

## BIOAG PROJECT FINAL REPORT 2013

**TITLE:** Evaluating Apple Varieties for Hard Cider Production

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**KEY WORDS**

apples, hard cider, productivity, juice analysis, tannin, brix, pH, malic acid, bloom dates

**ABSTRACT**

This project addresses the BIOAg priority of innovation and diversification by supporting the formation of a hard cider industry in the Pacific Northwest. The project includes: an analysis of juice of cider apple varieties grown in the region; a comparison of four varieties each grown in five different orchards to better understand if there is regional variation in juice quality due to location; four new varietal ciders were initiated following the 2012 harvest; an evaluation by a trained sensory panel of nine varietal ciders made in 2011 at WSU Mount Vernon NWREC; the formation of a cider sensory evaluation panel comprised of regional cider experts; and the online posting of a training workshop for bud grafting of cider and dessert apples. The project goal is to increase knowledge about the characteristics of cider apple juice and varietal ciders, and to support the production of quality cider. Cider is a high-value apple product that can be processed and marketed year-round, which can improve the economic sustainability of growers' orchards and provide local employment opportunities beyond the harvest season, promoting greater sustainability in the rural community as a whole. Washington is poised to become a leader in cider research and production in the U.S., and WSU Mount Vernon NWREC has one of the most active cider research programs in the country. Cider is well suited to small-scale artisanal producers in western Washington who rely on local markets, as well as large-scale wholesale producers in central Washington who rely on mass production and export. Additionally, cider apple production is well suited to western Washington where environment-induced disease such as scab otherwise limits apple production. This project will provide a foundation for an expanding Washington cider industry.

**PROJECT DESCRIPTION**

This study was conducted at WSU Mount Vernon NWREC and with cooperating growers and cider experts in 2012-2013. The planting at WSU Mount Vernon includes a total of 69 cider apple varieties (as of May 2013) in 3 field blocks:

**Block 1:** 32 cider apple varieties of 3 - 5 trees each, includes: 6 varieties established in 1994; from 1999 to 2005, 3 varieties were removed and 14 were added; in 2005-2006, new varieties were added and diseased trees were removed in 2009-2010;

**Block 2:** A trellis planting of 5 cider apple varieties in 4 rows closely spaced on strongly dwarfing rootstocks (M27 and M9) with 40-60 trees per row, established to investigate mechanical harvest;

**Block 3:** 27 cider apple varieties, single trees planted in 2004 and 2006; includes classic American cider varieties and other varieties from the European cider making centers of England and France; 8 more were added in 2013.

Trees in the NWREC research orchard were monitored for bloom date and density, fruit was collected from varieties that set fruit, and juice was pressed and analyzed. Cider was made from a few select varieties. Cooperating orchardists were contacted at two locations each in western and central Washington for comparison of fruit from the same 4 commonly grown cider varieties. Samples were collected from cooperators' orchards, dates of harvest were recorded, the fruit was pressed and juice frozen for analysis.

Finished ciders produced from single varieties at WSU Mount Vernon NWREC in 2011 were evaluated by selected panels of trained evaluators, using the sensory analysis methods developed by Peter Mitchell, international cider expert and cider judge. The panels were conducted by Drew Zimmerman.

A training video for bud grafting of cider and dessert apples was recorded with Tom Thornton, a local nursery grower and orchardist, and the video has been posted online.

## OUTPUTS

### Work Completed:

Bloom date and bloom density (abundance) were recorded once a week, beginning in early May 2012, for all trees in the study at WSU Mount Vernon NWREC. In September fruit set was rated, and observations on tree vigor, habit, or disease susceptibility were noted. Data for 2012 is shown in Table 1 and included in tables of cumulative bloom data that can be accessed on our website <http://extension.wsu.edu/maritimefruit/Documents/CiderBloomData.pdf>.

