

## Journey hard red spring wheat

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Graf, R. J., Potts, D. A. and Hanson, K. M. 2003. **Journey hard red spring wheat**. Can. J. Plant Sci. **83**: 807–811. Journey hard red spring wheat is adapted to the wheat-growing regions of the Canadian prairies. Evaluation occurred in Central Bread Wheat Cooperative registration tests in 1997, 1999 and 2000 relative to Neepawa, Roblin, AC Majestic, McKenzie and AC Barrie. Journey displayed high grain yield, mid- to late-season maturity, reduced height, very strong straw, high test weight, high protein content and improved pre-harvest sprouting resistance. It exhibited resistance to the prevalent races of stem rust, leaf rust and common bunt, and intermediate resistance to loose smut and Fusarium head blight. Journey is eligible for all grades of Canada Western Red Spring (CWRS) wheat.

**Key words:** *Triticum aestivum* L., cultivar description, red spring wheat, strong straw, grain protein, test weight, preharvest sprouting resistance, disease resistance.

Graf, R. J., Potts, D. A. et Hanson, K. M. 2003. **Le blé de printemps roux vitreux Journey**. Can. J. Plant Sci. **83**: 807–811. Le blé de printemps roux vitreux Journey est une variété bien acclimatée aux zones de culture du blé des Prairies canadiennes. Le cultivar a été évalué aux essais centraux coopératifs du blé panifiable en 1997, 1999 et 2000 et comparé à Neepawa, Roblin, AC Majestic, McKenzie et AC Barrie. Journey est un cultivar à rendement grainier élevé, de maturité moyenne à tardive, à hauteur réduite et à paille très robuste, qui donne un poids spécifique élevé, une forte teneur en protéines et une meilleure résistance à la germination sur pied. Journey résiste bien aux races courantes de rouille de la tige, de rouille des feuilles et de carie ainsi que modérément au charbon nu et à la fusariose de l'épi. Ce cultivar entre dans toutes les catégories de blé roux de printemps de l'Ouest canadien.

**Mots clés:** *Triticum aestivum* L., description de variété, blé roux de printemps, paille robuste, protéines du grain, poids spécifique, résistance à la germination sur pied, résistance à la maladie

Journey hard red spring wheat (*Triticum aestivum* L.) was developed by Saskatchewan Wheat Pool (SWP), Agricultural Research and Development. It received registration No. 5436 from the Variety Registration Office, Canadian Food Inspection Agency on 9 April 2002.

Journey wheat was named in acknowledgement of the role that Canada's wheat exports play in feeding a hungry world. Every year, Canadian farmers produce millions of tonnes of numerous grains that are transported to nations around the globe.

### Breeding Method and Pedigree

Journey wheat was selected from the three-way cross CDC Teal//Grandin/PT819 made in 1992 at the SWP Agricultural Research and Development Farm at Watrous, SK. CDC Teal is a CWRS wheat cultivar developed at the Crop Development Centre, University of Saskatchewan (Hughes and Hucl 1993); Grandin is a Dark Northern Spring wheat

cultivar developed and released by North Dakota State University in 1989; PT819 is an experimental line developed by AgriPro Wheat with the pedigree Columbus/Butte.

Following greenhouse increase of the F<sub>1</sub> seed, approximately 125 F<sub>2</sub> plants were selected from space planted bulk plots at Watrous and Portage la Prairie, MB, in 1993. The F<sub>3</sub> generation was grown as head rows in Chile, with one head per row advanced to an artificially inoculated stem rust (*Puccinia graminis* Pers.: Pers. f. sp. *tritici* Eriks. & e. Henn.) and leaf rust (*P. triticina* Eriks. = *P. recondita* Roberge ex Desmaz.) screening nursery near Portage la Prairie. Selection of one head per F<sub>4</sub> row was based on maturity, plant height, straw strength, plant vigour, resistance to stem rust, leaf rust, and Fusarium head blight (caused by *Fusarium* species), protein content and SDS sedimentation volume. In 1995, nine F<sub>4</sub>-derived F<sub>5</sub> head rows were harvested in Chile and subsequently evaluated in single replicate trials with repeated checks under dryland conditions at Watrous, and under irrigation near Outlook, SK. Stem and leaf rust reactions were determined in an artificially inoculated nursery at Saskatoon, SK; resistance to common bunt [*Tilletia laevis* Kuhn in Rabenh. and *T. tritici* (Bjerk.) G. Wint. in Rabenh.] was determined at Watrous.

