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CULTIVAR DESCRIPTION

CDC Alloy durum wheat

C.J. Pozniak and J.M. Clarke

Abstract: CDC Alloy durum wheat is adapted to the durum production area of the Canadian prairies. This conventional height durum wheat cultivar combines high grain yield potential with high grain pigment and protein concentrations and low grain cadmium. CDC Alloy is resistant to prevalent races of leaf, stem and stripe rust, and common bunt and expresses end-use quality suitable for the Canada Western Amber Durum (CWAD) class.

Key words: Triticum turgidum L. var *durum*, durum wheat, yield, yellow pigment, cultivar description.

Résumé : La variété de blé dur CDC Alloy est bien acclimatée à la région des Prairies canadiennes où l'on cultive le blé dur. Ce cultivar de taille ordinaire combine un rendement grainier potentiel élevé à un grain très pigmenté et très riche en protéines, mais contenant peu de cadmium. CDC Alloy résiste aux races courantes de la rouille de la feuille, de la rouille de la tige et de la rouille jaune ainsi qu'à la carie. Sa qualité en fonction de l'usage final classe la variété dans la catégorie du blé dur ambré de l'Ouest canadien (CWAD). [Traduit par la Rédaction]

Mots-clés : Triticum turgidum L. var *durum*, blé dur, rendement, pigment jaune, description de cultivar.

Introduction

CDC Alloy, a spring durum wheat (*Triticum turgidum* L. var. *durum*), was developed at the Crop Development Centre (CDC), University of Saskatchewan, Saskatoon, SK, and received registration No. 7831 from the Canadian Food Inspection Agency (CFIA) on 16 Oct. 2015. Plant Breeders' Rights protection has been filed with the CFIA (No. 15-8659).

Pedigree and Breeding Method

CDC Alloy is derived from the cross Strongfield/Brigade made at the CDC in the summer of 2006. Strongfield (Clarke et al. 2005) and Brigade (Clarke et al. 2009) are registered Canadian cultivars. The F_1 generation was increased at a contra-season nursery in New Zealand and the resulting F_2 plants were grown in a space-planted nursery at Saskatoon, SK in 2007. More than 300 single F_2 spikes were selected and the F_3 and F_4 generations were increased in the greenhouse using the single seed descent method. In 2008, $F_{4:5}$ rows were planted at Saskatoon and the line D06X.29.107 was identified as having acceptable plant height, maturity, and straw strength. In 2009, D06X.29.107 was evaluated in un-replicated F_6 yield trials conducted at Saskatoon. Quality evaluations on F_6 harvested seed indicated appropriate yellow pigment, and acceptable grain protein concentration and gluten strength for the CWAD class. In the same year, resistance to leaf rust (caused by *Puccinia triticina* Eriks.) and Fusarium head blight (FHB, caused by *Fusarium graninearum* Schwabe) were evaluated in inoculated nurseries at Saskatoon, and Carman, MB, respectively. The rust races used in the nursery were representative of those found in disease surveys the previous year (Fetch 2009; McCallum and Seto-Goh 2008, 2009). In 2010, D06X.29.107 was evaluated for agronomic traits in replicated yield trials in the Saskatoon area at the University of Saskatchewan Kernen and Goodale farms, Swift Current, SK, Moose Jaw, SK, and Elrose, SK. Leaf spot reaction, primarily caused by tan spot (*Pyrenophora tritici-repentis* Died.) and septoria (*Septoria tritici* Roberge in Desmaz.), was noted in trials from Kernen, Goodale, and Swift Current. End-use quality evaluations (grain protein content, yellow pigment content, gluten strength, and milling potential) were conducted on an equal-weight composite sample from each environment. In the same year, resistance to leaf rusts and FHB were evaluated in inoculated nurseries at Saskatoon, and Carman, respectively. DNA marker testing in the F_7 generation with *usw47* (Wiebe et al. 2010) was conducted and confirmed

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Table 1. Grain yield (kg ha^{-1}) of CDC Alloy and check cultivars in the Durum Wheat Cooperative Registration Trial 2012–2014[a].

