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Performance of 17 Peach and Nectarine Cultivars in a Southern-Ontario, Non-traditional Growing Region

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Abstract

The horticultural performance of 17 peach (*Prunus persica* (L.) Batsch) and nectarine cultivars (*Prunus persica* var. *nucipersica*) was evaluated for seven years in Simcoe, Ontario, a non-traditional region for growing peaches. The trees were established at a spacing of 2.5 m x 4.5 m in 2004 and trained as a central leader supported on a post and wire trellis. Tree vigor, mortality, productivity, bloom, maturity date, yield and fruit size were monitored annually. After seven growing seasons, no significant difference in tree mortality, tree width or tree height was observed among cultivars. Despite winter minimum temperatures falling below -28°C in 2004 and 2005, which killed flower buds in two years out of seven, no substantive injury to the tree or scaffold branches was sustained. At the end of the study, 'AC Harrow Dawn' was the most vigorous while 'Redhaven' and 'Virgil' were the least vigorous. 'Redhaven', HW272, and V84061 were the most productive cultivars. The bloom dates for all cultivars ranged from 19 Apr to 13 May, a period in the region which is still at risk of spring frosts. Fruit from 'Harrow Beauty', V85384, HW273, and 'Vivid' trees had the largest overall fruit size. On average, harvest dates ranged over a six week period (23 Jul – 4 Sep). In general, the nectarine cultivars 'Harflame' and 'Harblaze' did poorly primarily because of their greater predisposition to foliar and fruit damage from Japanese beetles (*Popillia japonica* Newman). We conclude from this study that the establishment of peach orchards in the Norfolk region of southern Ontario is feasible. Vigorous, healthy tree growth was evident in most cultivars, however care is warranted to select cultivars that are productive, and that have the adequate fruit size for the desired market.

Southern Ontario and the Okanagan Valley of British Columbia are on the northern limits of commercial peach production in North America (26). Protected sites along the Great Lakes and Okanagan Lake provide thermal protection against winter temperatures below -24°C when bud injury to *Prunus* spp. is often sustained (26). Pressures of urban expansion, limited suitable well-drained coarse-textured soils, and competition with other agriculture sectors such as vinifera grapes, ornamentals and greenhouse crops are limiting the ability of the peach industry to expand in these unique climatic regions.

The cultivars that are growing in these regions were specifically developed by long-standing breeding programs initiated in the region in 1911 by the Department of Agriculture at the Vineland Research Station, Ontario. By 1964, fourteen cultivars had been released to extend the `Elberta` (from Georgia, USA) season as well as to be used for the canning and processing industry. In the 1970s, a second breeding program was developed by Agriculture Canada in Harrow, Ontario to expand fresh market peach cultivars with enhanced cold-hardy resistance (14, 20). Some of the breeding selections from Harrow also resulted in the introduction of white-fleshed cultivars that are increasing in consumer appeal (1, 5, 6, 19). Two of these, HW271 and HW273 are included in the present study.

The slight but gradual warming in the climate and longer growing seasons (7) provides impetus to explore the feasibility of growing peaches in the less traditional regions along the north shore of Lake Erie where highly desirable coarse-textured and well-drained soils exist. The primary risks to *Prunus* species are associated with flower bud loss followed by tree injury from mid-winter temperatures below -24°C combined

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with secondary perennial canker (*Leucostoma sp.*) causing tree decline. Spring frosts during bloom can also damage flower buds and pose a risk in these regions.

The objective of this experiment was to study the performance of commercially accepted cultivars and advanced selections of peaches and nectarines in a non-traditional growing region of Ontario. The usefulness of such findings can be applied in many areas with a similar climate to that found in Ontario.

Materials and Methods

Seventeen peach and nectarine cultivars (*Prunus persica* (L.) Batsch) were "T"- bud grafted in a research nursery on 'Bailey' seedling rootstock (*Prunus persica* 'Bailey') at the University of Guelph, Simcoe, Ontario in August, 2002. The peach cultivars included both clingstone and freestone, white flesh and yellow flesh, and were as follows: 'Harrow Beauty', 'AC Harrow Diamond', 'AC Harrow Dawn', 'Harson', HW271, HW272, HW273, 'Redhaven', V840601, V85384, 'Venture™', 'Vinegold', 'Virgil', 'Vivid' and 'Vulcan'. Nectarines cultivars included 'Harblaze' and 'Harflame'.

Ten trees of each cultivar were established in 2004 at the University of Guelph, Simcoe Campus, Ontario (lat. 42°51'40" N, long. 80°16'8" W). Cultivars were planted as 1-yr-old whips at a spacing of 2.5 x 4.5 m (889 trees·ha^{-1}), with the base of the bud union 2-4 cm above the soil line. Cultivars were arranged in a randomized complete block design with five replications, and two trees per treatment replication where data were averaged from the two-tree plots.

The research orchard, previously planted to apples in 1997, was kept fallow for five years. Prior to planting in September 2003, 40 t·ha^{-1} of un-composted broiler poultry manure was surface broadcast and immediately incorporated to a soil depth of ~20 cm to help overcome the potential of soil replant disease affecting the new planting (25). The orchard soil was classified as a Brady sandy loam (Aquaic Hapludalf) with imperfect drainage and soil textures consisting of mainly lacrustrine sand and sandy loam over glaciolacustrine clays at depths greater than 1.5 m. Soils in this non-traditional peach growing region are fairly course sands with low water holding capacity and are well-suited to stone fruit production.

