

Helios hard red spring wheat

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DePauw, R. M., Knox, R. E., Clarke, F. R., Clarke, J. M., Fernandez, M. R. and McCaig, T. N. 2007. **Helios hard red spring wheat**. Can. J. Plant Sci. **87**: 515–520. Helios hard red spring wheat (*Triticum aestivum* L.) has expressed high grain yield and medium time to maturity. The straw length and strength, volume weight, and seed size were intermediate to the check cultivars. It expressed resistance to prevalent races of stem rust and loose smut, intermediate resistance to common bunt and Fusarium head blight, and moderate susceptibility to leaf rust and leaf spots. It expressed resistance to pre-harvest sprouting and high Hagberg falling number. The end-use suitability of Helios was similar to that of the controls and, therefore, it is eligible for all grades of the Canada Western Red Spring (CWRS) wheat class.

Key words: *Triticum aestivum* L., cultivar description, grain yield, disease resistance, Hagberg falling number

DePauw, R. M., Knox, R. E., Clarke, F. R., Clarke, J. M., Fernandez, M. R. et McCaig, T. N. 2007. **Le blé roux vitreux de printemps Helios**. Can. J. Plant Sci. **87**: 515–520. Helios est une variété de blé roux vitreux de printemps (*Triticum aestivum* L.) à haut rendement grainier et à précocité moyenne. Elle se caractérise par une paille de longueur et de robustesse moyennes, une densité apparente moyenne et des graines de calibre moyen comparativement aux cultivars témoins. Helios résiste aux races communes de rouille de la tige et de charbon nu, résiste modérément à la carie et à la brûlure de l'épi causée par *Fusarium*, mais est modérément sensible à la rouille et aux taches des feuilles. La variété résiste à la germination sur pied et présente un indice de Hagberg élevé. Helios convient aux mêmes usages que les variétés témoins, donc est admissible au classement en tant que blé roux de printemps de l'Ouest canadien.

Mots clés: *Triticum aestivum* L., description de cultivar, rendement grainier, résistance à la maladie, indice de Hagberg

Helios hard red spring wheat (*Triticum aestivum* L.) was developed at the Semiarid Prairie Agricultural Research Centre (SPARC), Agriculture and Agri-Food Canada (AAFC), Swift Current, SK. It received registration No. 6079 from the Variety Registration Office, Plant Production Division, Canadian Food Inspection Agency on 2006 Mar. 27.

Pedigree and Breeding Method

Helios derives from the cross BW674/AC Cadillac//AC Barrie made in 1996 at SPARC, AAFC, Swift Current, SK. BW674 was developed by P. Hucl, University of Saskatchewan from the cross Israel 676/Neepawa//Columbus (DePauw et al. 1995). BW674 has a semi-dwarf stature with higher grain yield than the check cultivars. AC Cadillac and AC Barrie have high grain yield and protein concentration (McCaig et al. 1996; DePauw et al. 1998). A modified pedigree breeding method was employed in the development of Helios. In 1997 the F₂ seed was inoculated with common bunt [*Tilletia laevis* Kühn in Rabenh., and *T. caries* (DC.) Tul. & C. Tul.] races L1, L16, T1, T6, T13 and T19 (Hoffmann and Metzger 1976). About 10 000 F₂ seeds were planted 13 cm apart within a row and with 25 cm between rows in a leaf rust (*Puccinia triticina* Eriks.) and

stem rust (*P. graminis* Pers.:Pers. f.sp. *tritici* Eriks. & E. Henn.) epiphytotic nursery. The leaf rust races used in this nursery were representative of those found the previous year (McCallum and Seto-Goh 2003). Stem rust races used were: QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2003). A total of 427 F₂ plants, which expressed resistance to the rusts and bunt, were selected and 104 were discarded based on high levels of kernel diseases and inappropriate kernel shape for the Canada Western Red Spring (CWRS) wheat market class. The 323 F₃ progeny were grown as head rows to inbreed and multiply seed in a contra season nursery near Lincoln, New Zealand. Rows selected on the basis of time to maturity, plant height and straw strength were harvested as individual rows. In the F₄ generation, 141 lines were grown in four-row plots in a two-replicate trial near Swift Current and in unreplicated trials at Regina and Indian Head, and selected for agronomic performance. Grain protein concentration was assessed on a sample from each location using near infrared reflectance spectroscopy (Williams 1979). End-use suitability, test weight, seed size and kernel attributes suitable for the CWRS market class were assessed on the grain samples. Forty-five F₅ families, at five selections per family were grown as head rows to inbreed and multiply seed in a contra

