

Brigade durum wheat

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Clarke, J. M., Knox, R. E., DePauw, R. M., Clarke, F. R., Fernandez, M. R., McCaig, T. N. and Singh, A. K. 2009. **Brigade durum wheat**. Can. J. Plant Sci. **89**: 505–509. Brigade durum wheat [*Triticum turgidum* L. subsp. *durum* (Desf.) Husn.] is adapted to the durum production area of the Canadian prairies. It combines yield similar to the checks, very strong gluten, and low grain cadmium concentration. Brigade has better straw strength than Strongfield, slightly later maturity, and Fusarium head blight resistance better than other currently registered Canadian durum cultivars.

Key words: *Triticum turgidum* L. subsp. *durum* (Desf.) Husn., durum wheat, cultivar description, yield, protein, disease resistance

Clarke, J. M., Knox, R. E., DePauw, R. M., Clarke, F. R., Fernandez, M. R., McCaig, T. N. et Singh, A. K. 2009. **Le blé dur Brigade**. Can. J. Plant Sci. **89**: 505–509. Brigade est une variété de blé dur [*Triticum turgidum* L. sous-esp. *durum* (Desf.) Husn.] adaptée aux zones de production du blé des Prairies canadiennes. Brigade a un rendement similaire à celui des variétés témoin, un gluten très ferme et une faible concentration de cadmium dans le grain. Ce cultivar se caractérise par une paille plus robuste que Strongfield, une maturité légèrement plus tardive et une meilleure résistance à la brûlure de l'épi causée par *Fusarium* que la plupart des autres cultivars de blé dur homologués au Canada.

Mots clés: *Triticum turgidum* L. sous-esp. *durum* (Desf.) Husn., blé dur, description de cultivar, rendement, protéine, résistance à la maladie

Brigade durum wheat was developed at the Semiarid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, Swift Current, Saskatchewan. Filing for Plant Breeders' Rights protection (08-6332) was accepted on 2008 May 07, and Brigade received registration No.6502 from the Canadian Food Inspection Agency on 2008 Aug. 22.

Pedigree and Breeding Method

Brigade was selected from the cross DT513/DT696 made in 1999 and was developed using a modified pedigree technique. DT513 (DT625/DT612) was developed at the Crop Development Centre, University of Saskatchewan, and DT696 (DT618/DT 637//Kyle) derives from our breeding program. F₁ plants were grown in the greenhouse, from which seed was harvested and bulked. The F₂ generation was grown in a space-planted field nursery near Lincoln, New Zealand, in 1999–2000 and selected for plant height, straw strength and maturity. Individual heads from 250 selected plants were grown as F₃ rows near Swift Current in 2000, and selected rows were bulk-harvested and evaluated for test weight, grain pigment by near infrared/visual reflectance spectroscopy and cadmium concentration by atomic absorption (Clarke et al. 1997). Three heads of 87

selected lines were sown in individual F₄ rows in a nursery near Irwell, New Zealand, and selected for plant height, straw strength and maturity. The F₅ generation of 116 lines was grown in un-replicated yield trials near Swift Current and Regina, SK, and near Lethbridge and Vauxhall (irrigated), AB, in 2001, selected for agronomic performance, disease resistance, grain cadmium concentration and quality (protein, pigment, gluten strength). Five heads of each of 41 selected lines were sown in individual F₆ rows in a nursery near Irwell, New Zealand, and selected for plant height, straw strength and maturity. An un-replicated F₇ yield trial comprising 95 lines was grown near Swift Current, Regina, and Indian Head, SK, and Lethbridge, AB, in 2002 and selected for agronomic performance, disease resistance, grain cadmium concentration and quality (protein, pigment, gluten strength). Leaf (*Puccinia triticina* Eriks.) and stem rust (*P. graminis* Pers.: Pers.) reactions were assessed in hill plots in the F₇ generation in a rust nursery near Glenlea, MB, and Fusarium head blight [*Fusarium graminearum* Schwabe, Group II [teleomorph *Gibberella zeae* (Schwein.) Petch]] was assessed in an inoculated nursery near Minto, MB. The stem rust races were representative of naturally occurring races (Fetch 2005), as were the races of leaf rust (McCallum and