Trunk circumference was measured 30 cm above the soil after harvest at the end of each growing season when the trees were dormant and converted to trunk cross-sectional area (TCSA). Trees were trained as a modified central leader with a 2.5 m metal support post adjacent to each tree. In the absence of sufficient natural rainfall, trees were trickle-irrigated with approximately 25 mm of water weekly during June- August using 2 L·hr^{-1} emitters spaced 60 cm apart within the row. Trees were hand- thinned annually after 'June drop' approximately 30-45 days after full bloom (DAFB) and spaced ca. 15 cm apart. Standard cultural and pest management practices for Ontario were used (20).

Date of full bloom (about 80% flowers open) was recorded for six years beginning in spring of 2006. Daily growing degree days from 1 Jan to full bloom and harvest were calculated as the daily mean temperature (^{o}C) - 4.4^{o}C when the daily mean temperature was greater than 4.4^{o}C. Cumulative degree days were calculated as the sum of degree days to full bloom or harvest dates for each cultivar in each year (4, 5). All cultivars were harvested 'tree ripe' over multiple dates (up to three harvests each season) and the weight and number of fruit picked per tree recorded to determine mean fruit size and crop density (number of fruit per unit trunk cross-sectional area). Cumulative yield efficiency was calculated as the sum of annual yields divided by final TCSA. In 2010, tree mortality and mean tree width in the north-south and east-west dimensions as well as tree height were recorded.

Individual cultivars were subjected to analysis of variance using SAS procedure MIXED (SAS, Cary, NC) (17) with cultivars as fixed effects. The model considered replication as a random effect because of the potential for missing plots (trees) over time

Table 1. Tree vigor, as measured by trunk cross-sectional area (cm^2), and tree mortality of seventeen peach and nectarine cultivars growing in Simcoe, Ontario, 2004-10

	Year 1		Year 2	Year 3	Year 4	Year 5		Year 6		Year 7		2010		
Cultivar	2004		2005	2006	2007	2008		2009		2010		Tree width (m)	Tree height (m)	Tree mortality (%)
'Harblaze'	4.4	abcde[z]	10.7	19.8	28.9	42.3	cde	51.6	bcde	53.6	bc	1.9	3.2	10
'Harflame'	3.6	defgh	11.8	20.9	30.9	42.6	cde	49.7	def	55.8	abc	2.0	3.1	0
'Harrow Beauty'	3.8	cdefg	11.4	20.7	28.5	38.4	def	46.9	def	50.1	bc	1.9	2.9	30
'Harrow Dawn'	3.5	fghi	9.1	22.4	35.7	53.0	a	63.1	a	72.1	a	2.1	3.0	20
'Harrow Diamond'	3.3	ghi	12.9	21.7	32.3	47.3	abcd	55.3	abcd	57.9	abc	2.0	3.1	30
'Harson'	4.0	bcdefg	10.2	20.0	33.0	43.2	bcde	50.6	cdef	58.1	abc	2.2	3.0	20
HW271	5.2	a	10.4	20.3	30.4	41.7	cdef	50.1	cdef	55.5	abc	2.0	3.1	50
HW272	4.5	abcde	11.2	21.6	30.9	44.0	abcde	56.2	abcd	60.9	abc	2.0	3.0	30
HW273	3.0	hi	10.0	20.0	31.3	44.1	abcde	52.4	abcde	57.9	abc	2.1	3.0	10
'Redhaven'	4.7	ab	11.3	19.4	28.4	37.1	ef	43.4	ef	47.6	c	2.0	3.0	20
V84061	4.2	bcdef	11.4	21.3	33.2	50.9	abc	61.9	ab	68.0	ab	1.9	2.9	20
V85384	3.4	fghi	10.3	19.2	28.6	42.4	cde	46.4	def	53.3	bc	2.1	3.1	40
'Venture'	3.8	cdefgh	11.7	22.2	34.6	52.3	ab	59.7	abc	67.2	ab	2.2	2.9	0
'Vinegold'	3.9	bcdefg	11.7	20.5	31.3	46.0	abcde	54.5	abcd	59.9	abc	2.0	3.1	30
'Virgil'	3.6	efghi	10.3	17.1	24.6	32.8	f	40.2	f	44.6	c	2.1	2.8	20
'Vivid'	2.8	i	8.4	18.7	28.9	42.2	cde	50.8	cdef	56.0	abc	2.0	3.1	20
'Vulcan'	4.2	bcdef	9.3	20.7	30.6	44.0	abcde	54.2	abcde	61.0	abc	2.0	3.0	30
Significance[y]	***		ns	ns	ns	***		***		*		ns	ns	ns
P value	<0.0001		0.1496	0.3156	0.1016	0.0002		0.0001		0.0406		0.1168	0.2554	0.3296

[z] average values with the same letter within a given column are not significantly different according to Duncan's multiple range test at P=0.05.
[y] ns, ***, **,*, indicates non significance and statistical significance at P=0.001, P=0.01, and P=0.05, respectively

Table 2. Environmental and phenological conditions at Simcoe, Ontario between 2004 and 2010.

