

Centennial Brown brown condiment mustard

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Rakow, G., Raney, J. P., Rode, D. and Relf-Eckstein, J. 2009. **Centennial Brown brown condiment mustard**. *Can. J. Plant Sci.* **89**: 337–340. Brown condiment mustard (Common Brown) has about 10% lower grain yield than oriental condiment mustard (yellow seeded), which both belong to the same species [*Brassica juncea* (L.) Czern.]. Yield improvements in brown condiment mustard are therefore of great importance. The Saskatoon Research Centre of AAFC initiated a condiment brown mustard improvement program in 1996 applying pedigree selection of single plants from the condiment brown mustard cultivar Blaze, which resulted in the selection and registration of the cultivar Centennial Brown. Centennial Brown yielded 3.2% more grain than the landrace Common Brown, on average over 81 location years in 9 yr of condiment mustard Co-op tests (1999–2007) and was well adapted to the mustard-growing areas of the Canadian prairies. Support for registration was based on 6 yr of Co-op tests. Centennial Brown had the same maturity (91 d) and was 5 cm taller (116 cm) than Common Brown. It had 1.5% lower fixed oil (36.6%) and 1.2% greater protein content (30.0%) compared with Common Brown. It had 0.4 g heavier seed (2.96 g 1000 seed⁻¹) than Common Brown. Centennial Brown had 0.9 mg g seed⁻¹ greater allyl glucosinolate content than Common Brown (9.15 mg g seed⁻¹). Green seed counts were low in Centennial Brown (0.64%) compared with Common Brown (0.79%). This was confirmed in chlorophyll content measurements, 4.76 mg kg⁻¹ for Centennial Brown and 5.24 mg kg⁻¹ for Common Brown. Centennial Brown was resistant to blackleg disease [*Leptosphaeria maculans* (Desm.) Ces. et de Not.] and highly susceptible to the *B. juncea* races of white rust [*Albugo candida* (Pers.) Kuntze], equal to Common Brown. Centennial Brown will quickly replace Common Brown in the market place because of its increased grain yield and much superior seed quality.

Key words: *Brassica juncea* (L.) Czern., cultivar description, grain yield, seed quality

Rakow, G., Raney, J. P., Rode, D. et Relf-Eckstein, J. 2009. **La moutarde brune Centennial Brown**. *Can. J. Plant Sci.* **89**: 337–340. La moutarde brune se caractérise par un rendement grainier d'environ 10 % inférieur à celui de la moutarde orientale (jaune), qui appartient à la même espèce [*Brassica juncea* (L.) Czern.]. Améliorer le rendement de telles variétés revêt donc la plus haute importance. En 1996, le centre de recherches de Saskatoon d'Agriculture et Agroalimentaire Canada lançait un programme reposant sur l'amélioration généalogique de plants issus du cultivar de moutarde brune Blaze. Il en résultait la sélection puis l'homologation de la variété Centennial Brown. En moyenne, Centennial Brown a produit 3,2% plus de graines que la variété naturelle Common Brown à 81 sites-années, lors des 9 années d'essais coopératifs sur la moutarde de 1999 à 2007. Le cultivar est bien adapté aux zones de culture de la moutarde des Prairies canadiennes. Les preuves à l'appui de son homologation émanent de six années d'essais coopératifs. Centennial Brown a la même précocité (91 jours) que Common Brown mais ses plants ont 5 cm de plus (116 cm). Sa teneur en huile fixe est plus faible de 1,5% (36,6%) tandis que ses graines renferment 1,2% plus de protéines (30,0%) que celles de Common Brown. Les semences de Centennial Brown pèsent 0,4 g de plus (2,96 g par 1 000 graines) que celles de Common Brown. Elles renferment 0,9 mg par gramme de semences de plus d'allyl glucosinolate que celles de Common Brown (9,15 mg par g de semences). Centennial Brown donne peu de semences vertes (0,64%) comparativement à Common Brown (0,79%), ce que confirme la teneur en chlorophylle (4,76 mg par kg pour Centennial Brown contre 5,24 mg par kg pour Common Brown). Centennial Brown résiste au charbon bactérien [*Leptosphaeria maculans* (Desm.) Ces. et de Not.] mais est très sensible aux races de rouille blanche de *B. juncea* [*Albugo candida* (Pers.) Kuntze], comme Common Brown. Centennial Brown remplacera rapidement Common Brown sur le marché en raison d'un rendement grainier plus élevé et de graines de qualité nettement supérieure.