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Table 1. Grain yield of Journey compared with check cultivars, Central Bread Wheat Cooperative registration test, 1997, 1999 and 2000

Cultivar	Grain yield (kg ha <sup>-1</sup> )					
	Zone 1 <sup>z</sup>		Zone 2		Grand mean	
	3 yr	2 yr <sup>y</sup>	3 yr	2 yr	3 yr	2 yr
Neepawa	3410	3510	3520	3750	3460	3630
Roblin	3340	3740	3410	3630	3380	3680
AC Majestic	3620	3900	3720	3970	3670	3930
McKenzie	4480	4780	4120	4520	4300	4640
AC Barrie	–	4100	–	4070	–	4080
Journey	4090	4260	3770	3970	3920	4110
LSD <sup>x</sup>	290	320	220	270	190	210
Tests	14	9	15	10	29	19

<sup>z</sup>Zone 1, locations in Manitoba; zone 2, locations in eastern Saskatchewan.

<sup>y</sup>AC Barrie was added as a check cultivar in 1999.

<sup>x</sup>Least significant difference,  $P \leq 0.05$ , based on the mean squares genotype-by-environment interaction.

Based on favourable agronomic performance, disease resistance and end-use quality, a line designated SWP 950-252 was evaluated at seven sites in Alberta, Saskatchewan, and Manitoba in 1996, through the cooperation of the Alberta Wheat Pool and Manitoba Pool Elevators. Stem and leaf rust reaction were verified in artificially inoculated nurseries at Saskatoon and Winnipeg, MB; common bunt resistance was assessed at Saskatoon; loose smut [*Ustilago tritici* (Pers.) Rostr.] reaction was determined at Winnipeg.

Suitability for registration based on merit assessment of agronomic performance, disease resistance, and end-use quality was determined in the Central Bread Wheat Cooperative (CBWC) registration tests in 1997, 1999 and 2000, under the designation of BW243. The check cultivars were Neepawa (Campbell 1970), Roblin (Campbell and Czarnecki 1987), AC Majestic, McKenzie (Graf et al. 2003) and AC Barrie (McCaig et al. 1996). Agronomic testing was performed by AAFC, the University of Saskatchewan and United Grain Growers; reaction to diseases was determined by AAFC; end-use quality testing was done by the Canadian Grain Commission. The MINITAB GLM procedure was used for the combined statistical analysis of the presented data, in which the effects of environment were considered to be random and genotypes were fixed (MINITAB Inc. 2000).

During the 3 yr of registration testing, resistance to the major wheat diseases in western Canada was assessed. Seedling resistance to individual races of stem and leaf rust prevalent in Canada was determined. The stem rust races used for 1 or more years were: QFC, QFCSH, QTH, QTHST, RKQ, RKQSR, RTH, RTHJT, TMR, TMRTK, TPM and TPMKR (Harder 1999; McCallum et al. 2000). The leaf rust races used for 1 or more years were: MBR, MBDS, MBRJ, MCDS, MGB, MGBJ, TGBJ, TJB and TJBj (Kolmer 1998, 2001). Adult plant reactions to stem and leaf rust were determined in field nurseries near Glenlea, MB, using a composite of races which were similar to those employed for the seedling tests. Resistance to common bunt was ascertained by inoculating the seed with races L1, L16, T1, T6, T13 and T19, and planting into cold soil at Lethbridge, AB. Loose smut reaction was assessed using the

prevalent races T2, T9, T10 and T39, which were mixed and artificially injected into florets at anthesis. Fusarium head blight and leaf spot reactions were determined in artificially inoculated nurseries near Winnipeg. The race designations are those described by Green (1965) and Roelfs and Martens (1988) for stem rust, Long and Kolmer (1989) for leaf rust, Hoffman and Metzger (1976) for common bunt, and Nielsen (1987) for loose smut.