Parameter	2004	2005	2006	2007	2008	2009	2010
Mean daily minimum temperature (°C)	3.2	2.6	4.0	4.1	3.9	3.5	6.3
Extreme daily minimum temperature (°C)	-30.4	-28.8	-19.5	-20.5	-18.4	-24.9	-19.1
Mean daily maximum temperature (°C)	12.8	13.7	14.4	13.7	13.1	13.1	16.3
Extreme daily maximum temperature (°C)	30.7	34.9	34.7	33.3	31.8	31.0	33.2
Total rainfall (mm) (1 April - 30 Sept)	438	540	593	325	560	487	764
Degree days (>5°C) 1 Jan - 30 Sept	1995	2183	2101	2262	2134	2026	2351
Bloom date of 'Redhaven'	-[z]	-[z]	9-May	12-May	7-May	6-May	23-Apr

[z] - no bloom because of winter injury to flowers

Table 3. Date of full bloom, average full bloom date, and average degree days at full bloom for various peach and nectarine cultivars growing in Simcoe, Ontario from 2006-2010. Cultivars listed in ascending order of average bloom date.

	Date of Full Blom (FB)								
Cultivar	2006	2007	2008	2009	2010	2011	Range (2006-2011)	Average date of FB (2006-11)	Average days[z] (2006-2011)
'Harson'	10-May	7-May	6-May	2-May	23-Apr	12-May	19	4-May	189
HW 272	8-May	10-May	7-May	1-May	22-Apr	13-May	21	4-May	184
'Harflame'	9-May	9-May	7-May	5-May	23-Apr	11-May	18	4-May	189
HW 271	9-May	10-May	6-May	2-May	23-Apr	14-May	21	4-May	190
V84061	8-May	12-May	7-May	6-May	23-Apr	11-May	19	5-May	186
V85384	7-May	10-May	6-May	8-May	22-Apr	12-May	20	5-May	187
HW 273	8-May	12-May	7-May	6-May	23-Apr	12-May	19	5-May	188
'Harrow Beauty'	8-May	9-May	7-May	5-May	23-Apr	15-May	22	5-May	192
'Harblaze'	10-May	12-May	6-May	3-May	23-Apr	11-May	19	5-May	193
'Redhaven'	9-May	12-May	7-May	6-May	23-Apr	13-May	20	5-May	194
'Harrow Dawn'	10-May	11-May	7-May	7-May	24-Apr	11-May	17	5-May	196
'Harrow Diamond'	10-May	9-May	8-May	6-May	24-Apr	13-May	19	5-May	200
'Venture'	11-May	10-May	5-May	9-May	21-Apr	11-May	20	5-May	202
'Vulcan'	11-May	14-May	9-May	3-May	24-Apr	13-May	20	6-May	206
'Virgil'	11-May	12-May	8-May	10-May	24-Apr	11-May	18	6-May	208
'Vivid'	11-May	12-May	9-May	9-May	25-Apr	15-May	20	7-May	217
'Vinegold'	11-May	14-May	9-May	11-May	25-Apr	14-May	19	8-May	217
Range	4	7	4	10	4	4		4	33

[z] GDD=cumulative growing degree-days from 1 Jan to date of full bloom and calculated as [the sum of daily maximum temperature (°C) + daily minimum temperature (°C)]/2 - 4.4°C.

because of tree mortality (18). Means were separated using Duncan's HSD ($P \leq 0.05$).

Results and Discussion

Tree Survival and Vigor: No significant differences in tree mortality, tree width or tree height were observed among cultivars after seven growing seasons (Table 1). All 'Venture™' and 'Harflame' trees survived after seven years, however 40 and 50% of V85384 and HW271 died over the same period. Winter temperature lows of -30.4°C and -28.8°C (Table 2) were recorded in 2004 and 2005, respectively, resulting in visible flower bud damage (using a 10x magnification hand lens) and no fruit set occurring during the first two years of establishment. No appreciable trunk or scaffold injury to trees was observed. By 2010, most trees had filled their allotted space and were being restricted to their in-row spacing and to a height of ~ 3 m by pruning.

At the end of the first growing season, significant differences in tree vigor, as expressed by TCSA, were observed among cultivars (Table 1). HW271 and 'Redhaven' were the most vigorous while HW273 and 'Vivid' were among the least vigorous cultivars. During years 2 to 4, growth of the 17 cultivars was similar. In year 5, differences in tree vigor amongst cultivars began to emerge and remained so to year 7. At the end of

Table 4. Cumulative yield of seventeen peach and nectarine cultivars growing in Simcoe, Ontario, 2006-10

Cultivar	Cumulative yield (kg/tree)										Cumulative yield efficiency	
	2006		2007		2008		2009		2010			
'Redhaven'	17.4	a[z]	39.0	ab	64.5	a	85.6	a	126.1	ab	2.73	a
HW272	14.7	a	43.1	a	59.5	abc	76.7	abc	113.5	ab	1.92	c
V84061	15.1	a	31.8	bcd	56.2	abc	73.0	abcd	105.7	bcd	1.60	de
'Vinegold'	10.6	bc	29.4	cd	52.3	bc	65.5	bcde	98.8	bcd	1.67	cd
'Harrow Dawn'	8.0	c	33.2	bc	60.9	ab	78.3	ab	98.4	bcd	1.30	fg
'Virgil'	14.0	ab	33.2	bc	53.4	abc	64.5	cde	96.9	bcd	2.28	b
'Harson'	9.8	c	32.8	bc	55.7	abc	70.6	bcd	96.8	bcd	1.73	cd
HW271	0.0	e	26.9	cd	49.5	bc	60.5	de	94.5	bcd	1.70	cd
'Vivid'	10.5	bc	26.4	cd	47.9	c	61.1	de	93.3	cd	1.76	cd
'Harrow Diamond'	8.2	c	30.2	bcd	51.6	bc	59.4	de	80.7	de	1.35	ef
'Vulcan'	8.3	c	23.1	d	35.9	d	54.8	e	72.7	e	1.20	fgh
HW273	0.0	e	0.0	f	5.4	fg	16.9	fg	53.4	fg	0.93	h
'Harrow Beauty'	0.0	e	0.0	f	5.0	fg	15.0	gf	49.4	fg	1.03	gh
'Venture'	0.0	e	0.0	f	0.0	g	2.8	hi	38.6	fg	0.60	i
'Harblaze'	3.8	de	9.2	e	14.0	ef	28.7	f	37.7	fg	0.64	i
V85384	0.0	e	0.0	f	0.0	g	3.1	hi	32.5	fgh	0.64	i
'Harflame'	7.6	cd	14.1	e	19.6	ef	19.7	fg	19.7	h	0.35	i
significance[y]	***		***		***		***		***		***	
P value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	

