Ronald oat

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Mitchell Fetch, J. W., Brown, P. D., Duguid, S. D., Chong, J., Haber, S. M., Menzies, J. G., Ames, N. and Fetch, T. G. 2003. **Ronald oat**. Can. J. Plant Sci. **83**: 101–104. Ronald is a high-yielding, white-hulled, tall semidwarf oat (*Avena sativa* L.) cultivar with greatly improved panicle emergence compared with previously tested semidwarf lines. Ronald is postulated to carry the crown rust resistance combination *Pc38*, *Pc39* and *Pc68*, which is highly effective against most of the present crown rust races on the Canadian prairies. It has very good resistance to loose and covered smut and good resistance to most of the prevalent races of stem rust, due to the likely presence of *Pg2*, *Pg9* and *Pg13*, and moderate tolerance to barley yellow dwarf virus. Ronald has good kernel characteristics, such as high test weight, kernel weight and percent plump kernels. The grain characteristics exhibited by Ronald including hull-to-groat ratio, protein content and oil content should make it suitable for milling. It has excellent resistance to lodging. Ronald is well adapted for the oat growing areas of western Canada and in particular the Black Soil Zone of Manitoba and Saskatchewan where oat crown rust is prevalent.

Key words: Oat, *Avena sativa* L., cultivar description, semidwarf oat, disease resistance, milling oat

Mitchell Fetch, J. W., Brown, P. D., Duguid, S. D., Chong, J., Haber, S. M., Menzies, J. G., Ames, N. et Fetch, T. G. 2003. **L'avoine Ronald**. Can. J. Plant Sci. **83**: 101–104. Ronald est une variété d'avoine (*Avena sativa* L.) semi-naine de grande taille, à balle blanche et à rendement élevé dont les panicules émergent nettement mieux que les lignées semi-naines testées antérieurement. On suppose qu'elle porte les gènes *Pc38*, *Pc39* et *Pc68* codant une forte résistance à la plupart des races de rouille couronnée présentes dans les Prairies canadiennes. Le cultivar résiste bien au charbon nu et au charbon couvert et se caractérise par une bonne résistance aux races les plus courantes de rouille de la tige, sans doute à cause de la présence des gènes *Pg2*, *Pg9* et *Pg13*, ainsi que par une tolérance moyenne au virus du nanisme jaune de l'orge. Le grain de Ronald est de bonne qualité, comme le démontrent un poids spécifique et un poids d'amandes élevés ainsi que la proportion de grains ventrus. Si l'on se fie aux qualités du grain, notamment au rapport entre la balle et le grua, à la concentration de protéines et à la teneur en huile, cette variété devrait se prêter à la mouture. Ronald résiste très bien à la verse et est bien adaptée aux régions de l'ouest du Canada où l'on cultive l'avoine, surtout la zone des sols noirs du Manitoba et de la Saskatchewan où sévit largement la rouille couronnée.

Mots clés: Avoine, *Avena sativa* L., description de cultivar, avoine semi-naine, résistance aux maladies, avoine de mouture

Ronald is an oat (*Avena sativa* L.) cultivar developed by Agriculture and Agri-Food Canada, Cereal Research Centre, Winnipeg, MB. It was registered (Reg. No. 5244) by the Variety Registration Office, Plant Health and Production Division, Canada Food Inspection Agency, on 5 February 2001.

Breeding Method and Pedigree

Ronald is a white-hulled F_6 -derived tall semidwarf line developed utilizing a modified pedigree method. The cross that produced Ronald was W89329/AC Medallion, where W89329 was a semidwarf selection from the cross W84188/Robert. W84188 was a tall semidwarf selection resulting from several years of crossing and selection with lines carrying the *Dw-6* dwarfing gene from gamma irradiated OT184 (Brown et al. 1980). Many of the semidwarf progenies observed from the original crosses failed to produce panicles that emerged completely from the flag leaf sheath, resulting in yield loss. Semidwarf progeny with intermediate heights (tall semidwarfs) were selected where the panicle emerged at least 10 cm from the base of the flag leaf. Brown et al. (1980) concluded there might be genes present in those lines modifying

the expression of the *Dw-6* gene and allowing the peduncle to elongate so the panicle can fully extend from the sheath, thus producing the tall semidwarf lines.