	2012			2013			2014			2012–2014			2013–2014		
	Black	Brown	Mean	Black	Brown	Mean	Black	Brown	Mean	Black	Brown	Mean	Black	Brown	Mean
Brigade	—	—	—	4891	5156	5108	5170	4173	4375	—	—	—	5008	4653	4725
AAC Cabri	3070	3822	3595	4619	4951	4891	5078	3874	4113	4243	4240	4219	4874	4415	4509
AC Navigator	2138	3055	2780	3556	4540	4367	4045	3349	3490	3195	3685	3569	3777	3975	3949
Strongfield	2934	3359	3232	4174	4816	4701	4896	3748	3978	3996	3992	3987	4561	4302	4350
CDC Alloy	3227	3927	3713	4730	4955	4911	5313	4067	4315	4411	4323	4327	5063	4488	4603
$LSD_{0.05}$	472	382	308	668	245	240	761	356	334	249	355	234	553	301	267
No. of tests	3	7	10	2	9	11	2	8	10	7	24	31	4	17	21

[a]Black soils: Indian Head, SK; Brandon and Souris, MB (2012); Brown and Dark Brown soils: Moose Jaw (2012, 2013), Pense (2014), Regina (2012), Scott, Saskatoon, Stewart Valley, Swift Current, Vanguard (2013, 2014), SK; Lethbridge, Vulcan, AB.

that D06X.29.107 carries the allele for low grain cadmium concentration.

In 2011, D06X.29.107 was evaluated at Swift Current, Regina, SK, Lethbridge, AB, and Kernen, Goodale, and Brandon, MB (site abandoned) in the Durum Wheat B Test (and associated disease nurseries) and advanced after evaluation of end-use functionality on composite samples. D06X.29.107 was evaluated as DT579 in the Durum Wheat Cooperative Registration Trial over 3 yr (2012–2014). The variables measured and the operating protocols followed in the Durum Wheat Cooperative Registration Trial were those approved each year by the Prairie Recommending Committee for Wheat Rye and Triticale (current operating procedures can be found at http://www.pgdc.ca/committees_wrt.html). In agronomic performance trials, the check cultivars over all 3 yr of trialing were Strongfield, AC Navigator (Clarke et al. 2000), and AAC Cabri. Brigade was added as a check in 2013. In cooperative trials, the stem rust races were TPMK, TMRT, RHTS, QTHS, RTHJ, RKQS, and MCCF (Roelfs and Martens 1988; Fetch et al. 2011). The leaf rust inoculum comprised a mixture of prevalent races isolated from the western Canadian prairies as determined from yearly survey studies (McCallum et al. 2010, 2011, 2013). Resistance to races T26, T32, and T33 of loose smut (*Ustilago tritici* (Pers.) Rostr.) (Nielsen 1987) and L1, L16, T1, T6, T13, and T19 of common bunt (*Tilletia laevis* Kühn in Rabenh., and *T. tritici* (Bjerk.) G. Winter in Rabenh.) (Hoffman and Metzger 1976) were evaluated in the Durum Registration Trials. End-use quality was assessed at the Grain Research Laboratory, Canadian Grain Commission using approved methods (AACC 2000) each year on composite grain samples from all locations with acceptable physical condition (grade Canada Western Amber Durum #3 or better) to give a target grain protein concentration of 13%.

Data presented here were analyzed using SAS PROC MIXED (Littell et al. 2006), with replications, sub-blocks, zones, locations, and years considered as random effects, and entries considered fixed. The *diff* command was used to estimate the standard error of the difference between entries, which in turn was used to estimate an F-protected least significant difference (LSD) at a significance level of 5% ($LSD_{0.05}$). For end-use quality data, years were considered as replications.

Performance

Agronomy: Averaged over 31 station-years, CDC Alloy yielded 9% more than Strongfield, 21% more than AC Navigator, and 3% more than AAC Cabri (Table 1). CDC Alloy yielded approximately 3% less than Brigade in 2013–2014, but this difference was not statistically different ($P > 0.05$). CDC Alloy expresses conventional height similar to AAC Cabri, with lodging resistance intermediate to Brigade and Strongfield (Table 2). Maturity of CDC Alloy was similar to Strongfield and test weight was similar to the highest checks Brigade and AAC Cabri. Kernel

Table 2. Agronomic performance of CDC Alloy and check cultivars in the Durum Wheat Cooperative Registration Trial 2012–2014[a].