**Table 1.** Mean date of full bloom 2000-2012, full bloom 2012, mean bloom density 2000-2012, and bloom density 2012 in cider apple varieties observed at WSU Mount Vernon NWREC, listed in order from mean earliest to latest bloomers.<sup>1</sup>

Variety	Mean FB Date	FB 2012	Mean Bloom Density <sup>2</sup>	BD 2012
Gravenstein <sup>3</sup>	4/26	5/2	4.3	4.0
Grindstone	4/29	5/10	2.5	3.0
Ross Nonpareil	4/30	5/2	5.0	5.0
Golden Russet	5/2	5/2	4.6	5.0

Granniwinkle	5/2	4/30	4.8	4.0
Roxbury Russet	5/3	5/6	3.3	3.0
Jouveaux	5/3	5/2	4.2	1.0
Jonagold <sup>3</sup>	5/4	5/8	4.8	5.0
Grimes Golden	5/4	5/6	4.5	4.0
Fillbarrel	5/4	5/2	3.5	5.0
Maude	5/5	5/8	4.6	5.0
Track Zero (Ross Sdlg)	5/6	5/12	3.8	5.0
Foxwhelp	5/7	5/2	3.9	4.0
Reine des Pommes	5/8	5/14	2.8	2.0
Campfield	5/8	5/8	4.1	4.0
Tom Putt	5/8	5/12	4.4	5.0
Smith's Cider	5/8	5/10	3.3	2.0
Zabergau Reinette	5/9	5/12	3.7	3.0
Cap of Liberty	5/9	5/10	4.2	5.0
Domaines	5/10	5/10	4.1	4.0
Redstreak	5/10	5/16	3.3	2.0
Finkenwerder Herbstprinz	5/10	5/12	3.7	4.0
Bramley's Seedling	5/10	-	2.4	0.0
Bulmer's Norman	5/11	5/14	4.7	5.0
Amere de Berthcourt	5/11	-	2.4	0.0
Harrison	5/11	5/12	3.7	3.0
Frequin Rouge	5/11	5/10	4.3	4.0
Sweet Alford	5/11	5/2	3.0	4.0
Reine des Hatives	5/13	5/14	1.5	1.0
Muscadet de Dieppe	5/13	5/14	2.9	2.0
Whidbey	5/13	5/10	2.9	3.0
Bouteville	5/14	5/14	3.4	3.0
Brown's Apple	5/14	5/14	3.7	3.0
Michelin	5/14	5/16	4.3	3.0
Taylor's	5/14	5/14	3.4	3.0
Mettais	5/14	5/14	4.3	3.0
Doux Normandie	5/15	5/14	4.9	5.0
Kingston Black	5/15	5/14	3.3	2.0
Bramtot	5/16	5/16	4.5	4.0
Taliaferro	5/16	5/14	1.8	1.0
Muscat de Bernay	5/16	5/14	3.1	3.0
Yarlington Mill	5/17	5/16	3.7	5.0
Kermerrien	5/18	-	2.8	0.0
Peau de Vache	5/18	5/14	4.0	2.0
Chisel Jersey	5/18	5/16	3.1	1.0
Lambrooke Pippin	5/18	5/16	3.0	2.0
Harry Masters' Jersey	5/19	5/17	3.7	4.0
Blanc Mollet	5/20	-	2.3	0.0

Major	5/20	5/14	2.9	3.0
Dabinett	5/21	5/23	3.4	4.0
Stembridge Jersey	5/22	-	2.9	0.0
Sweet Coppin	5/22	5/16	2.5	1.0
Brown Snout	5/24	5/23	3.5	2.0
Vilberie	5/25	5/23	3.0	4.0
Breakwell Seedling	5/26	5/23	3.8	5.0
American Forestier	5/27	-	2.6	0.0
Brown Thorn	5/27	-	2.7	0.0
Cort Pendu Rose	5/28	-	2.2	0.0
Royal Jersey	5/28	5/26	2.3	1.0
Stoke Red	5/31	-	1.7	0.0
Cimitiere	6/1	-	2.4	0.0
Medaille D'Or	6/2	5/27	3.5	3.0