season nursery near Lincoln, New Zealand. Families were selected on the basis of grain quality and kernel attributes. Rows within acceptable families were selected on the same basis as the F_3 generation. In the F_6 generation, 100 $F_4:F_6$ lines were evaluated in agronomic and end-use suitability trials similar to those of the F_4 generation. Twenty-seven F_7 families, 19 at five selections per family and eight at four selections per family, were grown as head rows to inbreed and multiply seed in a winter nursery near Irwell, New Zealand. Families and rows within families were selected on the same basis as the F_5 . In the F_8 generation, 60 $F_6:F_8$ lines were evaluated in trials similar to those of the F_4 and F_6 generation. In the F_4 , F_6 , and F_8 generations, reaction to leaf and stem rust was used as a selection criterion by assessing response to the rusts in an epiphytotic nursery near Glenlea, Manitoba. Selected F_8 lines were screened for reaction to a mixture of races T2, T9, T10, and T39 of loose smut [*Ustilago tritici* (Pers.) Rostr.] (Nielsen 1987), and races L1, L16, T1, T6, T13 and T19 of common bunt. The above procedure resulted in an experimental line 9610-AN02E being identified, which met all of the selection criteria at each generation of selection. The designations are as follows: "9610" refers to the cross name, "AN" refers to the alpha character assigned sequentially to the 323 F_2 -derived F_3 lines, "02" refers to the sequential selection number assigned to the F_4 -derived F_5 line within the family "AN", and "E" refers to the alpha character assigned sequentially to the F_6 -derived F_7 line within the family "AN02".

The experimental line, 9610-AN02E, was evaluated in the Western Bread Wheat 'A_2' test in 2001, and as PT211 in the Parkland Wheat Cooperative tests from 2002 to 2004. The check cultivars in the Parkland Wheat Cooperative tests were AC Barrie, AC Intrepid, Katepwa, AC Splendor and CDC Teal for the three test years 2002 to 2004. The variables measured and the protocols followed in the Parkland Wheat Cooperative test have been described by Fox and McCallum (2006). The PROC MIXED procedure was used to analyze the data annually and to perform a combined analysis over years using a mixed model with environments and replications considered random and genotypes considered fixed (SAS Institute, Inc. 1999).

PT211 was assessed also for reaction to several diseases from 2002 to 2004. Leaf and stem rust seedling infection types were assessed using stem rust races: QTHST (C25), RHTSK (C20), RKQSR (C63), RTHJT (C57), TMRTK (C10), and TPMKR (C53) (Roelfs and Martens 1988; Fetch 2003), and leaf rust races: MBDS (12-3), MBRJ (128-1), MGBJ (74-2), and TJJJ (77-2) (McCallum and Seto-Goh 2003). Field evaluations of leaf and stem rust reactions, using leaf rust races representative of those found the previous year and the same stem rust races as for the seedling tests, were measured annually in epiphytotic nurseries near Glenlea, MB. Reaction to Fusarium head blight (FHB) caused by *Fusarium graminearum* Schwabe (teleomorph *Gibberella zeae* (Schwein.) Petch) was assessed in artificially inoculated field tests conducted annually near Glenlea and Carman, MB (Gilbert and Woods 2006). Fusarium head blight failed to develop in 2004 in the nursery near Glenlea. To determine response to loose smut, a mixture of the prevalent races T2, T9, T10 and T39 was injected into florets at anthesis of plants grown in the field (Fox and McCallum 2006). To determine response to common bunt, a mixture of prevalent races L1, L16, T1, T6, T13 and T19 was used to inoculate the seed planted in mid-April of each year near Lethbridge, Alberta (Fox and McCallum 2006). Response to the leaf spot complex [caused by *Pyrenophora tritici-repentis* (Died.) Drechs., *Phaeosphaeria nodorum* (E. Muller) Hedjaroude, *Mycosphaerella graminicola* (Fuckel) J. Schrot. in Cohn (anamorph *Septoria tritici* Roberge in Desmaz.), and *Cochliobolus sativus* (Ito & Kuribayashi) Drechs. ex Dastur] was determined by scoring infection type and leaf area infected following the McFadden scale on naturally infected plots grown near Swift Current, SK. (Fernandez et al. 1996).