[z] average values with the same letter within a given column are not significantly different according to Duncan's multiple range test at *P*=0.05.

[y] ns, ***, **, *, indicates non significance and statistical significance at *P*=0.001, *P*=0.01, and *P*=0.05, respectively

Table 5. Mean fruit weight (g) of seventeen peach and nectarine cultivars growing in Simcoe, Ontario, 2006-10

Cultivar	2006		2007		2008		2009		2010	Overall mean fruit weight (2006-2010)	Mean crop load (no frt cm^{-2} TCSA)	
'Harrow Beauty'	-[z]		-		174	a[y]	214	a	151	180	1.5	e
V85384	-		-		-		201	ab	128	172	0.9	e
HW273	-				155	ab	146	de	207	165	1.6	e
'Vivid'	176	ab	155	a	155	cd	195	abc	145	165	3.3	d
'Harson'	172	abc	135	bcd	167	bc	164	bcde	134	159	3.6	d
V84061	155	abc	147	a	155	cd	161	bcde	156	153	3.5	d
'Virgil'	165	abc	141	b	178	bc	163	bcde	167	151	4.5	bc
'Redhaven'	169	abc	142	bc	168	cde	167	bcde	194	149	5.4	a
'Vinegold'	187	a	127	bcd	138	def	148	f	130	139	3.8	cd
'Harrow Diamond'	131	bcd	120	bcd	136	def	151	de	112	136	3.6	d
'Harblaze'	123	bcd	118	bcd	98	def	152	de	94	130	1.4	e
'Harflame'	141	abcd	97	cd	91	f	144	de	-	129	1.2	e
HW271	-	-	139	bcd	143	def	142	de	149	124	3.8	cd
HW272	140	bcd	132	d	126	def	130	def	149	123	5.0	ab
'Vulcan'	107	d[z]	122	bcd	114	def	140	de	120	117	3.4	d
'Harrow Dawn'	139	bcd	120	cd	124	f	119	ef	115	115	4.0	cd
'Venture'	-		-		-		95	de	117	108	1.2	e
significance[x]	*		***		***		***		ns	***	***	
P value	0.0179		<0.0001		<0.0001		<0.0001		0.8355	<0.0001	<0.0001	

[z] data not available

[y] average values with the same letter within a given column are not significantly different according to Duncan's multiple range test at P=0.05.

[x] ns, ***, **, *, indicates non significance and statistical significance at P= 0.001, P= 0.01, and P=0.05, respectively

the study, 'AC Harrow Dawn' was the most vigorous while 'Redhaven' and 'Virgil' were the least vigorous among the 17 cultivars, the latter two approximately 35% smaller than 'AC Harrow Dawn' based on TCSA.

Flowering, Fruit Size, Harvest Dates and Yield: Dates of full bloom ranged from 21 April for 'Venture' to 15 May for 'Harrow Beauty' and 'Vivid' over a period of six years (2006-2011) (Table 3). The span of flowering among cultivars was narrower within than between years. For example, in 2009, flowering occurred over a 10 day period (1-May to 11-May) but between 2006 and 2011, the range in flowering dates ranged from 18-22 days for a given cultivar. This represented, on average, a range of 33 degree days between the earliest and latest booming cultivar. Within a cultivar, dates of annual flowering were closely associated with heat accumulation once dormancy had been fulfilled in late winter (data not shown), resulting in the wide span of bloom dates. For 'Redhaven', a popular cultivar grown in Ontario, the bloom dates were considered early (2010) and late (2007) in one of five years and close to 'average' in three of five years (2006, 2008, 2009) (Table 3).

These data are comparable to other peach cultivar studies that have monitored bloom dates over several years (4, 5). Differences among and within cultivars in bloom date are both a function of genetic response to the environmental conditions within a season and thermal heat accumulation (eg, degree days) for a given cultivar between seasons.

The reported average date (50% likelihood)

of spring frost (<0°C) in Simcoe, Ontario is 5-May (2, 3). Based on 30 year climate normals, the authors suggest that the risk of frost decreases by 25% for each additional 7 days after this date. Furthermore, Simcoe is 10 km north of Lake Erie, and it is estimated that the risk of frost increases by 1 day for every 1-2 km inland (up to 15 km) from the Great Lakes (3). Over the past two decades at the Simcoe Horticultural Research Station, average bloom dates of apples, which flower about 10 days later than peaches, have advanced 1-2 days earlier (personal observation) perhaps due to climate change (7) or other climatic factors. Nevertheless, there remains a high probability of frost injury to peach bloom in this region, although this was not experienced over the 7 years of this study.