<sup>1</sup>Cumulative data 2000-2012 shown on website; blank (-) indicates no bloom

<sup>2</sup>Abundance rating:

1= Very few blooms

2= Light bloom, below needed amount to set commercial crop

3= Normal bloom, sufficient to set commercial crop

4= Abundant bloom, between normal and snowball- thinning may be required

5= Snowball bloom, very abundant, may cause alternate bearing if not thinned early

<sup>3</sup>Bloom dates of 2 dessert apples (Gravenstein and Jonagold) were recorded for comparison

In September/October 2012 fruit was sampled weekly to determine optimum harvest dates for each variety. As each variety matured, approximately 50 ripe fruit were collected (1 box); the fruit was processed in a hand cider press, and the juice frozen for analysis at the end of the harvest season (November-January). Samples were collected and pressed from 33 named cider apples and 2 named rootstocks (Table2).

**Table 2.** Cider apples harvested and pressed for juice samples at WSU Mount Vernon NWREC in 2012 (H Date = harvest date; P Date = pressing date).

Cv.	H Date	P Date	Cv.	H Date	P Date
Bouteville	9/20	11/14	Jouveaux	10/9	11/7
Bramtot	10/5	11/21	Kermerrien	10/10	10/31
Breakwell Seedling	9/20	10/31	Kingston Black	9/15	10/5
Campfield	11/1	11/21	Lambrooke Pippin	11/1	11/7
Cap of Liberty	10/9	10/31	M27 (rootstock)	9/18	11/7
Chisel Jersey	10/9	11/7	M9 (rootstock)	9/7	9/25
Dabinett	11/1	11/7	Maude	10/5	11/7
Domaines	10/9	10/31	Medaille D'Or	10/29	11/28
Doux Normandie	11/1	11/14	Mettais	10/9	10/31
Fillbarrel	11/1	11/21	Muscadet de Dieppe	10/11	10/31
Foxwhelp	10/9	10/31	Muscat de Bernay	11/1	11/14
Frequin Rouge	10/10	11/7	Ribston Pippin	11/1	11/21
Golden Russet	10/9	10/31	Roxbury Russet	9/26	11/14

Granniwinkle	9/7	10/5	Taylor's	11/1	11/7
Grimes Golden	10/10	11/7	Track Zero (Ross Cider)	11/1	11/14
Grindstone	11/1	11/14	Yarlington Mill	10/5	11/7
Harry Masters Jersey	10/10	11/21	Zabergau Reinette	11/1	11/21
Hewes Virginia Crab	9/10	9/25			

Juice analysis was completed in January 2013 (Appendix, Table 6).

Four cider apple varieties (Granniwinkle, Medaille D'Or, and rootstock varieties M9 and M27) were harvested for cider making; the fruit was pressed, juice analysis performed, and the fermentation process initiated.

Nine finished ciders pressed in 2011 were evaluated by panels of trained evaluators in Port Townsend, Wenatchee, and Salem, Oregon (Table 3 and Appendix, Table 4).

**Table 3.** Finished ciders produced at WSU Mount Vernon NWREC evaluated by sensory panels in 2012.

Location	Date	Evaluators	Ciders Evaluated
Snowdrift Cidery, East Wenatchee, WA	May 24, 2012	Lars Ringsrud Peter Ringsrud Marcus Robert Tim Larsen Nathan Getzin	Chisel Jersey Harrison Hewes Virginia Crab Major Mettais Zabergau Reinette Medaille D'Or
Alpenfire Cider, Port Townsend, WA	July 31, 2012	Nancy Bishop Steve Bishop Phillipe Bishop Eric Jorgensen Krystie Kistler Trudy Davis Kellie Henwood	Chisel Jersey Harrison Hewes Virginia Crab Major Mettais Zabergau Reinette Blanc Mollet Golden Russet
Wandering Aengus Cider, Salem, OR	January 24, 2013	Nick Gunn James Kohn Kevin Zielinsky Matt Radtke Mike Radtke Cindy Lund Sarah Williams	Chisel Jersey Harrison Hewes Virginia Crab Mettais Blanc Mollet Golden Russet