End-use suitability was determined on a composite sample made up of unequal quantities of grain from sites with grain samples representative of the top hard red spring wheat grades. All end-use suitability analyses were performed by personnel at the Grain Research Laboratory, Canadian Grain Commission, Winnipeg, MB, following protocols of the American Association of Cereal Chemists.

Table 1. Grain yield (kg ha⁻¹) of Helios compared with the check cultivars in the Parkland Wheat Cooperative tests from 2002 to 2004

Cultivar	2002			2003			2004 ²			2002-2004		
	Zone 1 ³	Zone 2	Mean ^x	Zone 1	Zone 2	Mean	Zone 1	Zone 2	Mean	Zone 1	Zone 2	Mean
AC Barrie	2784	2902	2859	3420	3906	3756	2550	4071	3603	2932	3656	3451
AC Intrepid	3144	2684	2853	3471	4030	3858	2663	4271	3776	3095	3699	3542
AC Splendor	2550	2416	2464	3206	3833	3639	2293	3945	3437	2671	3428	3223
CDC Teal	2842	2648	2723	3359	3781	3654	2454	3945	3486	2863	3548	3357
Katepwa	2646	2522	2562	3426	3843	3713	2504	3868	3449	2876	3391	3262
Helios	3031	2776	2871	3468	3935	3793	2777	4259	3803	3066	3718	3541
LSD ^w	296	222	184	213	178	144	302	313	239	165	230	148
No. tests	4	7	11	4	9	13	4	9	13	12	25	37

²RCB design used in 2004 whereas in 2002 and 2003 a lattice design was used.

³Locations for the 3 yr in the Zone 1: Beaverlodge, Dawson Creek, Fort St. John, Fort Vermilion; and Zone 2: Clive, Ellerslie, Kernan, Kelvington, Killam, Lacombe, Lake Lenore, Loon Lake, Melfort, Neapolis, Russell/Roblin

^xMeans are based on PROC MIXED procedure.

^wLeast significant difference, $P \leq 0.05$, includes variation from the genotype by environment interaction.

Table 2. Agronomic performance of Helios compared with the check cultivars in the Parkland Wheat Cooperative tests from 2002 to 2004

Cultivar	Maturity (d)				Height (cm)	Lodging ^y (1–9)	Test weight (kg hL ⁻¹)	Kernel size (mg)
	2002	2003	2004	2002–2004 ^z	2002–2004	2002–2004	2002–2004	2002–2004
AC Barrie	101.5	91.9	110.1	103.1	81.5	2.8	78.5	36.0
AC Intrepid	99.7	91.2	108.4	101.9	83.5	2.5	78.1	35.8
AC Splendor	99.2	90.7	107.6	100.9	80.5	2.6	77.9	35.1
CDC Teal	101.1	91.4	109.1	102.4	81.7	2.4	78.2	34.8
Katepwa	100.6	91.2	108.7	101.7	83.7	3.2	78.1	34.3
Helios	100.1	90.6	109.6	102.0	81.5	3.0	78.4	35.3
LSD ^x	1.6	0.8	1.6	1.2	1.6	0.8	1.2	2.2
No. tests	5	7	10	22	34	7	35	35

^zRCB design used in 2004 whereas in 2002 and 2003 a lattice design was used. Data analyzed using PROC MIXED procedure.

^yStraw strength rated on a scale of 1 indicating that all plants in plot are erect to 9 indicating that all plants in a plot are lying horizontal.

^xLeast significant difference, $P \leq 0.05$, includes variation from the genotype by environment interaction.