The final cross to produce Ronald was made in the growth chamber in the fall of 1991. The F_1 generation was grown in the greenhouse during the winter of 1991–1992. A bulk F_2 was grown in the 1992 rust/smut nursery at Glenlea, MB, where plants were screened for resistance to oat crown rust (*Puccinia coronata* Cda f. sp. *avenae* Eriks.) and oat stem rust (*Puccinia graminis* Pers. f. sp. *avenae* Eriks. and E. Henn.). The seed from these plants was bulked and sized, and the most uniformly plump seeds were sent to the 1992–1993 winter nursery near Palmerston North, New Zealand. In the winter nursery, F_3 panicles were selected from a space-planted row. Selection for crown rust resistance and for barley yellow dwarf virus (BYDV) tolerance was possible in this nursery. One hundred sixty panicle rows of F_4 progeny were screened in the 1993 Glenlea rust/smut nursery. Selections from this nursery were based on resistance to stem rust, crown rust, loose smut [*Ustilago avenae* (Pers.) Rostr.] and covered smut (*U. kollerii* Wille), and for desirable agronomic traits, such as height and maturity similar to or better than that of the includ-

ed checks. The F_5 progeny were grown in the 1993–1994 winter nursery near Palmerston North, New Zealand. Concurrently, F_5 plants were screened for oat crown and stem rust resistance in the Cereal Research Centre greenhouse in Winnipeg to verify the New Zealand rust readings. Known tester races of oat crown rust and oat stem rust were used to postulate the presence of *Pc38*, *Pc39*, *Pc68*, *Pg2*, *Pg9* and *Pg13*. Utilizing pathogen races with different virulence patterns can enable the postulation of the presence of specific resistance genes in the line being evaluated. Panicles from agronomically desirable, disease-resistant plants were selected in New Zealand, and panicle rows were planted in the 1994 Glenlea F_6 rust/smut nursery. The F_7 generation was screened concurrently for crown and stem rust resistance in the Cereal Research Centre greenhouse in Winnipeg during the winter of 1994–1995 and for BYDV tolerance in the 1994–1995 New Zealand winter nursery. Ronald was tested in the 1995 and 1996 Preliminary Yield Trial, grown at Glenlea and Portage la Prairie, Manitoba, as W95648 and W96714, respectively. It was then tested for 1 yr in the 1997 Rust Area Test, which was grown at eight locations in western Canada (Portage, Morden, Brandon, Indian Head, Melfort, Kernen, Goodale, Lacombe). Ronald was tested for 2 yr (1998–1999) in the Western Cooperative Oat Test (WCOT), grown at various locations in western Canada (Table 1) as OT296. F_{13} panicles were planted in isolation at Glenlea in 1998 to provide the source for breeder seed to be increased near Lincoln, New Zealand in 1999–2000. One hundred sixty-three lines were harvested and bulked for the final breeder seed source.

Performance

Based on agronomic, kernel quality, and disease data, Ronald was very well suited for production in the Black Soil Zone of Manitoba and Saskatchewan (Tables 1, 2 and 3). Ronald was a high-yielding cultivar and exceeded the highest yielding check cultivars in the Black Soil Zone for the 2 yr it was grown in the WCOT (Table 1). The maturity of Ronald was the same as that of AC Medallion (Table 2). It was approximately 8 to 10 cm shorter than AC Medallion and CDC Pacer. It had significantly better lodging resistance and improved test weight compared to the check cultivars. Ronald had slightly higher percent plump kernels than CDC Pacer, but its percentage of thin kernels was higher than the checks. The percent hull for Ronald was lower than the check cultivars. Its percent milling yield was not significantly higher than that of CDC Pacer or AC Medallion. Milling yield was determined by subtracting the percentage of oat hulls, coarse feeding oatmeal, grain screenings (including thin kernels) and moisture loss occurring during the milling process. Ronald contained a similar amount of protein as AC Medallion but more than CDC Pacer. Ronald contained the same amount of oil as AC Medallion.

Other Characteristics

Seedling Characteristics

COLEOPTILE COLOUR. Green.

JUVENILE GROWTH HABIT. Erect.