Genetics, environment, and crop load are the primary factors influencing yield and fruit size of peaches (26). Four cultivars: 'Harrow Beauty', HW273, V85384 and 'Venture™' had little or no fruit yield between 2006-08 (Table 4). In contrast, HW272, 'Redhaven', V84061 and 'Virgil', had high early yields in 2006 and 2007, leading to high cumulative yields by 2010 (Table 4). Overall, 'Redhaven', V84061 and HW272 had the greatest cumulative yields while 'Harblaze', V85384, 'Venture™', and 'Harflame' had the lowest. Other cultivars had intermediate cumulative yields in comparison.

Significant genotype differences in fruit size were observed over the five bearing years of this study. Fruit size appeared to be mostly a function of genetic potential rather than crop load. This is based on the fact that trees were irrigated and crop loads were managed to commercial levels (ca. 15 cm spacing). Furthermore, there appeared to be little or no overall relationship between mean fruit

Table 6. Average harvest dates of peach and nectarine cultivars. Horticultural Experiment Sation, Simcoe, Ontario

Cultivar	Peach (P) or Nectarine (N)	Flesh color	Clingstone (C)/ Freestone (F)	Use[z]	Date[y]	Days before (-) or after (+) 'Redhaven'	Time bloom harvest (days)	Avg. degree days[x] (2006-(2010)
'Harrow Diamond'	P	Yellow	F	Fresh	27-Jul	-19	83	1313
'Harrow Dawn'	P	Yellow	F	Fresh	29-Jul	-17	85	1411
'Vulcan'	P	Yellow	C	Processing	1-Aug	-14	87	1323
'Vinegold'	P	Yellow	C	Processing	8-Aug	-7	92	1462
HW272	P	Yellow	F	Fresh	9-Aug	-6	97	1543
'Virgil'	P	Yellow	F	Fresh	9-Aug	-6	95	1490
HW271	P	White	F	Fresh	10-Aug	-5	98	1469
'Harson'	P	Yellow	F	Fresh	11-Aug	-4	99	1522
V84061	P	Yellow	C	Processing	11-Aug	-4	98	1564
'Harflame™'	N	Yellow	F	Fresh	13-Aug	-2	101	1550
'Redhaven'	P	Yellow	F	Fresh	15-Aug	0	102	1583
'Vivid'	P	Yellow	F	Fresh	16-Aug	1	101	1619
'Harblaze'	N	Yellow	F	Fresh	17-Aug	2	104	1560
'Harrow Beauty'	P	Yellow	F	Fresh	25-Aug	10	112	1527
HW273	P	White	F	Fresh	27-Aug	12	114	1816
V85384	P	Yellow	F	Fresh	3-Sep	19	121	1835
'Venture™'	P	Yellow	C	Processing	4-Sep	20	122	1898

[z] - Uses are fresh market (fresh) or canning (processing). Usually the former have melting flesh and the later have non-melting flesh
[y] Dates represent a 4-yr average (2007-10)
[x] GDD=cumulative degree-days from 1 Jan to first harvest and calculated as the sum of [daily maximum temperatue (°C) plus daily minimum temperatures (°C)/2]-4.4°C]

Table 7. Summary of peach and nectarine fruit and tree characteristics

	Nectarines (Fresh Market)
'Harblaze'	'Harblaze' is a cross made in 1973 between 'Stark Delicious' x 'Hardired', tested as HW104, and introduced by Agriculture Canada, Harrow in 1989 (10). This cultivar has promise as a commercial-type nectarine that ripens during the late 'Redhaven' season. Previous reports indicate that the tree is vigorous and productive and equally bud and wood-hardy as 'Redhaven' (1). The fruit skin has 90% bright red blush over yellow-orange ground color. Fruit are medium-to-large-sized and are semi-freestone (1, 24). In the present study, the tree had moderate vigor with low cumulative yields of small-medium sized fruit (130 g). The fruit tends to soften quickly near maturity during final swell. 'Harblaze' has a good level of resistance to bacterial spot, brown rot and powdery mildew. It is susceptible to foliar and fruit damage caused by Japanese beetles (*Popillia japonica* Newman). It is recommended for trial planting in this production region.
'Harflame'	Harflame' is a cross made in 1973 between 'Fantasia' x H7343017 and introduced in 1996 (11) by Agriculture Canada, Harrow. 'Harflame' ripens 1 day before 'Harblaze'. The tree is reportedly as hardy as 'Redhaven', has medium vigor, somewhat upright and moderately productive (24). In the present study, the tree had moderate vigor with very low cumulative yields of small-medium sized fruit (129 g). It has good field resistance to bacterial spot, brown rot and canker but is susceptible to foliar and fruit damage caused by Japanese beetles. The fruit is attractive, medium sized with 80% dark red blush on yellow background. It is semi-freestone, ripens uniformly with a medium-firm yellow flesh, medium quality and a low incidence of split-pits. It is recommended for trial planting in this production region.
	Peaches (Fresh Market)
'Harrow Beauty'	'Harrow Beauty' is a 1983 Agriculture Canada introduction formerly tested as HW231 ('Cresthaven' x 'Harken')(8). It ripens with 'Loring' and 'Canadian Harmony' but is more winter-hardy. The fruit resembles 'Harken' (1) with very firm, highly attractive, medium-sized fruit that ships well. The yellow, freestone flesh has red anthocyanin around the pit cavity. Leaves and fruit have good resistance to perennial canker, bacterial spot and brown rot. The skin is well-colored and attractive. In the present study the tree had moderate vigor with low cumulative yield. Fruit size was, however, excellent on average (180 g).
'AC Harrow Dawn' (PBR No. 0573)	'AC Harrow Dawn' is a cross between 'Cresthaven' x 'Harbinger', tested as HW254 released in 1996 by Agriculture Canada, Harrow (13). The tree is hardier than 'Redhaven', very vigorous, productive, with medium-to-high field resistance to bacterial spot, brown rot and canker. Fruit are very attractive with a bright red blush on a yellow background. Fruit ripen 17 days before 'Redhaven', are uniform in ripening, are small - medium in size with firm yellow flesh. The fruit is usually freestone when ripe, medium-to-good quality, and has very few split-pits. This cultivar was one of the best performing early peach cultivars tested in this experiment.
'AC Harrow Diamond'	'AC Harrow Diamond' is a cross between 'Redskin' x 'Harbinger', tested as HW213 and released in 1984 by Agriculture Canada, Harrow (9). 'AC Harrow Diamond' ripens about 1 week before 'Garnet Beauty', about 21 days before 'Redhaven' and is reportedly winter hardy, disease resistant and has few split-pits. The fruit have an attractive red solid blush over a bright yellow ground color. The fruit flesh is deep yellow, low-oxidizing, melting, medium firm, moderately sweet and juicy, and nearly freestone when fully ripe. Because the fruit tends to be small, this cultivar must be thinned early and adequately to obtain suitable size. Fruit soften quickly so timely harvest is important. The tree has moderate