Table 1. Grain yield (least squares means) of Brigade and check cultivars in the Durum Cooperative Test, 2005 to 2007

	2005			2006			2007			2005–2007 means		
	Zone 1 ^z	Zone 2	Mean	Zone 1	Zone 2	Mean	Zone 1	Zone 2	Mean	Zone1	Zone2	All
	(kg ha ⁻¹)											
AC Avonlea	4580	4690	4660	4200	4070	4130	3090	3290	3240	3890	4050	4010
AC Morse	3980	4410	4260	4570	4050	4270	3300	3480	3420	3870	4030	3990
AC Navigator	3800	4860	4470	4430	4410	4420	3150	3420	3340	3710	4260	4080
Strongfield	5070	5040	5050	4500	4390	4430	3420	3410	3410	4250	4310	4300
Commander	3590	4710	4300	4520	4570	4550	3370	3610	3540	3730	4330	4140
Brigade	5940	5080	5400	4560	4350	4440	3250	3360	3330	4510	4290	4390
LSD _{.05}	560	320	370	430	270	240	320	190	180	760	290	420
No. tests	4	7	11	5	7	12	3	8	11	12	22	34

^zZone 1 (Black Soils): Indian Head, Souris, Glenlea (2005 abandoned 2007 not seeded), Brandon, Langdon (2007 excluded due to high cv).

Zone 2 (Brown and Dark Brown Soils): Swift Current, Stewart Valley, Saskatoon, Regina, Lethbridge, Irricana (2005), Biesecker (2006 and 2007), Shouldice (2005), Vanguard (2007), Avonlea (2006 and 2007).

Table 2. Agronomic characteristics (least squares means) of Brigade and check cultivars in the Durum Cooperative Test, 2005 to 2007

	Days to maturity			Test weight			1000- kernel wt g	Height cm	Lodging 1–9 ^y
	Zone 1 ^z	Zone 2	Mean	Zone 1	Zone 2	Mean			
	(kg hL ⁻¹)								
AC Avonlea	96	104	101	75.6	78.9	77.9	40.4	94	3.2
AC Morse	96	104	101	74.2	78.2	77.0	39.7	89	2.4
AC Navigator	98	106	103	75.5	80.0	78.5	41.1	79	2.5
Strongfield	97	104	102	76.8	79.8	78.8	40.3	92	3.1
Commander	97	105	102	74.6	79.1	77.6	41.6	76	2.0
Brigade	99	106	104	76.9	80.1	79.1	41.4	98	2.6
LSD _{.05}	2	1	1	1.3	0.6	0.8	1.5	2	0.8
# Tests	10	17	27	13	22	35	35	35	12

^zZone 1 (Black Soils): Indian Head, Souris, Glenlea (2005 abandoned 2007 not seeded), Brandon, Langdon.

Zone 2 (Brown and Dark Brown Soils): Swift Current, Stewart Valley, Saskatoon, Regina, Lethbridge, Irricana (2005), Biesecker (2006 and 2007), Shouldice (2005), Vanguard (2007), Avonlea (2006 and 2007).

^y1 = no lodging, 9 = completely lodged.