Mots clés: *Brassica juncea* (L.) Czern., description de cultivar, rendement grainier, qualité des semences

Centennial Brown brown mustard [*Brassica juncea* (L.) Czern.] was developed at the Saskatoon Research Centre (SRC), Agriculture and Agri-Food Canada (AAFC), Saskatoon, SK. Centennial Brown was named in recognition of Saskatchewan's 100th anniversary in

2005. Co-op testing was conducted from 1999 to 2004 for 6 yr and support for registration received in February of 2005. Centennial Brown received registration No. 6066 on 2006 Mar. 14 from the Variety Registration Office, Food Production and Inspection Branch, Agriculture Canada.

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Pedigree and Breeding Methods

Centennial Brown was developed through single plant selections isolated from the brown condiment mustard cultivar Blaze, licensed 1976 Apr. 28, licence No. 1686, Production and Marketing Branch, Plant Products Division, Agriculture Canada. Blaze was a single plant selection from a composite of high yield, high allyl glucosinolate lines identified in the landrace Common Brown and was the first licenced cultivar of brown mustard in Canada (Agriculture Canada 1978). Blaze contained less than 0.5% of yellow coated seeds, which led to its deregistration after a few years. The industry does not accept a brown mustard cultivar that has even very low levels of yellow-seeded plants.

In 1996, a field plot of Blaze was grown at Saskatoon and 200 open-pollinated plants individually harvested. A total of 193 of the 200 plants were progeny tested in a two-replicate, 3-m double row nursery in 1997 at Saskatoon. The rows were rated for agronomic performance and harvested. Seed was analyzed for brown colour, fixed oil content and seed weight. Five best progeny rows were entered into preliminary yield tests at Saskatoon, Scott and Melfort, Saskatchewan, in 1998. Line J97-149 was selected for its high yield and low fixed oil content and entered into the Co-op mustard test in 1999. Seed from the 1997 row nursery was used for these tests.

Centennial Brown was supported for full registration by the Oilseed Subcommittee of the Prairie Registration Recommending Committee for Grain (PRRCG) at its annual meeting in February 2002. Two of the 300 single plants individually harvested from the 2002 breeder plot had yellow seed, which was not acceptable for a brown mustard cultivar by the mustard processing industry. Three generations of inbreeding of single plants derived from the original single plant produced in 1996 was carried out and true brown breeding plants and lines produced in 2004. The plants were grown under isolation in the field in 2004 and several hundred plants were individually assessed for colour. All plants had brown seed and no yellow seed contaminant was found. The seed was bulked and used for breeder seed production in 2005. J97-149 was registered as Centennial Brown.

The check cultivar for Centennial Brown was Common Brown (Table 1). The cultivar Duchess became the new check cultivar after 2005. This cultivar description is based on 9 yr of Co-op mustard tests (1999-2007). Totals of 81, 84 and 71 station years of data were obtained for grain yield, maturity and plant height, respectively, and 64 station years of data for seed quality (fixed oil, seed protein, seed weight, allyl glucosinolate, seed chlorophyll content and distinctly green seed). The tests were randomized complete block designs with four replicates. Statistical analysis of variance was performed using Agrobases™ 21 for Windows (Agronomix Software Inc. Winnipeg, MB) and the SAS® System release 8.2, PROC MIXED model (SAS Institute Inc. Cary, NC). Years, locations and their interactions with entries

were classified as random variables for determination of grand means over all locations in the 9-yr performance table. Analysis of variance was performed on a site basis and only locations with less than 16% coefficient of variation for grain yield were included to eliminate locations with questionable data from the data set. A one-sided test was used for calculating LSD values at the 5% significance level for comparison of means between Centennial Brown and the check Common Brown.

