

C17-833 camelina

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GERMPLASM DESCRIPTION

C17-833 camelina

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Abstract

Camelina (*Camelina sativa*) elite germplasm C17-833 was developed at the Agriculture and Agri-Food Canada Saskatoon Research and Development Centre. It was developed through hybridization of camelina cultivar AAC 10CS0048 and F₄ line 11CS0231-24-10 and subsequent pedigree selection. C17-833 yields significantly higher (114%) than the check cultivar AAC 10CS0048. It also has significantly higher seed oil content (42.6 vs. 41.9%) and significantly larger seeds (126%). C17-833 has very good resistance to downy mildew disease caused by *Hyalonospora camelinae* and is adapted to all soil zones of the Canadian Prairies.

Keywords: germplasm description, camelina, *Camelina sativa*, pedigree breeding

Camelina (*Camelina sativa* L. Crantz) is a relatively new crop of the *Brassicaceae* family. It is a hardy oilseed with frost and drought tolerance and resistance to common Brassica diseases and pests (Berti et al., 2016), most notably flea beetles (*Phyllotreta* spp.) (Soroka and Grenkow, 2014). Camelina seed oil, high in unsaturated fatty acids and antioxidants (Zubr 1997), is used in human nutrition, as a feed ingredient for livestock and supplement for companion animals. As the demand for biofuels has risen dramatically in recent years, there has been a renewed interest in camelina as a biofuel feedstock crop. The crop is grown at a small scale in Canada, with the majority of the production established in the Prairie Provinces. C17-833 is a camelina line developed at the Agriculture and Agri-Food Canada Saskatoon Research and Development Center (AAFC-SRDC). This line was offered to Smart Earth Camelina Corporation under an option to license agreement and is being considered for a sole license.

Pedigree and Breeding Methods

C17-833 was developed with the objective of combining high seed yield and oil content with resistance to downy mildew [*Hyaloperonospora camelinae* (Gäum.) Göker, Voglmayr, Riethm., Weiss & Oberw.] and aster yellows (*Candidatus Phytoplasma asteris* Lee et al.). It is derived from a cross between AAC 10CS0048 ([Canadian Food Inspection Agency - AAC 10CS0048 \(canada.ca\)](#)), a high yielding cultivar with high seed oil content and good downy mildew resistance, and 11CS0231-24-10, an F₄ selection derived from a cross of large-seeded line 09CS0040 with high seed oil line 07CS002-32. 09CS0040 was selected from accession CN 101989 at Plant Gene Resources of Canada (PGRC); 07CS0002-31 is a nursery selection from the AAFC Research Farm in Beaverlodge, AB in 2009. 11CS0231-24-10 was chosen as parent

because of its high seed oil content, increased seed size and the fact that this family showed very little aster yellows symptoms in a year with very high overall infection levels in camelina yield trial and nursery plots in Saskatoon.

Parental lines AAC 10CS0048 and 11CS0231-24-10 were reciprocally crossed in the fall of 2012. F₁ and F₂ seed was produced in the greenhouse in early 2013. F₂ seed was bulked and seeded at the AAFC Saskatoon Research Farm in May of 2013. In total, 500 F₂ plants were individually harvested and the F₃ seed planted in the following year in paired progeny rows in the camelina breeding nursery. From 2014 to 2017, progeny were selected in four rounds of pedigree selection (Figure 1). Selections were made based on early season plant vigour, plant architectural traits such as height, number and length of racemes and pod canopy density, seed size (Thousand Kernel Weight, TKW), incidence of downy mildew and aster yellows and seed quality-related traits, such as seed oil and protein content and fatty acid composition. For seed quality analysis, a sample of at least 50 g from each plot was cleaned and dried for 48 h. Seed oil and protein contents were measured by near infrared reflectance (NIR) spectroscopy (Raney and Serblowski, 2007) and fatty acid profiles were determined by gas chromatography of the fatty acid methyl esters using a method described by (Thies, 1971). F₇ seed of selected progeny was harvested from the middle of the plot, subjected to quality analysis and superior families were sown in replicated yield trials in Saskatoon and Swift Current, SK in 2018. This was followed by multi-year performance evaluations of a smaller number of elite lines from 2019 to 2022. In all trials, AAC 10CS0048 served as check cultivar. F₇ seed was also used as source seed to grow isolated seed increases at Saskatoon in 2020.