In October 2012 fruit samples, consisting of 1 box each, from 4 commonly grown cider varieties Brown Snout, Dabinett, Kingston Black, and Yarlington Mill were collected from cooperator's orchards in different locations in western and central Washington:

- Rich Anderson, Westcott Bay Cider, 12 Anderson Lane, San Juan Island, WA 98250

- Steve and Nancy Bishop, Alpenfire Cider, 220 Pocket Lane, Port Townsend, WA 98368
- Craig and Sharon Campbell, Tieton Ciderworks, 323 Humphrey Rd., Tieton, WA 98947
- Lars Ringsrud, Snowdrift Cider Company, 277 Ward St., East Wenatchee, WA 98802

Samples of one variety, Kingston Black, were not collected from Tieton. The juice was pressed at NWREC and frozen for analysis as described above, and compared with the same varieties grown at NWREC. Results are shown in Appendix, Table 5.

Results of the trials will be presented in reports and workshops, and published online at <http://extension.wsu.edu/maritimefruit/Pages/Cider.aspx>.

A training video demonstrating techniques of bud grafting of cider and dessert apples was posted online at <http://ecommerce.cahnrs.wsu.edu/ExtensionOnlineCourses/shop/item.aspx?itemid=51>. A second training video demonstrating methods of cider juice analysis has been recorded, and is being prepared for online posting.

#### **Publications, Handouts, Other Text & Web Products:**

1. Miles, C, D. Bauermeister, A. Zimmerman, J. Roozen, and J. King. 2012. Hard Cider Project Summary 2012.  
<http://extension.wsu.edu/maritimefruit/Documents/CiderProjectOverview2012.pdf>
2. King, J., G.A. Moulton, and C. Miles. 2012. Cider Apple Bloom Data 2000 – 2012.  
<http://extension.wsu.edu/maritimefruit/Documents/CiderBloomData.pdf>
3. Hoffman, B., T. Thornton, and C. Miles. 2013. Propagating Dessert and Cider Apples with Chip Bud Grafting.  
<http://ecommerce.cahnrs.wsu.edu/ExtensionOnlineCourses/shop/item.aspx?itemid=51>

**Outreach & Education Activities:** Information gathered from this study will be combined with information gathered in previous years to form a multiple year data base of juice characteristics, and this data set will be prepared for publication. The WSU Mount Vernon Field Day on July 12, 2012 included a stop at the cider orchard, in which the mechanical raspberry harvester was displayed and information provided on the cider project. Three workshops were conducted at WSU-Mount Vernon: “Orchard Management: Cider Fruit Production” (June 23 and July 29, 2012), and “The Business of Making Hard Cider” (June 30, 2012). The NABC and Peter Mitchell, in cooperation with WSU Mount Vernon NWREC, conducted three week-long Cider School courses, two beginning courses (June 25-29 and July 23-27, 2012), and the advanced course December 10-14, 2012. A cider seminar was conducted by NABC, WSU, and the Northwest Cider Association at Skagit Valley Gardens, Mount Vernon, WA on December 15, 2012. A new training video for bud grafting has been posted online and a second video demonstrating techniques for cider juice quality analysis is being finalized for online posting.

#### **IMPACTS**

- **Short-Term:** We will continue to make 3-5 ciders each season and evaluate them through a trained sensory panel. This will add to the information on cider variety characteristics which will assist cider makers in deciding on potential apple varieties to use in cider production, and aid orchardists in evaluating the potential for growing and marketing cider fruit. Trials of a mechanical harvester for picking cider apples will be extended and training systems tested that can facilitate machine harvest.

