CULTIVAR DESCRIPTION

Pintail general purpose winter wheat

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Salmon, D. F., Helm, J. H., Graf, R. J., Albers, S., Aljarrah, M., Xi, K., Oro, M., Lohr, S. and Bergen, C. 2015. **Pintail general purpose winter wheat**. Can. J. Plant Sci. **95**: 1271–1276. Pintail is an awnless hard red winter wheat (*Triticum aestivum* L.) cultivar that was registered in 2012 and is eligible for grades of Canada Western General Purpose (CWGP) wheat. It was developed using wheat × maize-pollen doubled haploid techniques. Evaluated across western Canada from 2008 to 2010 relative to CDC Harrier, CDC Falcon and CDC Ptarmigan, Pintail expressed grain yield ranging from 98.6 to 105.8% of these CWGP wheat checks. Its area of greatest adaptation was in the parkland and semi-arid prairie regions of Alberta and western Saskatchewan, where cold tolerance is a primary concern. Pintail exhibited excellent winter survival, intermediate maturity, medium height and strong straw. Test weight was within the range of the checks, and kernel weight was lower than all of the checks. Pintail displayed moderate resistance to stripe rust, moderate susceptibility to stem and leaf rust, and susceptibility to common bunt and *Fusarium* head blight. The high yield and awnless spike of Pintail should make it particularly attractive in various livestock feed and forage applications.

Key words: *Triticum aestivum* L., wheat (winter), cultivar description, doubled haploid, grain yield, cold hardiness, stripe rust

Salmon, D. F., Helm, J. H., Graf, R. J., Albers, S., Aljarrah, M., Xi, K., Oro, M., Lohr, S. et Bergen, C. 2015. **Le blé d'hiver d'usage général Pintail**. Can. J. Plant Sci. **95**: 1271–1276. Pintail est une variété non barbue de blé roux vitreux d'hiver (*Triticum aestivum* L.) homologuée en 2012 et admissible à la catégorie « blé à des fins générales de l'Ouest canadien » (CWGP). Elle a été créée par la technique d'haploïdie double avec du pollen de blé et de maïs. Le cultivar a été évalué dans l'Ouest canadien de 2008 à 2010 et comparé aux variétés CDC Harrier, CDC Falcon et CDC Ptarmigan. Pintail donne un rendement grainier qui se situe entre 98,6 % et 105,8 % de celui des témoins CWGP précités. La variété est particulièrement bien adaptée aux régions des prairies-parcs et des prairies semi-arides de l'Alberta et de l'ouest de la Saskatchewan, où la tolérance au froid est une des grandes préoccupations. Pintail se caractérise par une excellente survie à l'hiver, une maturité intermédiaire, une hauteur moyenne et une paille robuste. Son poids spécifique reste dans la gamme des variétés témoins bien que son grain soit plus léger. Pintail affiche une résistance modérée à la rouille jaune, est modérément sensible à la rouille de la tige et des feuilles, et est sensible à la carie de même qu'à la brûlure de l'épi causée par *Fusarium*. Son rendement élevé et ses épillets glabres rendent la variété particulièrement attrayante comme fourrage ou aliment du bétail.

Mots clés: *Triticum aestivum* L., blé (d'hiver), description de cultivar, haploïde double, rendement grainier, rusticité, rouille jaune

Pintail general purpose winter wheat (*Triticum aestivum* L.) was developed by the Field Crop Development Centre (FCDC), Alberta Agriculture and Rural Development (AARD) in Lacombe, AB. Pintail was recommended for registration by the Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT) in February 2011 and was granted registration no. 7187 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 2012 Apr. 23. Plant Breeders' Rights Certificate no. 4651 was issued on 2013 Nov 22.

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High grain yield, excellent winter survival, improved agronomic traits and resistance to stripe rust make Pintail well-suited to the western prairie production environment. Pintail is the first winter wheat cultivar developed and registered by AARD-FCDC and is a testament to the tenacity of wheat and triticale breeder Dr. Donald F. Salmon (1951–2010), who passed away unexpectedly during its final year of registration testing. The name of this cultivar acknowledges the important role that winter wheat and other fall-seeded cereals play in creating habitat for the successful nesting of northern pintail ducks (*Anas acuta* L.) and other prairie wetland waterfowl.