Yield trial results showed that line C17-833 was agronomically superior with a significantly higher seed yield and oil content as well as significantly larger seed than AAC 10CS0048. F₉ seed was provided to Smart Earth Camelina Corporation in early 2024.

Performance and Adaptation

Advanced breeding line C17-833 was evaluated in comparison to AAC 10CS0048 in replicated yield trials at 27 sites across the four Western Canadian provinces between 2018 and 2022. Only site-years with a coefficient of variation <15% were compared statistically for seed yield, for a total of 20 sites. Between three to seven additional sites were included for statistical analysis of phenological, architectural and seed quality traits (Table 1). Field plots were rated for days to flowering (DTF), days to maturity (DTM), and downy mildew incidence and evaluated for plant height, seed yield, TKW and seed quality. The latter included seed oil and protein content and fatty acid composition, which were measured as described above. Days to flowering was determined as the time between seeding and the day when 50% of the plants within a plot had at least one flower open. Physiological maturity was reached when 50% of the pods within a plot had turned colour from green to yellow-brown. Plant height, as the average distance from the soil surface to the top of the plant, was measured during pod filling and before maturity to avoid seed loss due to shattering. The GLIMMIX procedure in SAS® Studio (Release 3.81, SAS Institute Inc., Cary, NC, USA) was used to perform multi-year analyses of the data, with years, locations and their interactions considered as random and entries considered as fixed effects. The standard error of the difference (sed) between entries was estimated using the *estimate* command; the sed was then used to estimate a Fisher's protected least significant difference at a significance level of 5% (LSD_{0.05}).

C17-833 yielded on average 14% higher and had a significantly higher seed oil content (42.6% vs. 41.9%) than AAC 10CS0048. Its seed were on average 26% larger than seeds of the check cultivar. Relative to AAC 10CS0048, C17-833 grew to the same height and flowered and matured on average 1 day earlier. Both linolenic acid content and the ratio of omega-3 to omega-6 fatty acids (n-3/n-6) was significantly increased in C17-833.

Other Characteristics

Disease response: Very good resistance to downy mildew [*Hyaloperonospora camelinae* (Gäum.) Göker, Voglmayr, Riethm., Weiss & Oberw.] (Figure 2). The resistance of C17-833 to downy mildew was evaluated in comparison to the susceptible cultivar ‘Calena’ in an irrigated nursery grown in 2021 in Saskatoon. On a rating scale of 1-5, where 1 is completely symptom free and 5 denotes a heavily diseased plot, the average disease rating for C17-833 was 1.1 (n=196) and 2.5 for ‘Calena’ (n=25).

Maintenance and Distribution of Pedigreed Seed

Breeder seed of C17-833 was produced in 2023 at AAFC, Saskatoon Research and Development Centre, 107 Science Place, Saskatoon, SK S7N 0X2, Canada, using F₈ seed from an isolated seed increase grown at Saskatoon in 2022 as source seed. Breeder seed plots were grown in isolation according to the guidelines specified by the Canadian Seed Growers’ Association (CSGA).

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Competing Interests

The authors declare there are no competing interests.

Data Availability

Data generated or analyzed during this study are available from the corresponding author upon reasonable request.