	Maturity (d)			Test weight (kg hL^{-1})			1000-kernel		
	Black	Brown	Mean	Black	Brown	Mean	weight (g)	Height (cm)	Lodging (1–9)
Brigade	98	106	105	75.3	79.6	78.7	41.4	103	2.1
AAC Cabri	97	105	105	75.9	79.5	78.6	39.3	97	3.0
AC Navigator	97	105	103	72.9	78.4	77.2	42.3	81	1.8
Strongfield	97	104	102	75.4	78.5	77.7	39.8	93	2.9
CDC Alloy	97	104	103	76.4	79.7	78.9	39.4	97	2.5
$LSD_{0.05}$	2	1	1	1.2	0.8	0.7	1.1	2	0.9
No. of tests	6	19	25	6	24	30	30	30	15

[a]Black soils: Indian Head, SK; Brandon and Souris, MB (2012); Brown and Dark Brown soils: Moose Jaw (2012, 2013), Pense (2014), Regina (2012), Scott, Saskatoon, Stewart Valley, Swift Current, Vanguard (2013, 2014), SK; Lethbridge, Vulcan, AB.

Table 3. Grain protein concentration (%) of CDC Alloy compared with check cultivars in the Durum Wheat Cooperative Registration Trial 2012–2014[a].

	2012			2013			2014			2012–2014	2013–2014
	Black	Brown	Mean	Black	Brown	Mean	Black	Brown	Mean	Mean	Mean
Brigade	—	—	—	12.7	12.7	12.7	12.8	13.0	12.9	—	12.9
AAC Cabri	16.0	14.2	14.8	13.9	13.1	13.3	13.5	13.9	13.8	14.1	13.5
AC Navigator	15.3	14.3	14.6	13.5	12.9	13.0	12.8	13.3	13.2	13.8	13.1
Strongfield	16.2	14.9	15.3	14.7	13.6	13.8	13.5	13.9	13.8	14.5	13.9
CDC Alloy	15.8	13.9	14.5	14.0	13.1	13.2	12.5	13.5	13.4	13.9	13.3
$LSD_{0.05}$	0.9	0.6	0.5	1.2	0.4	0.4	NA	0.6	0.6	0.3	0.3
No. of tests	3	7	10	2	9	11	1	8	9	30	20

[a]Indian Head, SK; Brandon and Souris, MB (2012); Brown and Dark Brown soils: Moose Jaw (2012, 2013), Pense (2014), Regina (2012), Scott, Saskatoon, Stewart Valley, Swift Current, Vanguard (2013, 2014), SK; Lethbridge, Vulcan, AB.

weight was within the range of the checks. Grain protein concentration of CDC Alloy was similar to AC Navigator over the 3 y, higher than Brigade in 2013–2014, and lower than the other checks (Table 3).

Disease: CDC Alloy was resistant to prevalent races of leaf and stem rust, and has excellent common bunt resistance, similar to the checks. Leaf spot reaction was similar to the most resistant checks, and loose smut reaction was similar to the checks (Table 4). FHB reaction and DON accumulation of CDC Alloy was within the range of the check cultivars (Table 4).

End-use Suitability: Grain protein concentration of CDC Alloy was slightly higher than Brigade and AC Navigator in the field (Table 3) and composite samples (Table 5). CDC Alloy has low cadmium concentration like Strongfield, but expresses yellow pigment higher than all of the check cultivars. The high yellow pigment was reflected in significantly greater pasta b* values than all of the checks except AAC Cabri. The average falling number of CDC Alloy was similar to Strongfield. CDC Alloy is a conventional gluten strength type, with gluten index and alveograph parameters similar to AC Navigator. Semolina milling yield and semolina ash content were within the range of the check cultivars.

Other Characteristics

SPIKES: Spikes of CDC Alloy are parallel-sided, medium density, medium length and erect, with a waxy bloom similar to Strongfield. Spikes express white awns that are longer than the spike; the width of the lower glumes is narrow to medium in width, while glumes are mid-long and glabrous; glume shoulders are elevated and are narrow; the glume beak is slightly curved; the lemma beak is straight to slightly curved.

KERNELS: Kernels are amber in color, medium sized, and elliptical; cheeks are slightly angular; crease is mid-deep, and mid-wide to wide; brush is short; embryo is medium sized.

END-USE SUITABILITY: CDC Alloy is eligible for grades of the Canada Western Amber Durum wheat class.

Maintenance and Distribution of Pedigreed Seed

Approximately 190 single spikes of CDC Alloy were selected from a F_9 increase grown at Saskatoon in 2012.

Table 4. Disease reactions of CDC Alloy and check cultivars grown in the Durum Wheat Cooperative Registration Trial 2012–2014.