vigor, with an open-spreading habit, and moderate cumulative yields based on the present study. It is tolerant to Leucostoma canker and resistant to bacterial spot and brown rot (1). Wood and fruit buds are reportedly winter hardy with full crops produced after exposure to -26 to -28°C (22) in other regions.

'Harson' A 1982 Agriculture Canada, Harrow introduction, 'Harson' ripens with 'Redhaven', producing highly colored and attractive medium-to-large-sized fruit that are nearly freestone with firm, yellow melting flesh. 'Harson' is a cross between 'Redskin' and 'Sunhaven', and was tested originally as H781. The crop ripens uniformly about 4 days before 'Redhaven' and is reported to pack out well (24). The tree has winter hardiness similar to that of 'Redhaven' with above-average resistance to bacterial spot and brown rot, and moderate tolerance to perennial canker. Fruit resembles 'Redhaven' with uniform size and yellow, melting flesh. In the present study, the tree was moderately vigorous, had high cumulative yields, high yield efficiency, and excellent fruit size. The cultivar performed very well in this test and is recommended for further planting in this region.

HW271 A white-fleshed freestone peach selection from Agriculture Canada, Harrow that ripens about 4-5 days before 'Redhaven'. The tree had moderate vigor, good cumulative yields and yield efficiency, but tended to have small fruit, although previous reports indicate HW271produced medium-large fruit in Harrow, ON (16). HW271 has winter hardiness similar to 'Redhaven' (8) and in previous studies the tree is reported to be productive, upright to spreading with good field resistance to canker, bacterial spot and brown rot (16). The fruit is attractively colored with 80+% red blush on a cream background. Flesh is white with light to moderate red pigmentation, firm, freestone and flavor is medium to good. Very few split pits have been observed. This is a promising white-fleshed peach for the fresh market and is recommended in trial plantings as an early-season white-fleshed peach for niche markets, road-side stands and farmers' markets.

HW272 A yellow-flesh peach test selection from Agriculture Canada, Harrow that ripened about 6 days prior to 'Redhaven', although previous reports indicate in ripens around 3 days before 'Redhaven' (15). The tree had moderate vigor, very high cumulative yields and yield efficiency, but tended to have small fruit, although previous reports indicate the fruit is medium to large (8, 16). It consistently set a good crop annually and therefore annual thinning is important. HW272 has flower buds that are reportedly hardier than 'Redhaven' and wood is as hardy as 'Redhaven' (8, 16). Growth habit is upright to spreading, and in previous tests, trees had good field resistance to canker, bacterial spot and brown rot (8, 16). The fruit is attractively colored with a 60-70% red blush on a bright yellow background. Flesh is yellow, firm, freestone and the flavour is good. There are usually no split pits. This was one of the few peaches to bear any fruit in 1994 after a severe winter. Further testing is required for large-scale planting of this cultivar.

HW273 A white-flesh peach test selection from Agriculture Canada, Harrow that ripens 12 days after 'Redhaven'. The tree had moderate vigor, moderate cumulative yields and low yield efficiency, but tended to have large fruit, although past reports indicate it to be productive and vigorous (15,16). It is recommended as a late-season white-fleshed peach for niche markets. The tree is reportedly hardier than 'Redhaven', resistant to bacterial spot, brown rot and canker (15, 16). Fruit are very good quality, large sized and attractive with 50-70% red blush, round and very smooth skin, consistent with other reports (16).

'Redhaven' A 1940 Michigan introduction. 'Redhaven' is mid-season peach with an attractive red color and good fruit quality. Fruit are medium in size, round, with yellow skin overlaid with red to deep red blush. The flesh is non-browning, very firm, melting with red color at the pit. Trees frequently set heavy crops and must be adequately thinned to obtain marketable size. The crop ripens unevenly, and trees must be harvested several times. When well grown and properly handled, 'Redhaven' is a superior cultivar with good winter hardiness. In the

present study it produced a weak tree of low vigor but had very high cumulative yields and extremely high cumulative yield efficiency. Fruit size was good and crop loads were consistently high. This cultivar was one of the best overall performers in the present study.