Table 3. Grain protein concentration (expressed on 13.5% moisture basis) measured on composites of replications within locations, and grain pigment concentration, semolina yield and gluten index measured on composites of locations of Brigade and checks from the 2005 to 2007 Durum Cooperative tests

	Protein concentration							Pigment (mg kg ⁻¹)	Semolina yield (%)	Gluten index (%)
	2005		2006		2007					
	Zone 1 ^z	Zone 2	Zone 1	Zone 2	Zone1	Zone 2	Mean			
	(g kg ⁻¹)									
AC Avonlea	155	144	151	143	158	142	144	8.36	65.7	35
AC Morse	147	139	145	142	152	135	139	8.47	65.3	59
AC Navigator	142	137	142	134	148	138	137	9.67	66.8	77
Strongfield	160	143	149	142	160	142	144	8.81	65.3	75
Commander	146	138	143	137	147	137	138	9.93	66.7	95
Brigade	140	135	149	135	150	137	137	9.78	65.3	95
LSD _{.05}	7	6	8	5	6	4	3	0.36	0.8	5
No. tests	3	7	4	7	3	8	32	3	3	3

^zZone 1 (Black Soils): Indian Head, Souris, Glenlea (2005 abandoned 2007 not seeded), Brandon.

Zone 2 (Brown and Dark Brown Soils): Swift Current, Stewart Valley, Saskatoon, Regina, Lethbridge, Irricana (2005), Biesecker (2006 and 2007), Shouldice (2005), Vanguard (2007), Avonlea (2006 and 2007).

Table 4. Summary of disease reactions of Brigade and check cultivars grown in the Durum Cooperative Test, 2005 to 2007

Cultivar		Stem rust	Leaf rust	Common bunt	Loose smut	Leaf spots	FHB Index and Reaction Type				
							Carman		Glenlea		
AC Avonlea	2005	R ^z	R ^z	MR-I ^z	73.0 ^x	S ^z	7.3 ^y	31.3 ^w	MS ^z	-	-
	2006	R	R	VR	0.0	R	7.0	45.7	S	67.5 ^y	S ^z
	2007	VR	R	VR	83.3	S	8.8	39.3	MS	43.0	S
AC Morse	2005	R	R	R	60.0	MS	7.0	51.2	S	-	-
	2006	R	R	VR	45.0	I	8.0	30.0	I	68.3	S
	2007	VR	R	VR	89.7	S	8.3	37.8	MS	42.5	S
AC Navigator	2005	R	R	R	-	-	7.2	29.3	MS	-	-
	2006	R	R	VR	48.0	I	8.0	29.5	I	63.0	S
	2007	VR	R	VR	50.0	I	8.5	36.6	MS	54.4	S
Strongfield	2005	R	R	R	38.7	I	6.7	24.8	MS	-	-
	2006	R	R	VR	-	-	7.5	39.8	MS	47.3	MS
	2007	VR	R	VR	20.5	MR	7.5	48.6	S	60.1	S
Commander	2005	R	R	R	63.6	MS	6.0	34.1	MS	-	-
	2006	R	R	VR	0.0	R	7.0	33.5	MS	42.0	S
	2007	VR	R	VR	100.0	S	8.5	43.7	MS	63.8	S
Brigade	2005	R	R	R	28.6	MR	6.0	8.2	MR	-	-
	2006	R	R	VR	87.2	S	7.0	14.3	MR	48.8	MS
	2007	VR	R	VR	73.7	MS	8.3	27.6	I	34.9	MS

^zReaction type: VR, very resistant; R, resistant; MR, moderately resistant; I, intermediate; MS, moderately susceptible; S, susceptible.

^yAdult plant, rated mid-grainfill at Swift Current (2005 and 2006) and Saskatoon (2007) a scale 0 = no symptoms, 11 = severe symptoms (McFadden 1991).

^x% incidence.

^wFusarium head blight index based on three replications: (% infected spikelets × % infected heads)/100; LSD_{.05}:8.0 (2005), 10.2 (2006), 14.7 (2007).

^vFusarium head blight index based on 2 replications (1 for Commander); LSD_{.05}:31.4 (2006), 35.9 (2007).