Pedigree and Breeding Method

Pintail is an F_1-derived doubled haploid (DH) cultivar produced from the complex cross 93W022/CDC

Kestrel//CDC Clair/3/AC Readymade/4/83W020007/5/CDC Harrier completed in 1998 at the AARD-FCDC in Lacombe. CDC Kestrel (Fowler 1997b), CDC Clair (Fowler 1997a), and CDC Harrier (Fowler 1999b) are hard red winter wheat cultivars developed by the University of Saskatchewan Crop Development Centre, recently moved from the Canada Western Red Winter (CWRW) to the Canada Western General Purpose (CWGP) wheat class. AC Readymade is a CWRW wheat cultivar developed by Agriculture and Agri-Food Canada (AAFC) at Lethbridge, AB (Thomas and Graf 2012a). The lines 93W022 and 83W020007 are germplasm developed by AARD-FCDC. 93W022 has complex parentage related to Norstar (Grant 1980) and Norwin (Taylor et al. 1986); 83W020007 was a hard white winter wheat line that was tested as W349 in the Western Winter Wheat Cooperative (WWWC) registration trial in 1999 and originated from a cross between a winter wheat composite selection '78W005002' and Norstar.

During increase of the F_1 seed in a growth room, desirable plants were selected for DH production using standard wheat × maize-pollen hybridization methods (Fedak et al. 1997; Knox et al. 2000). The resulting DH lines were first increased in growth rooms in 2001 and then evaluated in field screening rows at Lacombe in 2002 in which selection was based on winter survival, plant type, and resistance to prevalent diseases. From 2003 to 2007, numerous selections were evaluated in replicated agronomic trials, first in Alberta and then across western Canada. Disease resistance screening included stem rust (*Puccinia graminis* Pers.: Pers. f.sp. *tritici* Eriks. & E. Henn.) and leaf rust (*P. triticina* Eriks.) rating in an inoculated nursery in Winnipeg, MB, by staff of the University of Manitoba. Stripe rust (*P. striiformis* Westend.) resistance was evaluated in naturally infected seed increase plots grown at Hermiston, OR, USA, in cooperation with Oregon State University. Resistance to common bunt [*Tilletia tritici* (Bjerk.) G. Wint. in Rabenh. and *T. laevis* Kühn in Rabenh.] was estimated in Lethbridge by planting inoculated seed into cold soil in mid-October, in cooperation with the AAFC Lethbridge Research Centre (LRC). Based on several site-years of favourable agronomic performance and good stripe rust resistance, a line designated 00H050 was entered into the WWWC registration trial as W460 and grown for 3 yr (2008–2010).

Evaluation of suitability for registration in the WWWC registration trials was relative to CDC Harrier, CDC Falcon (Fowler 1999a) and CDC Ptarmigan (Fowler 2010), the designated CWGP check cultivars. The agronomic trials were grown in Alberta (Beaverlodge, Lacombe, Lethbridge "dry land", Lethbridge "irrigated", Olds, Vauxhall, Warner), Saskatchewan (Indian Head, Melfort, Saskatoon, Swift Current), and Manitoba (Brandon, Carman, Winnipeg) through the collaborative efforts of AAFC, AARD, the University of Saskatchewan, and the University of Manitoba. Analyses of variance were conducted using a combined mixed effects model where environments were considered random and genotypes were fixed. The least significant difference (LSD) test was used to identify significant differences in the means compared with the check cultivars.