SEEDLING LEAVES. Medium green; sheaths of lower leaves and the lower leaf blades have a few hairs (slightly pubescent).

Table 1. Grain yield ($t\ ha^{-1}$) of Ronald and check cultivars in the Western Cooperative Oat Test from 1998 to 1999 in western Canada by soil zones

Cultivar	Soil zone				Mean
	Black ^y	Black and Grey ^x	Brown ^w	Irrigated ^v	
AC Medallion	5.23	5.99	5.63	7.49	5.70
CDC Pacer	4.76	6.44	5.82	7.61	5.69
Ronald	5.85	5.83	5.48	7.89	5.89
LSD ^z ($P < 0.05$)	0.43	0.30	0.38	1.50	0.28
Station-years	13	10	7	2	32

^zCultivar means at each site were used for statistical analyses without partitioning for year effects; thus, each station-year of data was treated as one replicate.

^yTests grown at Glenlea [early and late planting (1998 only)], Portage la Prairie, Morden and Neepawa, MB, and Indian Head and Melfort, SK.

^xTests grown at Neapolis, Lacombe, Beaverlodge, Breton and Fort Vermillion, AB.

^wTests grown at Regina, Saskatoon, Swift Current and Scott (1998 only), SK.

^vTest grown at Lethbridge, AB.

Adult Plant Characteristics

GROWTH HABIT. Spring annual.

TILLERING CAPACITY. Intermediate.

FLAG LEAF. Medium green; slightly glaucous; medium wide, medium long length; attitude of flag leaf intermediate to upright; a ligule is present at base of flag leaf.

UPPER CULM NODE. Pubescent.

UPPER CULM INTERNODE. Medium glaucous.

Panicle Characteristics

SHAPE. Equilateral.

SIZE. Intermediate.

DENSITY. Lax.

PANICLE BRANCHES. Medium; semi-erect to horizontal; 5 whorls of branches per panicle; the lower whorl of branches attached to the first node; the lower panicle nodes have no hairs.

RACHIS. Straight; erect with the top few nodes nodding.

RACHILLA. Medium long; intermediate width; glabrous.

Spikelet Characteristics

ATTITUDE. Semi-nodding or drooping.

NUMBER OF FLORETS. 2–3.

SPIKELET SEPARATION. By fracture.

GLUMES (EMPTY). Short; medium wide.

NUMBER OF KERNELS/SPIKELET. 2–3.

Kernel Characteristics

SIZE. Medium long, medium wide kernels.

COLOUR. White to cream.

SHAPE. Plump.

BASAL HAIRS. Present.

LEMMA. Short; medium pointed tip.

LEMMA COLOUR. Yellow at maturity.

LEMMA AWNS. Generally absent or very infrequent.

PALEA. About the same length as the lemma.

CARYOPSIS. Pubescent; short brush hairs.

OFF-TYPES. None observed.

FREQUENCY OF FATUOIDS. None noted.

Table 2. Summary of agronomic and quality data of Ronald and check cultivars from the Western Cooperative Oat Test in western Canada, 1998–1999

Cultivar	Days to head	Days to mature	Height (cm)	Lodging resistance ^y (1–9)	Test weight (kg hL ⁻¹)	Kernel weight (mg)	Plump (%) ^x	Thin (%) ^w	Hull content (%) ^v	Milling yield (%) ^u	Protein (%) ^t	Oil (%) ^t
AC Medallion	61.6	98.4	110.7	4.4	48.7	37.2	63.5	3.9	23.4	73.8	11.6	6.7
CDC Pacer	60.5	95.0	108.9	3.8	48.1	37.3	50.1	4.3	24.3	72.6	11.1	6.0
Ronald	64.6	98.3	100.6	1.5	49.6	35.1	54.7	5.8	22.4	73.2	11.8	6.6
LSD ^z ($P < 0.05$)	0.7	1.1	2.0	0.9	1.2	1.2	8.1	1.6	0.9	1.8	0.5	0.3
Station-Years	23	26	32	24	31	31	11	11	11	11	11	11

^zCultivar means at each site were used for statistical analyses, without partitioning for year effects; thus, each station-year of data was treated as one replicate.

^y1 = no lodging; 9 = completely lodged.