V85384 — A late-season fresh market freestone peach that matured 3 Sept. in Simcoe, Ontario. The fruit is large and has a red blush. It also has exceptional storage life – much longer than most selections and cultivars grown in Ontario. The flesh is firm and melting with some red color around the pit. Trees display a moderately spreading growth habit with consistently good productivity. A major flaw with this selection is reported susceptibility to cold injury and perennial canker (J. Subramanian, personal communication), although neither were observed in the present study.

'Vivid' — A 1974 introduction (tested as V55115) from the Horticulture Research Institute of Ontario, Vineland. 'Vivid' is a cross between 'Sunhigh' and V46042 (= 'Early Halehaven' x 'Envoy') (19). Fruit are attractive with a bright red blush, with firm flesh, good size and quality. The trees are vigorous and productive. 'Vivid' has become an important cultivar in Ontario to follow 'Redhaven' as a fresh-market and processing peach. However, it is reportedly less winter hardy than 'Redhaven'.

Peaches (Processing)

V84061 — A cling-type ripening around 11Aug, and currently in the development stage by the University of Guelph, Vineland. This is a processing peach that has golden yellow flesh and no undesirable red pigment around the pit (J. Subramanian, personal communication). Application to Plant Breeder's Rights in Canada was abandoned in Oct 2008. In the present study, this cultivar had good vigor, excellent productivity based on cumulative yields with very good fruit size. Trial planting is recommended in non-traditional growing regions similar to Simcoe.

'Venture™' — Tested as V75024, 'Venture™' is a processing peach introduced by the University of Guelph, Vineland in 2000. It ripens 2 days after 'Babygold 5' and is capable of producing large crops of large fruit of good quality and firmness. The fruit has some red in the flesh near the pit under certain conditions but no more than 'Babygold 5'. The fruit has good resistance to bacterial fruit spot and brown rot and hangs well on the tree. The vigorous and productive tree (24) is less upright than 'Babygold 5' and easier to train, and is recommended as an excellent replacement for 'Babygold 5'. The cultivar is relatively free of split-pits (21). In the present study, cropping was poor during 2003-2009 leading to low cumulative yields. In spite of excellent performance in the Niagara Peninsula (J. Cline, personal observation), fruit size was also small and therefore further testing of 'Venture™' is recommended prior to large-scale adoption in non-traditional producing regions such as Simcoe.

'Vinegold' — 'Vinegold' ripens about 7 days before 'Redhaven' and is a good choice for an early-season canning peach. The moderately vigorous and spreading trees are productive and moderately disease resistant to bacterial canker (19). The medium size fruit are of a uniform round-blocky shape and process into a richly colored product. Split-pits have been observed during some fruiting seasons. 'Vinegold' is a processing cultivar worthy of trial planting in regions similar to Simcoe.

'Virgil' — 'Virgil' ripens ~7 days before 'Redhaven'. The large, round and uniform fruit has firm flesh and good quality. The fruit is also free of red color and resistant to split-pits (21). The trees are moderately resistant to bacterial spot, brown rot and Leucostoma canker. The uniformity of harvest makes this cultivar a good choice to precede 'Veecling', another processing peach cultivar grown in the region.

'Vulcan'	'Vulcan' ripens ~12 days before 'Veecling' and approximately 2 weeks before 'Redhaven'. This commercial cultivar is the earliest maturing processing peach. Fruit have a 60-80% red skin blush color and a firm golden flesh. 'Vulcan' is relatively free of split-pits for the early season (21). The trees are vigorous, winter hardy and resistant to bacterial spot and Leucostoma canker (19), but moderately susceptible to brown rot disease (24). In the present study, trees had low cumulative yields and fruit size was small (117 g). There are other processing cultivars that performed better in this study and therefore this cultivar is not recommended in regions similar to Simcoe.

size and mean crop load (Table 5) based on regression analysis (data not shown).

Average harvest dates ranged over a six week period (39 days) beginning on 27 Jul with "Harrow Diamond' and ending with 'Venture™' on 4 Sep (Table 6). These dates represent the average date of harvest, and not the picking window, which would normally extend 2-3 days before and after this date for a given cultivar. Differences existed in harvest dates and degree day accumulation (ranging from 1313 to 1898 units) to harvest among cultivars. These data are useful to estimate if and when these cultivars would mature for other growing regions of the world based on heat accumulation rather than calendar date (4, 5). Harvest date for each cultivar varied annually, but the sequence of harvest among cultivars generally stayed the same in each season. The range among cultivars was more spread for their harvest dates compared to bloom dates, consistent for other studies (5). Dates are all compared with 'Redhaven', a mid-season fresh-market peach very commonly grown in the Niagara Peninsula. A summary of fruit and tree characteristics of each cultivar is presented in Table 7 and is intended to form the key discussion points of this paper.