Setoh-Goh 2006). Races T26, T32 and T33 of loose smut [*Ustilago tritici* (Pers.) Rostr.] and races L1, L16, T1, T6, T13, and T19 of common bunt [*Tilletia laevis* Kuhn in Rabenh., and *T. tritici* (Bjerk.) G. Wint. in Rabenh.] were used to screen Durum Cooperative Test entries. The race designations are those described by Roelfs and Martens (1988) for stem rust, Long and Kolmer (1989) for leaf rust, Hoffmann and Metzger (1976) for common bunt, and Nielsen (1987) for loose smut. The Cooperative Test entries were screened in inoculated nurseries for the rusts, loose smut and fusarium near Glenlea, fusarium near Carman, MB, and for common bunt near Lethbridge, AB.

An F₅-derived F₈ line designated A9909-HD3D was advanced to the Durum Central A Test in 2003, and to the Durum B test in 2004, each grown at six locations in Alberta, Saskatchewan and Manitoba. From 2005 to 2007, A9909-HD3D was assessed in the Durum Cooperative Test as DT773. The 137 breeder lines originate from 144 plant rows grown in 2006, which in turn originate from F₅-derived F₁₀ plants in 2005.

Performance

On average Brigade yielded similar to the checks Commander, Strongfield and AC Navigator, and slightly more than AC Avonlea and AC Morse in the main durum production area (Zone 2) in 3 yr of cooperative testing (Table 1). Brigade had significantly ($P < 0.05$) higher yield than all of the checks in 2005 in Zone 1. In 2006 and 2007 yield of Brigade in Zone 1 was similar to the other checks, so did not differ significantly from the checks for yields averaged over the 3 yr. Maturity of Brigade was 1 d later than AC Navigator, 2 d later than Commander, and 3 d later than the other checks in the Brown and Dark Brown Soil Zones (Table 2). Test weight of Brigade was significantly higher ($P < 0.05$) than the other checks except Strongfield and AC Navigator. Brigade was 4 cm taller than AC Avonlea and 6 cm taller than Strongfield, but had slightly stronger straw.

Grain protein concentration of Brigade was similar to the strong gluten check Commander, and lower than AC Avonlea and Strongfield (Table 3). Brigade had high pigment concentration similar to AC Navigator and Commander and significantly greater ($P < 0.05$) than the other checks. Brigade had strong gluten, with gluten index similar to Commander and significantly greater ($P < 0.05$) than all of the other checks. Semolina yield of Brigade was similar to Strongfield.

Brigade is resistant to leaf and stem rust, and has a very resistant common bunt reaction similar to the checks, and is susceptible to loose smut races prevalent in western Canada (Table 4). Three years of testing indicated that Brigade has leaf spot [caused mainly by *Pyrenophora tritici-repentis* (Died.) Drechs. and *Stagonospora nodorum* (Berk.) Castellani & E.G. Germano] reaction (field rating of natural infection, primarily tan spot, in Saskatchewan) similar to Strongfield and

Commander, and slightly better than the other checks. Brigade had an FHB index lower than all of the checks in the Carman nursery and lower than the checks except Strongfield in 2006 in the Glenlea nursery.

Brigade had low grain cadmium concentration similar to Strongfield (Clarke et al. 2005; data not shown), and no DNA fragment is amplified with the OPC-20 cadmium marker described by Penner et al. (1995), indicating that it has the low cadmium allele described by Clarke et al. (1997).

Other Characteristics

SPIKES: Tapering, mid-dense, mid-long, erect; black awns; glumes mid-wide, mid-long, glabrous, white; glume shoulders straight to slightly sloping, some elevated; glume beak slightly curved to straight.

KERNEL: Colour amber; mid-size to large, elliptical; cheeks angular; crease mid-deep, mid-wide; brush small, short; embryo large, oval.

END-USE SUITABILITY: Eligible for the Canada Western Amber Durum wheat market class.

Maintenance and Distribution of Pedigreed Seed

Breeder seed will be maintained by the Seed Increase Unit, Agriculture and Agri-Food Canada, Indian Head, Saskatchewan, Canada S0G 2K0. Distribution and multiplication of pedigreed seed stocks will be handled by Viterra, 2625 Victoria Avenue Regina, Saskatchewan, Canada S4T 7T9.

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