During registration testing, reactions to the major diseases of economic importance to winter wheat in both the eastern and western prairies were determined by personnel at the University of Manitoba and AAFC. Supplementary checks were added as required to aid in these assessments. The adult plant reactions to stem and leaf rust were determined in artificially inoculated field nurseries conducted at the University of Manitoba in Winnipeg using race composites supplied by the AAFC Cereal Research Centre, and reported using the modified Cobb scale (Peterson et al. 1948). The stem rust races used for 1 or more years included: MCCFC (C17), QTHJC (C25), RHTSC (C20), RKQSC (C63), RTHJC (C57), TMRTC (C95) and TPMKC (C53) (Fetch 2005; Jin et al. 2008). Each year, the leaf rust races used for inoculation were a representative mixture collected in western Canada during the previous field season (McCallum et al. 2010, 2011). Stripe rust (*Puccinia striiformis* Westend.) ratings were determined under conditions of natural infection and in artificially inoculated nurseries conducted at AAFC LRC in 2010 (Puchalski and Gaudet 2011). Additional stripe rust resistance data for Pintail were collected at Pullman and Mount Vernon, WA, USA, through collaboration between AARD-FCDC and the United States Department of Agriculture, Agricultural Research Service. Estimates of common bunt reaction were taken in nurseries conducted by AAFC in Lethbridge by inoculating seed with a composite of races that included L1, L16, T1, T6, T13, and T19 (Hoffman and Metzger 1976; Gaudet and Puchalski 1989) prior to planting into cold soil at two locations in October. University of Manitoba staff assessed the response to FHB {caused by *Fusarium graminearum* Schwabe [teleomorph *Gibberella zeae* (Schwein.) Petch]} in a three-replicate, mist-irrigated field nursery in Carman. Each line was spray-inoculated with a suspension of *F. graminearum* macroconidia at 50% anthesis and again 3 to 4 d later. The spore suspension had a concentration of 50 000 macroconidia mL^{-1} and was prepared using equal quantities of two 3-acetyldeoxynivalenol (3-ADON) and two 15-acetyldeoxynivalenol (15-ADON) producing chemotypes. A visual index (% incidence × % severity/100) was used to rate the plants, typically 18 to 21 d after anthesis or when symptoms were well developed (Gilbert and Woods 2006; Cuthbert et al. 2007). Reactions to powdery mildew [*Blumeria graminis* (DC.) E.O. Speer] and unspecified leaf-spotting pathogens were recorded by trial collaborators at naturally infected test sites expressing differential symptoms.

The CWGP wheat class was established by the Canadian Grain Commission in 2008 to facilitate grain production from high-yielding cultivars that are of benefit to the livestock and bio-fuel industries. As such, the CWGP wheat class does not have any defined end-use quality parameters and hence precluded end-use

suitability analysis during registration testing. Test weight, kernel weight and grain protein concentration were determined as part of the agronomic assessment.

Performance

Data from across the Canadian prairies, collected at 25 sites over 3 yr (2008–2010), were used to establish the agronomic performance of Pintail relative to the CWGP winter wheat check cultivars CDC Harrier, CDC Falcon and CDC Ptarmigan. Fewer data points were available for CDC Ptarmigan because it was added as a check in 2009, 1 yr after Pintail began evaluation for registration. Data for Radiant (Thomas et al. 2012b), a CWRW wheat check in the WWWC registration trial, have also been reported as it has been a predominant winter wheat cultivar in the western prairies since the mid-2000s.

Across all sites over 3 yr, the average grain yield of Pintail was 103.6% of the CWGP check mean (NS), numerically higher than CDC Harrier (101.6%) (NS) and significantly greater than CDC Falcon (105.8%) ($P \leq 0.05$) (Table 1). Data collected for 2 yr showed that Pintail yielded 98.6% of CDC Ptarmigan (NS). Overall, Pintail was significantly higher yielding than Radiant (107.0%) ($P \leq 0.05$) CWRW wheat, but on a regional basis, significant differences over Radiant were only maintained in the eastern prairie rust hazard zone (zone 4), which includes Manitoba. Radiant is highly susceptible to stem and leaf rust (Table 3) and is therefore not well-suited for production in the eastern prairies.

Pintail exhibited better winter survival than all of the check cultivars, with statistical significance shown in all cases except when compared with CDC Harrier ($P \leq 0.05$) (Table 2). Examination of the yield data from the various agri-climatic zones across the Canadian prairies and on a provincial basis suggests that Pintail had its greatest advantage in areas of the western prairies where cold tolerance is a primary concern. Relative to the checks, Pintail yielded best in the parkland and semi-arid prairies (zones 2 and 3, respectively), where extreme cold in both regions and fluctuating temperature and snow cover in the latter, are often experienced. This hypothesis is supported by the change in ranking between Pintail and CDC Ptarmigan in Southern Alberta (zone 1), where realtively mild winter conditions may have fostered the high yield potential of CDC Ptarmigan to be more fully expressed. The prosaic yield performance of Pintail and CDC Ptarmigan in Manitoba, where snow cover normally insulates the crop from cold injury, could be the result of yield losses due to light infections of stem and leaf rust being partially compensated by greater yield potential, since both cultivars express poor resistance to these diseases under inoculated or epidemic conditions (Table 3).