### Performance

Evaluation in the CBWC test in 1997, 1999 and 2000 established that Journey had higher grain yield than all of the check cultivars except McKenzie (Table 1). The mean yield of Journey was 13.3% higher than Neepawa, 16.0% higher than Roblin, 6.8% higher than AC Majestic, but 8.8% lower than McKenzie. Based on 2 yr of testing, Journey yielded 0.7% higher than AC Barrie. Since the mean grain yields for the check cultivars in Zone 1 (Manitoba, 3712 kg ha<sup>-1</sup>) and Zone 2 (eastern Saskatchewan, 3695 kg ha<sup>-1</sup>) were similar, it appears that Journey had better adaptation to Zone 1, where it yielded 10.1% more than the check mean; in Zone 2, Journey yielded 1.9% more than the checks. Journey matured 2.6 d later than Neepawa, 4.1 d later than Roblin, 0.4 d later than AC Majestic, 2.2 d later than McKenzie, and 1.0 d later than AC Barrie (2 yr of data) (Table 2). Zonal comparisons revealed maturity differences relative to AC Majestic and McKenzie, as Journey was 1.6 d later than both cultivars in Zone 1, yet it was 0.7 d earlier than AC Majestic and 2.7 d later than McKenzie in Zone 2. Journey had shorter, stronger straw and higher test weight than all of the check cultivars. Seed weight was similar to Neepawa. Journey maintained a Hagberg falling number similar to the preharvest sprouting resistant checks, AC Majestic and McKenzie, based on field and artificially weathered samples.

Journey expressed resistant to moderately resistant reactions to the prevalent races of stem rust, leaf rust, and common bunt during registration testing (Table 3). Resistance to loose smut was considered to be intermediate (J. G. Menzies, personal communication, AAFC, Winnipeg). Journey had ratings of moderately resistant to intermediate for Fusarium head blight. The resistance to adult leaf spots

**Table 2. Mean agronomic performance of Journey and check cultivars, Central Bread Wheat Cooperative registration test, 1997, 1999 and 2000**

Cultivar	Maturity (d)						Lodging <sup>y</sup> (1-9)			Test weight (kg hL <sup>-1</sup> )			Kernel weight (mg)			Hagberg falling number (s)						
	Zone 1 <sup>z</sup>		Zone 2		Mean		Height (cm)		Lodging <sup>y</sup> (1-9)		Test weight (kg hL <sup>-1</sup> )		Kernel weight (mg)		Field		Artificial <sup>x</sup>		Field		Artificial <sup>x</sup>	
	3 yr	2 yr <sup>w</sup>	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr
Neepawa	90.7	92.0	97.3	100.5	94.4	97.0	103	106	2.8	3.0	77.5	76.3	30.0	29.3	271	313	228	263	271	313	228	263
Roblin	89.4	91.2	95.7	98.4	92.9	95.4	96	100	1.9	2.2	76.5	75.4	32.0	31.4	199	210	141	144	199	210	141	144
AC Majestic	91.8	92.4	100.5	104.3	96.6	99.4	97	101	2.1	2.3	78.2	77.1	31.4	30.9	348	403	358	398	348	403	358	398
McKenzie	91.8	93.1	97.1	99.9	94.8	97.1	98	100	3.0	2.9	79.6	78.9	31.5	31.2	340	391	337	388	340	391	337	388
AC Barrie	-	92.9	-	102.2	-	98.4	-	103	-	2.4	-	78.4	-	32.1	-	321	-	354	-	321	-	354
Journey	93.4	94.1	99.8	103.1	97.0	99.4	95	97	1.6	1.7	79.9	78.8	29.8	29.7	324	380	327	409	324	380	327	409
LSD <sup>y</sup>	1.1	1.4	1.6	2.2	1.0	1.1	2	2	0.5	0.5	0.6	0.8	0.8	1.0	101	149	111	105	101	149	111	105
Tests	12	7	15	10	27	17	27	18	22	16	30	20	30	20	3	2	3	2	3	2	3	2

<sup>z</sup>Zone 1, locations in Manitoba; Zone 2, locations in eastern Saskatchewan.

<sup>y</sup>Lodging rated as 1 = all plants vertical; 9 = all plants horizontal.

<sup>x</sup>Hagberg falling number determined following 48-49 h in a rainfall simulator.

<sup>w</sup>AC Barrie was added as a check cultivar in 1999.

<sup>y</sup>Least significant difference,  $P \leq 0.05$ , based on the mean squares genotype-by-environment interaction.

**Table 3. Disease reactions of Journey and check cultivars, Central Bread Wheat Cooperative registration test, 1997, 1999 and 2000**