^xPlump % based on proportion of a 100-g sample remaining on top of a 2.38 mm × 19.05 mm (6/64 × 3/4") sieve.

^wThin % based on proportion of a 100-g sample passing through a 1.98 mm × 19.05 mm (5/64 × 3/4") sieve.

^vHull content % determined on duplicate 100-g samples using a laboratory model impact dehuller.

^uMilling yield calculated as Milling yield percent = 100-(hulls + coarse feeding oatmeal + screenings + moisture loss)

^tDetermined on whole kernel basis.

Table 3. Summary of disease data of Ronald and check cultivars from the Western Cooperative Oat Test, 1998–1999

Cultivar	Field ratings				Oat crown rust (OCR)						Oat stem rust (OSR)							
	BYDV ^z	Loose smut ^y	OCR ^x	OSR ^w	Greenhouse crown rust number						Greenhouse North American number							
	(1–9)	(%)	(%)	(%)	13	181	192	223	225	185	8	16	25	26	27	28	55	67
<i>1998 Western Coop</i>																		
AC Medallion	4.8	0	0VR	30RMR	0 ^v	0	0	0	0	0	1 ^u	1	1	4	1	1	1	NA ^t
CDC Pacer	6.8	20	70S	70MS-S	4	4	4	4	4	4	4	4	4	4	4	4	4	NA
Ronald	3.9	0	0VR	30RMR	0	0	0	0	0	0	1	1	1	4	1	1	1	NA
<i>1999 Western Coop</i>																		
AC Medallion	5.6	0	0	30MR	0	0	0	0	0	0	1	1	1	NA	1	1	1	4
CDC Pacer	7.5	15	70MS-S	80S	4	4	4	3	4	3	4	4	4	NA	4	4	4	4
Ronald	4.1	0	Tr-S	40RMR	0	0	0	0	0	0	1	1	1	NA	1	1	1	4

^zVirulent *Rhopalosiphum padi* non-specific isolate Y9301 (PAV-like) was used. Barley yellow dwarf virus (BYDV) readings were taken at mid-dough using 1–9 (best–worst) scale; R = 1–4, MR = 4.1–4.7, MR-MS = 4.8–5.5, MS = 5.6–6.2, S = 6.3–9.

^ySmut data – a mixture of three races of *Ustilago avenae* (loose smut) (A13, A60 and A617) was used as inoculum. Resistance to these three races of *U. avenae* confers resistance to the predominant races of *U. avenae* and *U. kollerii* in western Canada (Menzies 2001). Smut infection classes: R = 0–15%, MR = 16–35%, MR-MS = 36–55%, MS = 56–75%, S > 75%.

^xOat crown rust – field ratings based on artificial inoculation with a composite of isolates bulked from the previous year annual crown rust survey in Manitoba. Ratings follow Peterson et al. (1948). 0 = immune; VR = very resistant; Tr = trace; R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible.

^wOat stem rust – field ratings based on reaction to a mixture of virulent races (excluding NA 26) artificially inoculated. Ratings follow Peterson et al. (1948).

^vOCR Greenhouse ratings – all entries were inoculated with six selected races of crown rust in greenhouse seedling tests. Ratings follow Roelfs and McVey (1979).

^uOSR Greenhouse ratings – following Roelfs and McVey (1979).

^tNA – Data not available.

Disease Reaction

Because of its resistance to most of the prevalent races of crown and stem rust (Table 3) Ronald can be safely grown in areas where rust poses a problem for oat production. Ronald exhibited a slightly higher level of tolerance to BYDV than the check cultivars. Ronald showed resistance to both loose and covered smut. Ronald was susceptible, as were all current cultivars, to the stem rust race NA67 (Table 3), which comprised more than 50% of the rust population collected from cultivated oat in 2000 (Fetch 2001).

Availability of Propagating Material

Breeder seed of Ronald will be maintained by Seed Increase Unit, Agriculture and Agri-Food Canada, Experimental Farm, Indian Head, Saskatchewan, Canada S0G 2K0. Multiplication and distribution of pedigreed seed will be

handled by SeCan, 201-52 Antares Drive, Ottawa, Ontario, Canada K2E 7Z1.

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