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Literature Cited

1. Brooks, R.M. and H.P. Olmo. 1972. Register of new fruit and nut cultivars. 2nd ed. ASHS Press, Alexandria, VA.
2. Brown, D. M., G.A. McKay and L.J. Chapman. 1980. The climate of Southern Ontario 5. Environment Canada, Atmospheric Environment Service, Climatological Studies, Ottawa.
3. Brown, D.M and A. Bootsma. 1991. Freeze risk during spring and autumn in Ontario. Ontario Ministry of Agriculture and Food. Agdex 072, Order No 91-006. Queens Printer of Ontario.
4. Fallahi, E., B. Fallahi, B. Shafii, M. E. Amiri and M. Mirjalili. 2009. Bloom and harvest dates, fruit quality attributes, and yield of modern peach cultivars in the intermountain western United States. HortTechnology 19:823-830
5. Fallahi, E., B. Fallahi, B. Shafii and M. E. Amiri. 2009. Growing degree days, bloom and harvest dates, fruit quality and yield of new yellow and white nectarines. Journal American Pomological Society 63:150-159.
6. Frecon, J. 2004. Peach. In Register of New Fruit and Nut Varieties List 42. W. R. Okie (ed.). HortScience 39:1509-1523.
7. Caprio, J.M. and H.A. Quamme. 2006. Influence of weather on apricot, peach and sweet cherry production in the Okanagan Valley of British Columbia. Canadian Journal of Plant Science 86:259-267.
8. Layne, R. E. C. 1984. Harrow Beauty peach. HortScience 19:729-730.
9. Layne, R. E. C. 1985. Harrow Diamond peach. HortScience 20:1143-1144.
10. Layne, R. E. C. 1991. Harblaze nectarine. HortScience 26:425-427.
11. Layne, R. E. C. 1991. 'AC Harflame' nectarine. HortScience 31:1050-1051.
12. Layne, R. 1996. HW 271 and HW 272 Peach Descriptions. WOFTA (Western Ontario Fruit Testing Association)News 27(3)
13. Layne, R. E. C. 1996. 'AC Harrow Dawn' peach.

HortScience 31:1046-1047.
14. Layne, R.E.C. 1997. Peach and nectarine breeding in Canada: 1911-1995. Fruit Varieties Journal 51:218-228.
15. Layne, R. 1999. HW273 Peach Description. OFTA (Ontario Fruit Testing Association) News 1:2
16. Layne, R. 2001. HW271, HW272, HW273 Peach Description. OFTA News 3 (September)
17. Layne, D. and D. Bassi. 2008. The Peach: Botany, Production and Uses. Oxford University Press. 632 p.
18. Marini, R., R. Moran, C. Hampson, M. Kushad, R.L. Perry and T.L. Robinson. 2008. Effect of Dwarf Apple Rootstocks on Average 'Gala' Fruit Weight at Six Locations over Three Seasons. J. Amer. Pomol. Soc. 62:129-136
19. Okie, W.R. 1998. Handbook of peach and nectarine varieties: Performance in the southeastern United States and index of names. U.S. Dept. Agr. – Agr. Res. Serv. Hdbk. No. 714.
20. Ontario Ministry of Agriculture, Food and Rural Affairs. 2008. Fruit production recommendations. Publication 360. Ontario Ministry of Agriculture, Food and Rural Affairs. Guelph, Ontario. Queen's Printer for Ontario, Toronto, Ontario.
21. O'Malley, C. and J.T.A. Proctor. 2002. Split pits in Canadian peaches. J. Amer. Pom. Soc. 56:72-75.
22. Quamme, H.A., R.E.C. Layne and W.G. Ronald. 1982. Relationship of supercooling to cold hardiness and the northern distribution of several cultivated and native Prunus species and hybrids. Canadian Journal of Plant Science 62:137-148.
23. SAS Institute, Inc. 1989. SAS/STAT user's guide. Version 6, Vol. 2. SAS Institute, Inc., Cary, NC.
24. Slingerland, K. and J. Subramanian. 2007. Peach and Nectarine Cultivars. Agdex 211. Ontario Ministry of Agriculture, Food and Rural Affairs. Guelph, Ontario. Queen's Printer for Ontario, Toronto, Ontario.
25. Stirling, G. R., S. R. Dullahide and A. Nikulin. 1995. Management of lesion nematode (*Pratylenchus jordanensis*) on replanted apple trees. Australian Journal of Experimental Agriculture 35:247–258.
26. Westwood, M.N. 1993. Temperate-Zone Pomology: Physiology and Culture, Third Edition. Timber Press, Portland, Oregon.

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A possible mechanism for phloem transport of boron in 'Hass' avocado (Persea americana Mill.) trees

A continuous supply of boron (B) is vital for the formation of new cells, with reproductive growth being particularly sensitive to boron deficiency. An inadequate B supply therefore has the potential to effect fruit set, which is a major problem in avocado (*Persea americana* Mill.) cultivation. B is not phloem mobile in many plant species, but when sorbitol or mannitol (both polyols) are present in phloem sap, then B forms a complex with the polyol, enabling transport in the phloem. Phloem mobility of B has never been demonstrated in avocado. Avocados are unusual in that they produce the 7-carbon sugar, D-mannoheptulose, and its polyol form, perseitol. In this work, we demonstrate that B forms a complex with perseitol *in vitro*, that both B and perseitol are found in avocado phloem sap, that B is found in higher concentrations within immature leaves than in mature leaves, and that ^{10}B is exported from mature leaves into inflorescences and new leaves. All these findings are consistent with B being transported as a B-perseitol complex in the phloem sap of avocado trees. Abstract from: P.E.H. Minchin, T.G. Thorp, H.L. Boldingh, N. Gould, J.M. Cooney, F.B. Negm, E. Focht, M.L. Arpaia, H. Hu and P. Brown, 2012**.** The Journal of Horticultural Science & Biotechnology 87(1):23-28