During the 9 yr of testing in Co-op mustard tests, blackleg [*Leptosphaeria maculans* (Desm.) Ces. et de Not.] adult plant stem infection and white rust [*Albugo candida* (Pers.) Kuntze] seedling infection types were assessed at AAFC Saskatoon. Reactions to blackleg were rated in field disease nurseries, while severity of white rust was assessed on cotyledons of seedlings under controlled environmental conditions in growth rooms against *Brassica juncea* races 2a and 2v (Anonymous 1985). These are the two races of white rust found on *B. juncea* in western Canada (Rimmer et al. 2000).

Infection by *Alternaria* species was occasionally observed in breeding nursery, but resistance was sufficient to prevent major damage.

Seed quality was evaluated at several locations each year on sites with acceptable CVs for grain yield representing mustard growing areas across the three prairie provinces. Fixed oil is primarily triglyceride, the oil (or fat) in oilseed such as canola in contrast to "volatile oil", which is the enzymatic (myrosinase) break down product of allyl glucosinolate in *B. juncea* seed. A low 'fixed oil' content is desirable to improve dry milling of seed and reduce "oiliness" in the final mustard product. Oil content was determined by nuclear magnetic resonance spectroscopy (Operating Procedures). Total nitrogen was measured by Dumas combustion (Leco) analysis and nitrogen values multiplied by the factor 6.25 for conversion to protein content. Fixed oil and protein data were reported as percent whole seed on a dry weight basis. Seed weight was determined on 500 counted seed and reported as g per 1000 seed. Allyl glucosinolate content was determined by gas chromatography.

Seed quality analysis (fixed oil and protein) from the 2007 Co-op test was done by near infrared reflectance spectroscopy after acceptable calibration sets had been developed (2007 Co-op Mustard Report, Operating Procedures).

Performance

Agronomic and seed quality data for 9 yr of Co-op mustard tests, 1999-2007 are summarized in Table 1. On average, grain yield of Centennial Brown was 3.2% greater than Common Brown at 81 locations (2126 kg ha⁻¹ compared with 2060 kg ha⁻¹). Centennial Brown and Common Brown had identical maturity at 84 locations averaging 91 d. Centennial Brown was 5 cm taller than Common Brown.

Table 1. Agronomic performance and seed quality of Centennial Brown condiment brown mustard [*Brassica juncea* (L.) Czern.] compared with the check cultivar Common Brown in Co-op Mustard Tests (1999–2007)^{z,y}

	Grain yield ^x (kg ha ⁻¹)	Maturity ^w (days)	Height ^v (cm)	Fixed oil ^u (% seed)	Protein ^t (% seed)	Seed weight ^s (g 1000 seed ⁻¹)	Allyl GSL ^r (mg g seed ⁻¹)	Seed chlorophyll ^q (mg kg ⁻¹)	Distinctly green ^p (No. of green in 1000 seed)
Common Brown	2060	91	111	38.1	28.8	2.57	9.15	5.24	0.79
Centennial Brown	2126*	91	116*	36.6*	30.0*	2.96*	10.05*	4.76	0.64
Location years	81	84	71	64	64	64	64	64	64
LSD (5%)	50	<1	1	0.2	0.2	0.04	0.19	0.60	0.16

^zLocations (grain yield):

1999: Rosebank, Elgin (Manitoba), Watrous, Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Standard, Bow Island, Oyen (Alberta).

2000: Avonlea, Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Standard (Alberta).

2001: Rosebank, Neepawa (Manitoba), Mortlach, Watrous, Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Oyen (Alberta).

2002: Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Neapolis, Lethbridge (Alberta).

2003: Elgin (Manitoba), Eyebrow, Watrous, Weyburn, Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Neapolis, Lethbridge (Alberta).

2004: Rosebank, Elgin (Manitoba), Eyebrow, Weyburn, Scott, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Neapolis, Lethbridge (Alberta).

2005: Rosebank (Manitoba), Eyebrow, Watrous, Weyburn, Swift Current, Saskatoon 1, Saskatoon 2 (Saskatchewan), Irricana, Congress (Alberta).

2006: Rosebank, Elgin (Manitoba), Eyebrow, Scott, Saskatoon 1, Saskatoon 2, Swift Current, Watrous, Weyburn (Saskatchewan) Irricana, Lethbridge, Neapolis (Alberta).