- **Intermediate-Term:** Growers will view the increased potential for producing cider apples in high demand for the specialty cider market and the economic potential of mechanical pickers such as raspberry harvesters in reducing harvest costs.
- **Long-Term:** Improvements in the economic status of cider orchards, including planting of those varieties most in demand, and adaptation of mechanical harvest options, will increase the economic viability and sustainability of orchardists throughout the region. Cider production can provide a high-value use for cull dessert apples as well, when combined with selected specialty cider varieties. By 2025 there will be at least 30 cideries in the region.

**ADDITIONAL FUNDING APPLIED FOR / SECURED**

WA State Dept. of Agriculture	\$ 74,990
Northwest Agricultural Research Foundation	\$ 3,480
Northwest Cider Association	\$ 1,600
WSU CSANR BIOAg	\$ 10,000
WA State Dept. of Agriculture (pending)	\$ 340,000

**GRADUATE STUDENTS FUNDED**

None

**RECOMMENDATIONS FOR FUTURE RESEARCH**

Determine costs of production and potential returns for cider apples in western and central Washington.

Investigate trellis training systems to facilitate mechanical fruit harvest.

Investigate new mechanical harvester for suitability in picking cider apples.

Investigate timing of cider harvest for mechanical picking, including use of pre-harvest sprays.

Investigate new apple varieties for cider production, particularly red-fleshed varieties with high levels of anthocyanins.

**APPENDIX:**

**Table 4.** Characteristics of varietal ciders produced at WSU Mount Vernon NWREC in 2011, evaluated 2012-2013. (AC=acidity; BIT=bitterness; SW=sweetness; AST=astringency; BDY=body; all rated to scale of Low-Medium-High)

VARIETY	DESCRIPTION	COLOR	AROMA	AC	BIT	SW	AST	BDY	FLAVOR PROFILE
Blanc Mollet	Mild to moderately bitter French bittersweet	Deep gold	Caramel, pear & jolly Rancher with wood, biscuit & tropical fruits	L	MH	L	M	M	A medium bodied bittersweet cider with light flavors & aromatics. Medium length finish with a bitter & mildly astringent aftertaste. A nice addition to a bittersweet blend.
Chisel Jersey	Full English bittersweet	Gloden amber	Bittersweet apple, bandaid (phenolic), citrus, floral, spicy, earthy & woody	L	MH	ML	MH	MH	Barnyard character typical of English farmhouse cider. Slight citrus & fruitiness accompanied by pronounced bitterness. Very long tannic, astringent finish. Good for structure, character & complexity in a blend.
Golden Russet	Medium sharp russet dessert apple	Straw	Estery, green apple, candy apple, honey, cidery & tropical fruits	M	LM	M	L	MH	Full-bodied, alcoholic, complex aromatics with good acid. Medium length Sauvignon Blanc finish. Excellent base for dessert apple cider blend.
Harrison	Old American moderately sharp cider apple	Gold	Fresh & bittersweet apple, floral, confectionary, cidery, woody & spirituous	L	LM	M	LM	M	Well balanced with delicate flavors & aromas. Soft, rounded mouth feel and good fruit character with a peachy, smoky, mildly astringent finish. This cider tends to not ferment to complete dryness. A wonderful single varietal or blender.
Major	Aromatic bittersweet	Amber copper	Bittersweet apple, caramel, cidery, dill, wood & blackberry leaves	L	M	L	MH	LM	Highly aromatic with some fruit, earthy wood & bitterness. Long, tannic, finish. Good addition to a bittersweet blend or can add body & complexity to a dessert apple blend.
Mettais	Moderately bitter French bittersweet	Deep amber	Bittersweet apple, caramel, bandaid (phenolic), cidery, tropical fruit, strawberry jam & earthy wood	M	M	L	M	M	Strongly aromatic – more aroma than taste. Apple character with notes of figs, dates & earthy wood. Medium bodied with astringent finish of good length. Wonderful deep rich color. Bittersweet blender.
Virginia Crab (Hewes, Huges)	Mild to moderately bitter buttersharp	Gold	Citrus, floral, grassy, tropical fruits, butterscotch & green apple	H	LM	L	MH	MH	Lemony bright apple flavor with banana, pear & butterscotch notes. Full bodied with white wine intensity and a nice soft astringent finish. Possible varietal or acid addition to a blend.
Zabergau Reinette	Moderately sharp russet dessert apple	Light gold	Sweet caramel & honey with hints of citrus, grass & herbs	M	LM	L	M	L	Light bodied & wine like with an even mouth feel. Short, slightly bitter finish, somewhat more complex than most dessert apple ciders. Good blending apple.