Table 3. Disease reactions of Helios and check cultivars in the Parkland Wheat Cooperative tests from 2002 to 2004

Cultivar	Leaf rust ^z			Stem rust ^z		
	2002	2003	2004	2002	2003	2004
AC Barrie	–	60MRMS	48MSS	–	25MRMS	7RMR
AC Intrepid	–	22MRMS	8MR	–	15MRMS	Tr R
AC Splendor	–	27RMS	12MR	–	10RMR	Tr R
CDC Teal	15MR	5MRMS	3MR	5RMR	15MRMS	Tr R
Katepwa	60MS	50MSS	55MSS	3R	7RMR	5RMR
Helios	60MS	47MRMS	43MSS	1R	20MRMS	5RMR

Cultivar	Common bunt ^z			Loose smut ^z		
	2002 ^y	2003	2004	2002	2003	2004
AC Barrie	Trace	6 I	25 I	50 I	29 MR	48 I
AC Intrepid	0	4 R	11 R-	9 R	27 MR	50 I
AC Splendor	0	7 I	10 R-	0 R	5 R	8 R
CDC Teal	0	1 VR	45 I+	13 MR	30 MR	19 MR
Katepwa	Trace	4 R	19 I	0 R	10 R	11 MR
Helios	0	3 R	35 I	0 R	7 R	8 R

Cultivar	Fusarium head blight										
	Glenlea				Carman				Leaf spot ^y		
	2002		2003		2002		2003		2004		2002
Index ^x	Reac ^w	Index	Reac	Index	Reac	Index	Reac	Index	Reac		
AC Barrie	47	I	23	I	26	MS	28	I	9	MR	9.5
AC Splendor	73	S	46	S	18	I	44	MS	22	I	10.0
AC Intrepid	68	S	38	MS	12	I	37	MS	49	S	9.8
CDC Teal	78	S	71	S	34	S	64	S	50	S	10.0
Katepwa	70	S	23	I	28	MS	24	I	19	I	10.3
Helios	50	I	21	I	14	I	17	MR	9	MR	9.8

^zPercent infection and type of reaction: Tr, trace; R, resistant; MR, moderately resistant; I, intermediate resistant; MS, moderately susceptible; S, susceptible.

^yDue to low infection levels bunt ratings in 2002 may not be indicative of actual reaction.

^xDisease index = (%infected spikelets on infected spikes * % infected spikes)/100.

^wReaction category: MR, moderately resistant; I, intermediate resistant; MS, moderately susceptible; S, susceptible.

^vMcFadden scale; 5 = R; 6 = MR; 7 = I; 8–9 = MS; 10–11 = S. Leaf spot ratings taken near Swift Current, SK. Percent isolation of the main leaf spotting pathogens: *Phaeosphaeria nodorum* = 74%, *Pyrenophora tritici-repentis* = 18%, *Septoria tritici* = 5%, *Cochliobolus sativus* = 4% .

Determination of kernel attributes and eligibility to meet grades of CWRS market class was done by personnel of the Inspection Division, Canadian Grain Commission. In 2004 and 2005, pre-harvest sprouting response was measured on intact spikes using the protocol described by DePauw and McCaig (1991).

Performance

Based on 37 replicated tests over 3 yr (2002 to 2004), Helios yielded more grain ($P \leq 0.05$) than all of the checks except AC Barrie and AC Intrepid (Table 1). In the Peace River Region, it yielded 14.8% more than AC Splendor, 7.1% more than CDC Teal and 6.6% more than Katepwa. In the

Table 4. Averages of end-use suitability^z traits of Helios and check-cultivars in the Parkland Bread Wheat Co-operative tests from 2002 to 2004