Based on all available data, the heading date for Pintail was similar to CDC Harrier and CDC Ptarmigan (NS) and significantly later than Radiant (+1 d) and CDC Falcon (+3 d) ($P \leq 0.05$) (Table 2). Maturity was significantly later than CDC Falcon (+4 d) ($P \leq 0.05$) and

Table 1. Grain yield (t ha^{-1}) of Pintail and the check cultivars, Western Winter Wheat Cooperative registration trials (2008–2010)

				Grand mean		Zone 1[y]		Zone 2		Zone 3		Zone 4		Alberta		Saskatchewan		Manitoba	
Cultivar	2008[z]	2009	2010	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
CDC Harrier	6.01	5.69	5.73	5.71	5.79	5.98	6.13	5.11	5.03	4.53	–	6.24	6.18	5.63	5.76	6.31	6.07	5.32	5.62
CDC Falcon	6.12	4.96	5.65	5.34	5.56	5.81	6.09	4.98	4.97	3.62	–	5.70	5.75	5.47	5.72	5.50	5.48	4.87	5.17
CDC Ptarmigan	–	5.67	6.02	5.86	–	6.53	–	4.95	–	3.96	–	6.44	–	5.90	–	6.60	–	5.05	–
Radiant[x]	6.18	4.84	5.56	5.24	5.50	5.75	6.14	4.89	4.87	3.85	–	5.42	5.50	5.41	5.72	5.92	5.67	4.13	4.68
CWGP check mean[x]	6.06	5.44	5.80	5.64	5.68	6.10	6.11	5.01	5.00	4.04	–	6.13	5.96	5.67	5.74	6.13	5.78	5.08	5.39
Pintail	6.15	5.58	5.95	5.78	5.88	5.97	6.22	5.50	5.35	4.30	–	6.28	6.20	5.78	5.93	6.55	6.27	5.01	5.37
LSD ($P \leq 0.05$)[w]	0.50	0.45	0.55	0.37	0.29	0.75	0.51	0.83	0.60	0.53	–	0.56	0.49	0.55	0.39	0.66	0.63	0.65	0.60
No. of tests	7	8	10	18	25	6	10	4	5	2	–	6	8	10	15	4	5	4	5

[z]All means are weighted by the number of tests.
[y]Zone 1: Southern Alberta sites (Lethbridge "dry land", Lethbridge "irrigated", Vauxhall, Warner). Zone 2: Parkland sites (Beaverlodge, Lacombe, Olds, Melfort). Zone 3: Semi-arid prairie site (Swift Current). Zone 4: Eastern prairie rust-hazard sites (Brandon, Carman, Indian Head, Saskatoon, Winnipeg).
[x]Radiant was a CWRW wheat check and is therefore not included in the CWGP check mean.
[w]Least significant difference includes variation from the genotype by environment interaction.

Table 2. Agronomic characteristics of Pintail and the check cultivars, Western Winter Wheat Cooperative registration trials (2008–2010)

	Winter survival (%)		Heading[z] (%)		Maturity[z] (%)		Height[y] (%)		Lodging[x] (1–9)	
Cultivar	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr
CDC Harrier	84	87	175.8	176.1	219.9	219.4	99	97	2.9	3.2
CDC Falcon	80	84	173.1	173.2	216.7	216.1	77	77	2.2	2.6
CDC Ptarmigan	77	–	176.1	–	219.4	–	98	–	3.2	–
Radiant	80	83	175.2	175.3	221.8	221.1	94	92	2.2	2.4
CWGP check mean[w]	80	86	175.0	174.6	218.7	217.7	91	87	2.8	2.9
Pintail	87	90	176.4	176.4	220.2	220.1	91	90	3.0	3.2
LSD ($P \leq 0.05$)[v]	6	5	0.7	0.6	1.2	1.1	2	2	0.6	0.6
No. of tests	15	20	13	18	14	18	17	23	10	13

[z]Days to heading and maturity expressed as day of the year.
[y]Height measured from ground to tip of spike, excluding awns.
[x]Lodging scale: 1 = all plants vertical, 9 = all plants horizontal.
[w]Radiant is not included in the CWGP check mean.
[v]Least significant difference includes variation from the genotype by environment interaction.

similar to CDC Harrier, CDC Ptarmigan and Radiant (NS). Pintail was within the range of the checks for height, being significantly shorter than CDC Harrier (−7 cm), CDC Ptarmigan (−7 cm) and Radiant (−2 cm), but significantly taller than CDC Falcon (+13 cm) ($P \leq 0.05$). Resistance to lodging was similar to CDC Harrier and CDC Ptarmigan (NS) but inferior to CDC Falcon and Radiant ($P \leq 0.05$).