Year	Entry	Stem rust	Leaf rust	Stripe rust	Common bunt	Loose smut	Leaf spots[a]	FHB index[b]		DON[c] (mg kg^{-1})
								Carman	Glenlea	
2012	Brigade	—	—	—	—	—	—	—	—	—
	AAC Cabri	25MR	0R	0VR	R	MR	8.0	56.5S	27.5MS	10.3
	AC Navigator	30I	0R	1VR	R	I	10.0	65.5S	10.2I	33.7
	Strongfield	15MR	0R	2R	R	MR	7.8	54.5MS	11.7I	12.5
	CDC Alloy	20MR	0R	0VR	R	I	8.0	47.2MS	21.0S	12.4
2013	Brigade	1R	0R	15R	R	R	8.3	22.7MR	7.0	—
	AAC Cabri	1R	0R	10R	R	R	7.8	33.8I	15.3	—
	AC Navigator	5MR	0R	60S	R	MR	9.3	50.5S	8.7	—
	Strongfield	1R	0R	15R	R	R	8.3	30.0I	10.3	—
	CDC Alloy	5MR	0R	15R	R	MR	8.5	40.0I	11.0	—
2014	Brigade	1R	0R	25MR	R	R	8.5	18.8I	—	30
	AAC Cabri	1R	0R	10MR	R	R	8.5	32.3MS	—	32
	AC Navigator	1R	0R	5R	R	R	9.8	56.2S	—	42
	Strongfield	1R	0R	1R	R	MR	8.8	39.8MS	—	35
	CDC Alloy	1R	0R	5R	R	MR	8.5	26.3I	—	27

Note: VR, very resistant; R, resistant; MR, moderately resistant; I, intermediate resistance; MS, moderately susceptible; S, susceptible.
[a]Adult plant rated at mid-grain fill at Swift Current, using the McFadden Scale where <5 = 6, 6 = MR, 7 = I, 8–9 = MS, and S = 10–11.
[b]Fusarium head blight index: (% infected spikelets × % infected heads)/100. Indices are averages from replicated trials at Carman and Glenlea, MB.
[c]Deoxynivalenol measured on composites of replications at Glenlea in 2012 and Carman in 2014.

Table 5. Average values for quality traits measured on yearly composite samples of CDC Alloy and check cultivars evaluated in the 2012–2014 Durum Wheat Cooperative Registration Trial.

	Grain protein (%)	FN[a] (s)	Yellow pigment (ppm)	Semolina				GI[b] (%)	Pasta (b*)	Alveograph				Grain Cd (ppm)
				Protein (%)	b*	Yield (%)	Ash (%)			P (mm)	W (10^{-4} J)	L (mm)	P/L	
Brigade	12.9	393	10.2	11.8	32.4	66.1	0.68	89	63.7	82	248	94	0.88	0.070
AAC Cabri	13.5	393	10.3	12.4	33.1	66.7	0.65	67	65.5	79	205	89	0.52	0.064
AC Navigator	13.0	412	10.2	12.1	32.3	67.8	0.70	78	64.0	57	162	111	0.91	0.224
Strongfield	13.8	365	9.2	12.8	31.1	66.3	0.63	70	62.9	67	183	90	0.76	0.078
CDC Alloy	13.2	367	10.8	12.1	33.4	66.8	0.68	80	65.1	75	207	91	0.84	0.070
$LSD_{0.05}$	0.3	43	0.3	0.3	0.7	0.6	0.02	8	1.0	8	24	13	0.15	0.012

[a]FN, falling number.
[b]GI, gluten index.

The $F_{9:10}$ spikes were threshed and grown as single 1 m row plots in 2013 and off-type rows discarded. The remaining head rows were harvested individually and used to establish one hundred and seventy-seven 27 m rows in 2014. Again, off type rows were discarded and the remaining rows bulk harvested to produce Breeder Seed. In total, 157 $F_{9:11}$ breeder lines were composited to form the Breeder Seed. CDC Alloy consists of a composite of 157 $F_{9:11}$ breeder lines. Breeder seed will be maintained by the Crop Development Centre, University of Saskatchewan, Saskatoon, SK S7N 5A8, Canada. CDC Alloy will be added to the Organisation for Economic Co-operation and Development list of cultivars. Distribution and multiplication of pedigreed seed stocks will be handled by FP Genetics, 426 McDonald Street, Regina, SK S4N 6E1, Canada. Commercial launch of CDC Alloy is anticipated in 2017.

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