**Table 5.** Cider apple juice characteristics of selected cider varieties sampled at WSU Mount Vernon NWREC and at 4 cooperating orchards in central and western WA in 2012.

Variety	Location	HDate	°Brix	pH	Spec. Gravity	Malic Acid (grams/liter)	Tannin
Brown Snout	Port Townsend <sup>1</sup>	11/16/2012	13.3	3.94	1.053	2.89	0.216
	Tieton <sup>2</sup>	10/5/2012	15.7	3.91	1.067	3.98	0.152
	Wenatchee <sup>3</sup>	9/28/2012	15.5	3.99	1.062	3.80	0.155
	San Juan Island <sup>4</sup>	10/18/2012	12.6	3.96	1.052	2.55	0.239
	WSU Mount Vernon	10/29/2012	15.5	3.85	1.068	4.58	0.228
Dabinett	Port Townsend	11/16/2012	12.8	4.17	1.051	1.71	0.279
	Tieton	10/17/2012	15.7	4.18	1.064	1.75	0.230
	Wenatchee	9/26/2012	14.6	4.19	1.057	1.65	0.210
	San Juan Island	10/1/2012	10.5	4.28	1.043	1.19	0.372
	WSU Mount Vernon	11/1/2012	16.3	4.26	1.065	2.15	0.350
Kingston Black	Port Townsend	11/16/2012	12.1	3.56	1.050	4.94	0.122
	Tieton <sup>5</sup>	-	-	-	-	-	-
	Wenatchee	9/21/2012	13.3	3.55	1.054	5.02	0.141
	San Juan Island	10/1/2012	11.6	3.45	1.046	5.10	0.199
	WSU Mount Vernon	9/15/2012	12.1	3.54	1.050	6.27	0.127
Yarlington Mill	Port Townsend	11/16/2012	12.2	3.99	1.047	2.59	0.401
	Tieton	10/2/2012	13.9	4.05	1.055	1.95	0.230
	Wenatchee	9/22/2012	13.3	4.06	1.053	2.15	0.210
	San Juan Island	10/10/2012	9.6	4.09	1.039	1.67	0.281
	WSU Mount Vernon	10/9/2012	11.7	4.03	1.045	1.91	0.170

<sup>1</sup>Steve and Nancy Bishop, Alpenfire Cider, 220 Pocket Lane, Port Townsend, WA 98368

<sup>2</sup>Craig and Sharon Campbell, Tieton Ciderworks, 323 Humphrey Rd., Tieton, WA 98947

<sup>3</sup>Lars Ringsrud, Snowdrift Cider Company, 277 Ward St., East Wenatchee, WA 98802

<sup>4</sup>Rich Anderson, Westcott Bay Cider, 12 Anderson Lane, San Juan Island, WA 98250

<sup>5</sup>'Kingston Black' samples not collected from Tieton.

**Table 6.** Percent tannin, brix, pH and titratable malic acid in juice of apples grown and tested at WSU Mount Vernon NWREC in 2009 – 2012.