Pintail expressed variable reactions to stem and leaf rust during the 3 yr (2008–2010) of registration testing (Table 3) and was categorized as moderately susceptible to these diseases by the Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT) Disease Evaluation Team. Pintail was highly susceptible to common bunt, hence seed treatment with an effective fungicide is recommended in all areas of western Canada (Gaudet et al. 2013). The reactions to powdery mildew and leaf spotting pathogens were similar to the check cultivars. Stripe rust data for Pintail relative to susceptible checks at Pullman, Mt. Vernon and Lethbridge showed predominantly resistant to moderately resistant responses (Table 4). Pintail was rated susceptible to FHB in each of the 3 yr of visual ratings relative to several supplemental checks with long-term established reactions (Table 5).

The test weight of Pintail was within the range of the checks: significantly higher than CDC Ptarmigan ($P \leq 0.05$) and significantly lower ($P \leq 0.05$) than CDC Harrier, CDC Falcon and Radiant (Table 6). Kernel weight was significantly lower than all of the checks ($P \leq 0.05$), being most similar to CDC Falcon. The grain protein concentration of Pintail was significantly higher than CDC Ptarmigan ($P \leq 0.05$) and significantly lower ($P \leq 0.05$) than the remaining CWGP checks, which were selected

Table 3. Disease reactions of Pintail and the check cultivars, Western Winter Wheat Cooperative registration trials (2008–2010)

Disease	Year	CDC Harrier	CDC Falcon	CDC Ptarmigan	Radiant	Pintail
Stem rust[z]	2008	10 I	5 R-MR	–	50 S	tr R
	2009	20 I	20 MR	80 S	50 S	20 MS-S
	2010	5 R-MR	20 MR	70 S	40 S	30 I
Leaf rust[z]	2008	50 MS-S	10 MR	–	40 S	15 MS
	2009	30 MS-S	20 I	50 S	20 S	15 MR
	2010	35 MS	30 MR	40 MS-S	25 MS-S	40 MS
Common bunt[z]	2008	82 VS	58 VS	–	62 VS	45 VS
	2009	66 VS	46 VS	62 VS	39 S	68 VS
	2010	33 VS	33 VS	37 VS	29 MS	45 VS
Powdery mildew[y]	2008	3.0	3.0	–	4.0	2.7
	2009	3.3	2.7	3.0	2.7	3.0
	2010	4.2	1.5	3.7	4.4	3.8
Leaf spots[yx]	2009	3.3	2.7	1.5	3.2	2.5
	2010	3.7	3.0	3.0	3.3	2.7

[z]Percent infection and type of reaction: tr = trace, R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, S = susceptible, VS = very susceptible.
[y]Rated using a 1–9 scale: 1 = disease free, 9 = very severe symptoms.
[x]Specific leaf spotting pathogens were not determined.

Table 4. Stripe rust reactions of Pintail, check cultivars and supplementary checks, Western Winter Wheat Cooperative registration trials (Lethbridge 2010) and United States Department of Agriculture (Pullman and Mt. Vernon 2008–2010)

	2008				2009				2010				
	Pullman		Mt. Vernon		Pullman		Mt. Vernon		Pullman		Mt. Vernon		Lethbridge
	IT[z]	%[y]	IT	%	IT	%	IT	%	IT	%	IT	%	% and response[x]
CDC Harrier	–	–	–	–	–	–	–	–	–	–	–	–	75 S
CDC Falcon	5	30	5	40	5	30	3	10	–	–	–	–	25 I
CDC Ptarmigan	–	–	–	–	–	–	–	–	–	–	–	–	60 S
Radiant	5	40	–	–	7	80	3	10	–	–	–	–	30 I
Pintail	0	0	2	10	3	5	2	10	8	60	5	20	0 R
Supplementary and other checks													
CDC Osprey	5	60	–	–	7	60	2	10	8	60	5	40	50 S
AC Bellatrix	8	30	8	80	8	80	3	30	8	60	8	60	80 S
PS279	8	80	8	90	8	100	8	100	8	80	8	80	–

[z]IT = infection type: Rated using a 1–9 scale. 1 = most resistant, 9 = most susceptible. IT 8 and 9 combined as 8. IT 0–3 = resistant, IT 4–6 = intermediate, IT 7–9 = susceptible.
[y]% = percentage of leaf area infected.
[x]Disease response category: R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, S = susceptible.