Cultivar	Wheat protein (%)		Flour protein (%)		Flour yield (%)		Flour colour Agtron	
	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004
AC Barrie	14.9	15.2	14.3	14.6	76.5	76.2	78.5	76.5
AC Intrepid ^y	14.2		13.8		74.6		80.0	
AC Splendor	15.0	15.4	14.5	14.9	75.1	74.7	79.0	76.6
CDC Teal	14.6	14.7	14.2	14.3	75.3	74.9	78.0	76.3
Katepwa	14.5	14.7	13.9	14.2	74.8	74.4	76.6	74.6
Helios	14.6	14.7	13.9	14.1	75.8	75.7	79.9	77.9
Std. Dev. ^x	0.05	0.05	0.05	0.05	0.34	0.34	0.9	0.9
	Flour ash (%)		Amylograph viscosity (BU)		Hagberg falling no. (s)		Starch damage (megazm)	
	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004
AC Barrie	0.42	0.42	528	557	368	370	7.4	7.8
AC Intrepid	0.42		385		330		7.3	
AC Splendor	0.45	0.43	510	535	365	362	6.9	7.2
CDC Teal	0.42	0.42	470	493	355	348	7.3	7.6
Katepwa	0.43	0.43	423	445	355	352	7.8	8.1
Helios	0.42	0.42	578	577	408	402	8.0	8.5
Std. Dev	0.005	0.005	5	5	15	15	0.08	0.08
Farinograph								
	Absorption (%)		DDT ^w (min.)		MTI (BU)		Stability (min.)	
	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004
AC Barrie	66.5	68.1	6.9	7.3	20.0	17.5	12.3	13.2
AC Intrepid	68.3		6.6		30.0		16.1	
AC Splendor	68.0	69.4	7.9	8.4	20.0	15.0	22.8	22.5
CDC Teal	66.5	67.7	7.1	7.2	25.0	17.5	14.1	15.4
Katepwa	67.7	68.8	5.8	5.9	30.0	25.0	8.6	9.3
Helios	68.2	69.9	7.8	8.1	20.0	17.5	14.1	15.1
Std. Dev	0.17	0.17	0.4	0.4	2.6	2.6	1.4	1.4
Canadian short process (150 ppm ascorbic acid)								
	Loaf volume (cc)		Mixing time (min.)		Absorption (%)			
	2003–2004	2002–2004	2003–2004	2002–2004	2003–2004	2002–2004		
AC Barrie	1118	1110	4.5	6.1	71.0	72.7		
AC Intrepid	1130		3.7		72.0			
AC Splendor	1163	1142	4.3	6.4	73.0	74.3		
CDC Teal	1183	1162	4.5	6.2	71.5	72.3		
Katepwa	1138	1127	3.8	4.9	71.5	72.7		
Helios	1118	1097	4.8	6.1	72.5	73.7		
Std. Dev	45	45	0.3	0.3	NA ^v	NA		

^zAmerican Association of Cereal Chemists methods were followed by the Grain Research Laboratory, Canadian Grain Commission for determining the various end-use suitability traits on a composite of 6 to 10 locations each year.

^yAC Intrepid was included as a check for end-use suitability in 2003 and 2004 only.

^xStd. Dev. is the standard deviation based on repeated testing of Allis mill check samples, and standard bake flour sample with replicate tests carried out over an extended period of time each season, provided by GRL, CGC.

^wDDT is the Farinograph dough development time; MTI is Farinograph mixing tolerance index expressed in Brabender Units (BU).

^vNA, std. dev. was not available.

Parkland Region, it yielded 8.4% more than AC Splendor, 4.8% more than CDC Teal, 9.6% more than Katepwa. Averaged over regions, it yielded 9.9% more than AC Splendor, 5.5% more than CDC Teal, 8.6% more than Katepwa.

Helios matured on average 1.1 d earlier than AC Barrie, at a similar time to AC Intrepid, CDC Teal and Katepwa, and 1.1 d later than AC Splendor (Table 2). The plant height of Helios averaged about 2 cm shorter than AC Intrepid and Katepwa and 1 cm taller than AC Splendor. The straw strength of Helios as indicated by the lodging score was similar to that of Katepwa and AC Barrie and not as strong as that of AC Intrepid or CDC Teal. The test weight

of Helios was at the high end of the range of the checks. Kernel size was intermediate to that of CDC Teal and AC Intrepid.

Other Characteristics

SPIKES: Oblong to tapering, mid-dense, mid-long, inclined to nodding, and apically awnleted; glumes are mid-wide, glabrous, and white; glume shoulders are primarily square, although some tending to oblique, rounded, and elevated, narrow to mid-wide; glume beak is short.

KERNEL: Colour is red; medium size, mid-wide, mid-long, and ovate to oval; cheeks angular to rounded; brush mid-size with mid-long to long hairs; embryo large and round.