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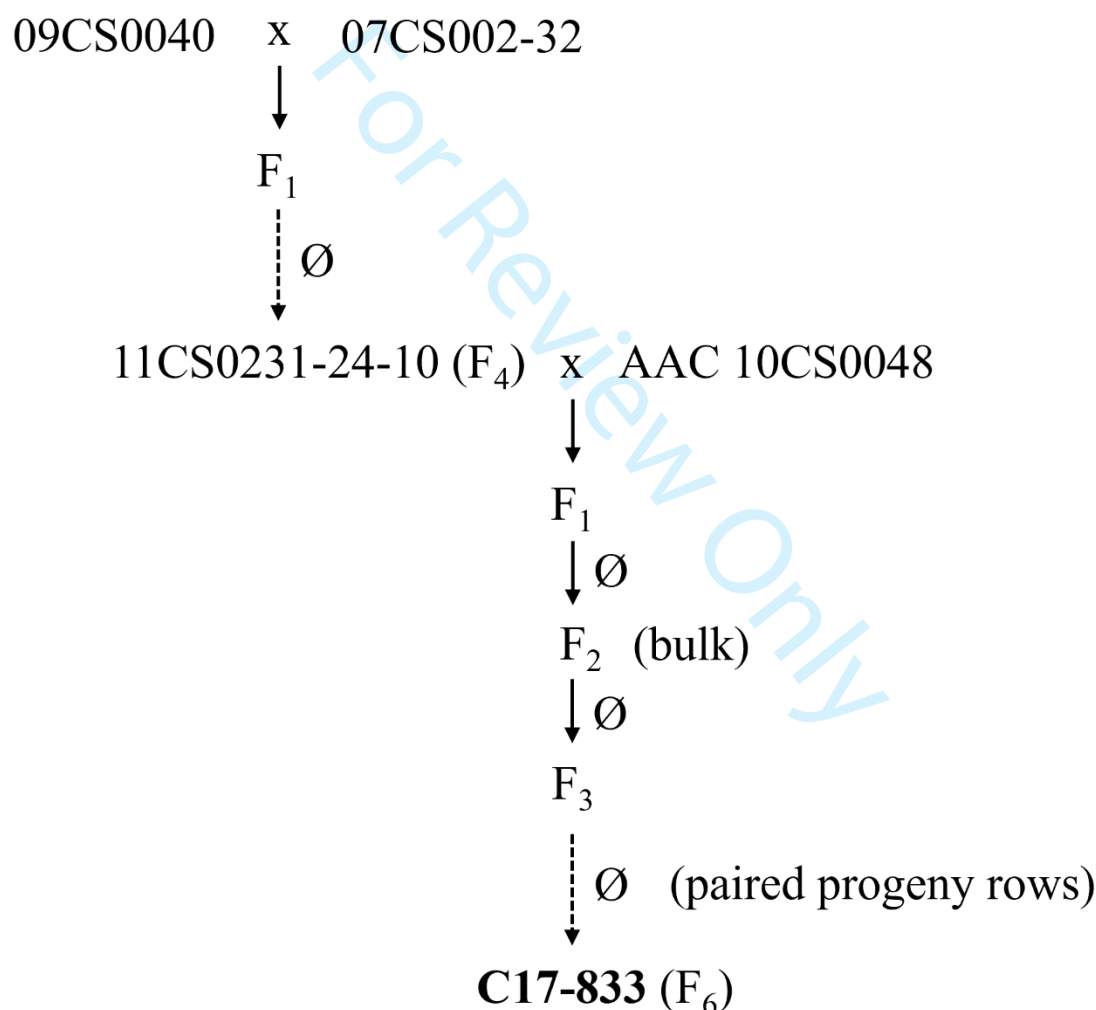


Figure 1: Schematic representation of the breeding strategy for the development of camelina elite germplasm C17-833. Dashed arrows indicate several generations of selfing.



Figure 2: Downy mildew (*Hyalonospora camelinae*) incidence in camelina experimental line 10-9b (left, disease rating 5) and elite line C17-833 (right, disease rating 1), Saskatoon, 2021.

Table 1: Agronomic performance and seed quality data of C17-833 in yield trials conducted in Canada from 2018 to 2022^a.

Germplasm	Yield (kg ha ⁻¹)	Percent of check yield (%)	DTF (d) ^b	DTM (d) ^c	Height (cm)	1000- seed wt. (g)	Oil content (% whole seed)	Protein content (% whole seed)	Linolenic acid content (%)	n-3/n-6 ratio
C17-833	2087	114	44.7	87.2	77.2	1.60	42.6	28.7	33.3	1.98
AAC 10CS0048	1835	100	45.7	87.7	76.9	1.27	41.9	28.6	32.9	1.62
LSD (0.05)	56		0.4	0.5	1.2	0.02	0.2	0.2	0.2	0.02
Site years	20		23	24	23	26	27	27	19	19

Note: LSD (least significant difference), derived from cultivar × test interaction mean square.

^aTests grown at Fort St. John, BC (2019); Beaverlodge, AB (2019, 2021, 2022); Taber, AB (2019, 2020); Lethbridge, AB (2021, 2022); Scott, SK (2019-2021); Saskatoon, SK (2018-2022); Swift Current, SK (2018, 2019, 2021, 2022); Indian Head, SK (2021, 2022); Redvers, SK (2021, 2022); Elm Creek, MB (2020); Melita, MB (2021, 2022).

^bDTF = days from seeding to flowering.

^cDTM = days from seeding to maturity