Table 5. *Fusarium* head blight (FHB) reaction of Pintail, check cultivars and supplementary checks, Western Winter Wheat Cooperative registration trials (2008–2010)

	Visual rating[z] (index and response[y])				
	2008	2009	2010	2 yr	3 yr
CDC Harrier	14 MR	6 R	22 I	14	14
CDC Falcon	53 S	51 S	36 MS	43	46
CDC Ptarmigan	–	15 MR	35 MS	25	–
Radiant	45 MS	46 S	22 I	34	37
Pintail	68 S	46 S	55 S	50	56
Supplementary checks[x]					
FHB148	5 R	6 R	5 R	5	5
Freedom	24 I	13 MR	14 MR	14	17
DH01W43I*45	17 MR	15 I	26 I	21	20
Caledonia	68 S	41 S	37 MS	39	49
Hanover	75 S	42 S	59 S	50	59

[z]Visual rating index = % incidence × % severity/100.
[y]Disease response category: R = resistant, MR = moderately resistant, I = intermediate, MS = moderately susceptible, S = susceptible.
[x]Supplementary checks were chosen to differentiate resistance levels based on long term data collection.

for milling and baking quality and originally designated as CWRW wheat cultivars. Pintail produced a grain protein yield per hectare that was similar to the CWGP checks, but lower than the CWRW wheat cultivar Radiant ($P \leq 0.05$).

Other Characteristics

SEEDLING: Coleoptile anthocyanin pigmentation absent.
PLANT: Winter growth habit, juvenile growth prostrate, semi-erect at tillering; flag leaf mid-long, mid-wide, glabrous, recurved at medium frequency; flag leaf sheath glabrous, medium glaucosity; auricle anthocyanin colouration absent.
SPIKE: Awnlets present, tapering, mid-long, weak glaucosity, white, mid-dense, inclined; glumes mid-wide, mid-long, glabrous; glume shoulders slightly sloping, mid-wide; glume beak mid-long, slightly curved; resistant to shattering.
KERNEL: Medium red, texture medium hard, small to mid-size.

Maintenance and Distribution of Breeder Seed

Although Pintail is a doubled haploid cultivar, a traditional approach was used to produce Breeder Seed. In fall 2008, 80 head rows derived from random selections taken from a rogued seed increase plot were seeded in Lacombe. In 2009, four off-type rows were discarded and seed from the remaining 76 rows was replanted as individual pre-breeder seed plots under isolation in Lacombe. These plots were rogued, inspected and harvested in bulk in 2010 to form the initial lot of Breeder Seed. Pintail Breeder Seed will be maintained by staff at the AARD-FCDC. All other pedigreed seed classes will be multiplied and distributed by Mastin Seeds, Rural Route 1, Sundre, Alberta, Canada T0M 1X0. Tel: 1.403.556.2609; website: http://mastinseeds.com.

Table 6. Seed characteristics of Pintail and the check cultivars, Western Winter Wheat Cooperative registration trials (2008–2010)

	Test weight (kg hL^{-1})		Kernel weight (mg)		Grain protein[z] (%)		Grain protein yield (kg ha^{-1})	
Cultivar	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr	2 yr	3 yr
CDC Harrier	76.2	76.6	32.5	32.2	10.7	10.8	610	624
CDC Falcon	77.5	78.1	31.0	30.7	11.5	11.4	609	632
CDC Ptarmigan	74.9	–	35.1	–	9.9	–	584	–
Radiant	78.2	78.6	35.2	35.2	11.7	11.8	616	654
CWGP check mean[y]	76.2	77.3	32.9	31.4	10.7	11.1	601	628
Pintail	75.8	76.2	29.5	29.3	10.4	10.5	596	612
LSD ($P \leq 0.05$)[x]	0.5	0.5	1.0	0.9	0.3	0.4	41	36
No. of tests	19	26	19	26	17	24	17	24

[z]Grain protein concentration determined using whole grain near infrared reflectance analysis.
[y]Radiant is not included in the CWGP check mean.
[x]Least significant difference includes variation from the genotype by environment interaction.

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