Cultivar	Year	Stem rust <sup>z</sup>	Leaf rust <sup>z</sup>	Common bunt <sup>z</sup>	Loose smut <sup>z,y</sup>	Common root rot <sup>x</sup>	FHB <sup>w</sup>	Adult leaf spot (1-11) <sup>v</sup>	<i>Stagonospora nodorum</i> (1-11) <sup>v</sup>	<i>Septoria tritici</i> (1-11) <sup>v</sup>
Neepawa	1997	3MR	30MR-S	25I	0R	7	23	11.0	-	-
	1999	5RMR	60MS	29MS	0R	57	10	-	9.8	2.0
	2000	tR	50S	22I	0R*	-	20	-	9.0	11.0
Roblin	1997	IR	10M	38S	24MR	5	35	11.0	-	-
	1999	tR	10MR	39S	0R*	44	62	-	9.8	2.0
	2000	0R	40MS	44S	9R	-	42	-	8.7	11.0
AC Majestic	1997	IR	5R	21I	65S	3	33	10.6	-	-
	1999	tR	40MR	8MR	3R	68	13	-	9.3	2.0
	2000	0R	15MRMS	10R	23MR	-	24	-	8.3	11.0
McKenzie	1997	IR	tR	3R	45HS	7	20	10.8	-	-
	1999	tR	tR	2R	0R*	53	18	-	9.5	2.0
	2000	0R	tR	0VR	38I	-	30	-	9.0	11.0
AC Barrie	1997	-	-	-	0R*	-	13	-	-	-
	1999	5R	40MRMS	25MS	0R*	83	13	-	9.5	1.0
	2000	0R	20MRMS	39S	3R	-	22	-	8.0	11.0
Journey	1997	5RMR	tR	3R	39MS	9	17	9.5	-	-
	1999	5RMR	5R	12I	29MR	73	13	-	8.5	2.0
	2000	0R	10MRMS	2VR	4R	-	30	-	8.0	11.0

<sup>z</sup>Percent infection and type of reaction: t = trace; VR = very resistant; R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; HS = highly susceptible.

<sup>y</sup>Ratings for the checks are based on reported data and previous screening results. Assessment made on less than 10 plants if marked by an asterisk.

<sup>x</sup>Percentage of plants with moderate to large lesions on the subcrown internode.

<sup>w</sup>Fusarium head blight index = (% infected spikelets × % infected spikes)/100, measured at Winnipeg, MB.

<sup>v</sup>Rated at the milk dough stage using a scale of 0-11: 0 = very resistant; 11 = very susceptible.

**Table 4. Mean end-use quality<sup>z</sup> of Journey and check cultivars, CBWC registration test, 1997, 1999 and 2000**

Cultivar	Wheat protein (%)	Hagberg falling no. (s)	Kernel hardness (PSI)	Starch damage (Ferrand units)	Amylograph peak viscosity (B.U.)
Neepawa	14.2	383	55.3	6.3	598
Roblin	15.2	327	58.3	5.2	360
AC Majestic	14.4	425	54.3	6.3	1042
McKenzie	14.2	390	51.7	7.3	663
Journey	14.6	378	54.0	5.9	652
Tests	3	3	3	3	3

  

Cultivar	Flour				Farinograph			
	Yield (%)	Protein (%)	Ash (%)	Agtron Colour	Absorption (%)	Dough development time (min)	Mixing tolerance index (B.U.)	Stability (min)
Neepawa	74.7	13.4	0.46	77	65.3	4.3	35.0	6.7
Roblin	74.8	14.5	0.44	75	65.9	7.8	21.7	13.8
AC Majestic	75.6	13.7	0.43	76	66.2	4.9	36.7	7.0
McKenzie	76.0	13.5	0.46	76	66.9	5.0	40.0	6.8
Journey	74.9	14.2	0.45	78	65.3	6.8	21.7	12.7
Tests	3	3	3	3	3	3	3	3

  

Baking: Canadian Short Process (150 ppm AA)				
Cultivar	Loaf volume (cm <sup>3</sup> )	Absorption (%)	Mixing energy (Whr kg <sup>-1</sup> )	Mixing time (min)
Neepawa	1107	69	11.4	8.3
Roblin	1148	70	16.3	13.1
AC Majestic	1080	70	13.8	10.4
McKenzie	1078	71	11.8	9.2
Journey	1130	70	16.4	12.6
Tests	3	3	3	3

<sup>z</sup>American Association of Cereal Chemists (AACC) methods were followed by the Grain Research Laboratory, Canadian Grain Commission for determining the end-use quality characteristics on a composite of six to eight locations per year.

caused by *Stagonospora nodorum* (Berk.) was better for Journey than for the check cultivars.

Journey exhibited higher wheat (grain) and flour protein content than all of the checks cultivars except Roblin (Table 4). The milling properties, functionality and baking performance fell within the limits set by the check cultivars. Journey had gluten strength that was somewhat weaker than Roblin, but stronger than the other check cultivars as indicated by various farinograph and Canadian Short Process baking parameters.