2007: Rosebank, Elgin (Manitoba), Scott, Saskatoon 1, Saskatoon 2, Swift Current (Saskatchewan), Beiseker, Lethbridge, Neapolis (Alberta).

^yLocations (seed quality):

1999, 2000, 2005 and 2007: the same as for grain yield.

2001: Irricana, Rosebank, Saskatoon 1, Swift Current, Watrous.

2002: Irricana, Saskatoon 1, Saskatoon 2, Scott, Swift Current.

2003: Neapolis, Saskatoon 1, Swift Current, Weyburn, Elgin.

2004: Irricana, Neapolis, Eyebrow, Saskatoon 2, Rosebank.

2006: same as for grain yield, except for Scott, Weyburn and Lethbridge locations that were not included.

2001, 2002, 2003 and 2004: Five locations with lowest CV for grain yield were selected for seed quality analysis. Seed quality was determined on seed from at least two replicates at each location.

^xGrain yield: 1.20 m × 6.00 m plots = 7.20 m², 4 replicates.

^wMaturity: at 30% seed colour change of seed in days from seeding.

^vHeight: 2 measurements per plot in 5 cm increments at swathing maturity.

^uFixed oil: by nuclear magnetic resonance spectroscopy (dry seed).

^tProtein: by Dumas combustion for N × 6.25 (dry seed).

^sSeed weight: by counting and weighing 500 seed.

^rAllyl GSL = allyl glucosinolate by gas chromatography (dry seed).

^qSed chlorophyll by solvent extraction of chlorophyll and spectrophotometry (dry seed).

^pDistinctly green seed: by counting of distinctly green seed in 1000 crushed seed.

*Significantly different at LSD (5%) from check cultivar Common Brown.

Centennial Brown had 1.5% lower fixed oil content and 1.2% greater seed protein content, significant improvements in a brown mustard cultivar. It also exhibited significantly higher seed weight than Common Brown as well as significantly higher allyl glucosinolate content both highly desirable improvements in a brown mustard cultivar. Green seed count was determined as number of distinctly green seed in samples of 1000 seed. Common Brown had 0.79% distinctly green seed and Centennial Brown had 0.64% distinctly green seed, which was significantly fewer. This result was confirmed by analysis of seed chlorophyll content. Common Brown had 5.24 mg kg⁻¹ chlorophyll content and Centennial Brown had 4.76 mg kg⁻¹ chlorophyll (64 station years of data over 9 yr). Low chlorophyll content or low green seed count is an important grading factor for mustard seed.

Centennial Brown represents major improvements in seed quality over Common Brown and will quickly replace Common Brown in the market place. However, brown mustard is about 10% lower in grain yield than oriental mustard (yellow seeded) in multi-location, multi-year replicated yield tests (Co-operative Mustard Reports 1999–2007). Both types of mustard belong to the *B. juncea* species. Further improvements in grain yield of brown mustard will be essential for the competitiveness of brown mustard to secure its production in Canada.

Other Characteristics

LODGING. Lodging as observed in tests that had superior growing conditions, but there was no difference between Centennial Brown and Common Brown (data not shown).

SEED COLOUR. (uniform brown seed) was visually assessed. The brown colour of Centennial Brown and Common Brown was not different. As required by the mustard industry, no yellow seed contaminants occur in breeder seed of Centennial Brown.

BLACKLEG. Blackleg disease was assessed in field disease nurseries every year (1999 to 2007), and Common Brown and Centennial Brown were both highly resistant, with severity ratings of less than 0.5 on a <0.5 to 5 severity scale (<0.5 = no disease, 5 = plants dead).

WHITE RUST. Common Brown and Centennial Brown were both highly susceptible to the *Brassica juncea* white rust races 2a and 2v. Development of resistant cultivars remains a major breeding objective.

Maintenance and Distribution of Pedigreed Seed

Centennial Brown breeder seed will be produced by AAFC Saskatoon Research Centre, 107 Science Place, Saskatoon, Saskatchewan, Canada S7N 0X2. Centennial Brown has been released for multiplication and distribution to members of the Canadian Mustard Association.

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