Table 5. Response of intact spikes to sprouting conditions collected on two sampling dates; and Hagberg falling No. and test weight of grain samples harvested at 16% moisture (wet weight basis) and about 30 and 60 d after initial harvest of Helios compared with other cultivars grown in length of dormancy trials near Swift Current in 2004 and 2005

Genotype	Seed colour	T1HS ²	T2HS	T1KS	T2KS	FNO	TWT
AC Barrie	Red	4.5	3.5	18.0	25.0	399	77.8
CDC Alsask	Red	3.5	8.5	17.7	48.7	366	76.0
CDC Go	Red	10.0	9.8	87.7	86.0	344	78.0
Helios	Red	4.5	4.5	21.7	29.0	402	76.8
Infinity	Red	2.7	6.5	13.3	34.3	377	77.0
Lillian	Red	2.7	7.2	9.7	44.0	418	76.3
Lovitt	Red	3.5	2.8	7.0	9.7	420	76.7
Neepawa	Red	3.2	8.0	11.7	46.7	388	75.8
CDC Osler	Red	3.0	6.8	9.7	34.3	388	77.6
RL4137	Red	0.0	0.2	0.0	1.0	439	77.3
Somerset	Red	5.8	8.0	28.3	47.7	338	75.1
Superb	Red	6.3	6.8	34.3	40.0	362	77.3
5602HR	Red	6.8	8.5	29.7	65.3	409	77.9
Mean		4.6	6.1	25.2	38.0	387	76.6
CV		0.0	8.5	5.7	0.0	2.7	1.6
LSD ³		5.5	4.8	31.2	34.9	41.6	1.8

¹T1HS = percentage of spikes with visible sprouts from heads collected at about 16% moisture on a wet weight basis (Time 1).

²T2HS = percentage of spikes with visible sprouts collected 10 days after Time 1 (Time 2).

³T1KS = percentage of kernels sprouted at Time 1.

⁴T2KS = percentage of kernels sprouted at Time 2.

FNO = mean Hagberg falling number (sec.) of three harvest samples at monthly intervals after achieving 16% moisture.

TWT = mean test weight of three harvest samples at monthly intervals after achieving 16% moisture.

⁵Least significant difference, $P \leq 0.05$.

SHATTERING: Resistant to seed shelling due to wind.

DISEASE REACTION: Resistant to prevalent races of stem rust and loose smut, intermediate resistance to common bunt and Fusarium head blight and moderately susceptible to leaf spots and leaf rust (Table 3). In most FHB nurseries, Helios had a lower FHB disease index than AC Intrepid, AC Splendor, CDC Teal and Katepwa and was similar to that of AC Barrie.

END-USE SUITABILITY: Based on 3 yr of testing in the Parkland Wheat Cooperative test (Table 4), Helios was rated equal to the check cultivars for grain quality by the Quality Evaluation Team of the Prairie Registration Recommending Committee for Grain. Helios is eligible for all grades of the CWRS market class.

PREHARVEST SPROUTING: Helios exhibited higher Hagberg falling number values than all check cultivars in 3 yr of end-use suitability testing (Table 4). High Hagberg falling numbers are indicative of undamaged kernels and may indicate some resistance to wet weather conditions prior to harvest. However, the Hagberg falling number is influenced by the attributes of the protein – starch matrix in the absence of elevated alpha amylase (Mathewson and Pomeranz 1978). In 2 yr of length of dormancy period testing, Helios exhibited lower indices ($P \leq 0.05$) of sprouting of intact spikes than CDC Go and Somerset (Table 5).

Maintenance and Distribution of Pedigreed Seed

Helios consists of a composite of 124 Breeder Lines selected from F₆:F₁₁ random single plants grown out as 144

Breeder-Lines in 3-m-long rows in isolation near Swift Current in 2003, and again as 15-m rows near Indian Head in 2004. Any Breeder Line which was atypical or which had more than 1 per 1000 off-type plant per row was discarded. Breeder Seed will be maintained by the Seed Increase Unit of the Research Farm, Indian Head, SK S0G 2K0. Application for Plant Breeders' Rights has been filed. The variety will be added to the OECD list of Cultivars. Helios has been released for distribution and multiplication to La Cooperative Federee de Quebec, 2405 de la Province, Longueuil, Quebec, Canada J4G 1G3.

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