#### Other Characteristics

**SEEDLING:** Coleoptile exhibits purple anthocyanin colouration.

**SPIKES:** Oblong, upright to slightly inclined at maturity, medium density, medium long, yellow to tan at maturity, apically awnletted; glumes narrow to mid-wide, mid-short, glabrous, light yellow; glume shoulders square to elevated, medium width; glume beak short and acute.

**KERNEL:** Medium red colour, mid-size to small, mid-long to short, mid-wide, oval; cheeks rounded to angular; crease mid-wide, mid-deep; brush mid-size, hairs short; embryo small to mid-size, oval.

**SHATTERING:** Resistant, similar to Neepawa.

**END-USE QUALITY:** Based on 3 yr of testing in the Central Bread Wheat Cooperative registration tests, Journey was rated as equal to Neepawa for grain quality (Table 4) and eligible for all grades of Canada Western Red Spring wheat.

#### Availability of Propagating Material

Breeder Seed of Journey was a composite of 70 breeder lines developed from F<sub>4</sub>-derived F<sub>8</sub> single head selections taken from an increase plot grown at Watrous in 1997. Following head row increase in Chile, seed derived from each head was grown in isolated small plots. Plots revealing off-types or contamination were discarded prior to harvest of the remaining plots in bulk. Breeder Seed derived from this bulk was grown in isolation and inspected by the Canadian Food Inspection Agency in 2001.

Breeder Seed is maintained by Saskatchewan Wheat Pool, Agricultural Research and Development, Watrous, SK, Canada S0K 4T0. Multiplication and distribution of pedigreed seed stock is handled by Saskatchewan Wheat Pool, Seed Marketing, 2625 Victoria Avenue, Regina, SK, Canada S4T 7T9. Plant Breeder's Rights certificate No. 1463 was issued by the Canadian Food Inspection Agency on 31 March 2003.

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**Campbell, A. B. 1970.** Neepawa hard red spring wheat. *Can. J. Plant Sci.* **50**: 752–753.

**Campbell, A. B. and Czarnecki, E. 1987.** Roblin hard red spring wheat. *Can. J. Plant Sci.* **67**: 803–804.

**Graf, R. J., Hucl, P., Orshinsky, B. R. and Kartha, K. K. 2003.** McKenzie hard red spring wheat. *Can. J. Plant Sci.* **83**: 565–569.

**Green, G. J. 1965.** Stem rust of wheat, rye and barley in Canada in 1964. *Can. Plant Dis. Surv.* **45**: 23–29.

**Harder, D. E. 1999.** Stem rusts on wheat, barley and oat in Canada in 1996 and 1997. *Can. J. Plant Pathol.* **21**: 181–186.

**Hoffman, J. A. and Metzger, R. J. 1976.** Current status of virulence genes and pathogenic races of the wheat bunt fungi in the northwestern USA. *Phytopathology* **66**: 657–660.

**Hughes, G. R. and Hucl, P. 1993.** CDC Teal hard red spring wheat. *Can. J. Plant Sci.* **73**: 193–197.

**Kolmer, J. A. 1998.** Physiologic specialization of *Puccinia recondita* f. sp. *tritici* in Canada in 1996. *Can. J. Plant Pathol.* **20**: 176–181.

**Kolmer, J. A. 2001.** Physiologic specialization of *Puccinia triticina* in Canada in 1998. *Plant Dis.* **85**: 155–158.

**Long, D. L. and Kolmer, J. A. 1989.** A North American system of nomenclature for *Puccinia recondita* f. sp. *tritici*. *Phytopathology* **79**: 525–529.

**McCaig, T. N., DePauw, R. M., Clarke, J. M., McLeod, J. G., Fernandez, M. R. and Knox, R. E. 1996.** AC Barrie hard red spring wheat. *Can. J. Plant Sci.* **76**: 337–339.

**McCallum, B. E., Harder, D. E. and Dunsmore, K. M. 2000.** Stem rusts on wheat, barley, and oat in Canada in 1998. *Can. J. Plant Pathol.* **22**: 23–28.

**MINITAB Inc. 2000.** MINITAB statistical software. Release 13.32. MINITAB Inc., State College, PA.

**Nielsen, J. 1987.** Races of *Ustilago tritici* and techniques for their study. *Can. J. Plant Pathol.* **9**: 91–105.

**Roelfs, A. P. and Martens, J. W. 1988.** An international system of nomenclature for *Puccinia graminis* f. sp. *tritici*. *Phytopathology* **78**: 526–533.