Sample	Tannin %				Brix				pH				Malic Acid g/L			
	2012	2011	2010	2009	2012	2011	2010	2009	2012	2011	2010	2009	2012	2011	2010	2009
Amere de Berthcourt	DNF	0.28	0.48	0.68	DNF	11.1	13.5	14.0	DNF	4.23	4.23	4.47	DNF	1.29	2.14	2.26
American Forestier	DNF	0.20	- <sup>2</sup>	0.19	DNF	11.6	-	11.8	DNF	4.09	-	3.63	DNF	1.98	-	1.98
Bedan de Parts	DNF	0.21			DNF	12.8			DNF	4.21			DNF	1.93		
Blanc Mollet	DNF	0.22	-	0.30	DNF	11.5	-	11.4	DNF	4.19	-	4.27	DNF	1.50	-	1.50
Bouteville	0.09	0.17	-	0.16	13.8	12.7	-	12.0	4.63	4.56	-	4.43	DNF	1.07	-	1.17
Bramley's Seedling	DNF	0.09	DNF	0.16	DNF	10.6	DNF	10.0	DNF	2.79	DNF	3.63	1.70	9.75	DNF	10.18
Bramtot	0.85	0.88	0.56	-	13.9	13.8	14.3	-	4.05	3.94	4.15	-	3.10	2.79	2.95	-
Breakwell Seedling	0.13	0.16	0.64	0.32	11.7	9.6	12.0	11.0	3.28	3.09	3.18	3.17	6.60	6.59	13.56	5.36
Brown Snout	0.23	0.16	0.20	0.26	15.5	11.4	12.0	12.0	3.85	3.72	3.77	3.73	4.58	2.20	2.95	3.00
Brown Thorn	DNF	0.14			DNF	10.5			DNF	4.18			DNF	1.23		
Brown's Apple	DNF	0.08			DNF	9.0			DNF	3.00			DNF	7.61		
Bulmer's Norman	-	0.19	-	0.25	-	10.5	-	11.2	-	3.98	-	3.94	-	2.14	-	1.88
Campfield	0.09	0.36	0.19	0.27	14.8	11.2	13.2	13.0	4.28	4.26	4.46	4.63	2.50	2.30	2.73	2.63
Cap O'Liberty	0.37	0.21	DNF	0.26	13.0	11.7	DNF	11.0	3.10	3.36	DNF	2.89	12.00	10.18	DNF	9.87
Chisel Jersey		0.32	1.00	0.43		13.0	15.6	14.2		4.04	4.49	4.93		2.25	3.38	1.88
Cimitiere	DNF	0.31	-	0.33	DNF	8.5	-	11.2	DNF	4.27	-	4.90	DNF	1.13	-	1.39
Coat Jersey		-	-	0.48		-	-	11.8		-	-	3.72		-	-	1.93
Court Pendu Plat		-	DNF	0.10		-	DNF	13.0		-	DNF	2.93		-	DNF	7.72
Court Pendu Rose	DNF	0.13	0.14	-	DNF	10.3	13.2	-	DNF	3.17	3.75	-	DNF	6.51	6.70	-
Crow Egg	dead	0.10	-	0.10	dead	10.6	-	10.2	dead	3.79	-	4.01	dead	3.22	-	3.27
Dabinett	0.35	0.17	0.69	0.32	16.3	12.4	14.9	14.0	4.26	4.25	4.38	4.90	2.20	8.52	2.57	1.34
Domaines	0.31	-	-	0.52	12.5	-	-	15.0	3.99	-	-	4.53	1.80	-	-	2.09
Doux Normandie	0.16	-	0.27	0.48	11.0	-	11.0	13.0	3.85	-	4.02	3.58	2.30	-	3.27	3.86
Dymock Red	dead	-	-	0.21	dead	-	-	13.0	dead	-	-	4.07	dead	-	-	1.82
Finkenwerder Herbstprinz	-	0.10	0.06	0.15	-	13.8	12.9	14.6	-	3.15	3.23	2.96	-	8.52	9.27	11.36
Foxwhelp	0.19	0.17	-	0.33	13.7	11.8	-	14.0	3.23	3.04	-	3.01	5.70	7.34	-	10.18
Frequin Audievre	dead	-	-	0.23	dead	-	-	12.0	dead	-	-	4.75	dead	-	-	1.40
Frequin Rouge	0.45	0.29	DNF	0.57	12.7	11.2	DNF	12.2	4.08	3.92	DNF	4.57	5.70	2.25	DNF	2.58
Frequin Tardif	dead	-	-	0.28	dead	-	-	12.0	dead	-	-	4.36	dead	-	-	2.58
Golden Russet	0.10	0.19	-	0.18	17.9	17.6	-	15.0	3.41	3.88	-	3.93	7.00	5.47	-	7.93
Granniwinkle	0.07	0.13	-	0.10	10.6	10.8	-	10.4	3.62	4.23	-	1.58	3.40	1.88	-	1.82
Grimes Golden	0.10	0.07	0.06	-	13.2	13.2	12.0	-	3.51	3.32	3.43	-	7.40	6.32	6.54	-
Grindstone	0.09	0.17	DNF	0.15	14.8	13.8	DNF	11.4	3.55	3.51	DNF	3.18	5.00	6.16	DNF	5.25
Harrison	-	0.15	0.14	0.19	-	15.7	15.6	16.0	-	3.47	3.69	2.94	-	4.98	8.25	10.08
Harry Masters' Jersey	0.30	0.18	-	0.30	14.7	10.5	-	12.0	4.40	4.30	-	4.18	2.30	1.55	-	1.72
Hewes Crab	0.19	0.29	0.32	-	14.2	15.0	15.0	-	3.26	3.13	3.29	-	8.70	7.84	10.66	-

