	95	33	31.7	22

Note: R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, S = susceptible.

^aINC, incidence.

^bSEV, severity.

^cVRI, visual rating index = [(R_{1inc} × R_{1sev}) + (R_{2inc} × R_{2sev}) + (R_{3inc} × R_{3sev})]/3.

^dDON, deoxynivalenol.

^eISD, incidence + severity + DON = (0.2 × mean incidence + 0.2 × mean severity + 0.6 × mean DON).

^fFDK, Fusarium-damaged kernels.

Table 4. Least squares means of different quality parameters for Jake and checks in Parkland Wheat Cooperative Tests, 2015–2017.

Cultivar	Wheat and flour characteristics				Milling performance					Dough properties						Baking quality ^c					
	Grain protein (%)	Flour protein (%)	Protein loss (%)	Falling number (s)	Amylograph peak viscosity (BU)	Clean flour yield	Flour PB 0.50 Ash	Flour ash (%)	Starch damage (mega-zeme)	Farinogram			Extensogram			Absorption (%)	Mixing time (min)	Mixing energy (W-h kg ⁻¹)	Loaf volume (cm ³ 100 g ⁻¹)	Loaf top ratio	
										Absorption (%)	Dough development time (min)	Mixing tolerance index (BU) ^d	Stability (min)	Area (cm ²)	R _{max} (BU)						Length (cm)
AC Splendor	15.0	14.1	0.83	395	570	76.1	77.7	0.43	6.5	65.3	6.8	20	10.7	125	508	20.0	71.7	3.33	9.6	887	0.53
Carberry	14.4	13.4	0.90	350	438	75.6	78.7	0.41	7.6	64.5	5.7	—	6.3	101	385	20.4	70.2	3.63	9.7	852	0.53
Glenn	14.5	13.6	0.80	320	565	75.1	78.5	0.41	8.4	66.1	7.3	25	9.8	149	649	18.7	72.0	4.53	12.4	937	0.66
Parata	14.6	13.8	0.73	425	583	76.4	78.5	0.41	7.2	64.8	7.1	25	10.2	126	524	19.6	70.7	4.20	11.6	858	0.51
Jake	14.9	14.3	0.60	397	533	75.3	78.7	0.41	7.0	65.2	7.2	15	10.2	141	615	18.9	71.3	3.97	10.9	885	0.56
CV (%)	2.3	2.3	12.5	8.9	13.5	0.5	0.9	3.3	2.8	0.74	12.7	—	8.4	5.2	6.9	4.8	1.3	5.8	6.9	4.2	2.8
LSD	0.6	0.6	0.2	62.1	135	0.7	1.2	0.03	0.4	0.9	1.6	—	1.5	12.3	68.4	1.7	1.7	0.4	1.4	67.4	0.03

($p \leq 0.05$)^e

^aQuality data were obtained by Grain Research Laboratory of the Canadian Grain Commission using approved methods of the American Association of Cereal Chemists (AACC 2000).

^bCarberry data is for 2016 and 2017 only.

^cLSD, least significant difference = Standard error of the difference between means \times 1.96.

^d2015 data only when Carberry was not in the test.

^eCanadian short process (150 ppm ascorbic acid) in 2015, whereas lean no time in 2016 and 2017.

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many parts of the world, some peace in the days and years to come.

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