Jouveaux	0.28	0.27	-	-	15.6	9.9	-	-	4.23	3.97	-	-	3.00	1.61	-	-
Kermerrien	0.42	0.28	0.48	0.46	14.8	11.2	13.2	12.8	3.26	3.79	3.82	3.86	2.30	2.30	2.54	2.47
Kingston Black	0.13	0.11	0.37	0.26	12.1	11.8	16.0	13.4	3.54	3.27	3.66	3.22	6.30	5.52	8.52	5.63
Lambrooke Pippin	0.39	0.31	-	0.51	11.6	12.3	-	14.4	3.30	3.20	-	2.86	11.4	7.40	-	10.61
Major	-	0.23	-	0.29	-	13.0	-	13.4	-	4.13	-	4.24	-	1.77	-	1.82
Marie Menard	-	-	0.35	-	-	-	13.6	-	-	-	4.41	-	-	-	2.03	-
Marin Oufroy	dead	-	0.32	0.24	dead	-	16.6	14.2	dead	-	4.57	4.47	dead	-	3.00	2.84
Maude	0.06	0.11	DNF	0.10	12.9	12.3	DNF	12.0	3.56	3.40	DNF	3.40	4.20	4.66	DNF	4.82
Medaille D'Or	0.73	0.69	1.02	1.75	17.4	14.7	14.0	17.2	3.95	4.18	4.26	4.37	4.00	2.84	3.32	3.54
Mettais	0.23	0.26	0.51	0.30	16.0	12.9	15.8	12.0	4.52	4.32	4.40	4.33	2.00	1.93	3.20	1.29
Michelin	-	0.14	0.26	-	-	11.3	12.8	-	-	3.88	4.11	-	-	2.41	3.10	-
Mott Pink <sup>3</sup>	-	0.05	-	0.11	-	9.0	-	12.0	-	3.30	-	3.16	-	4.45	-	7.08
Musc.t de Dieppe	0.21	0.17	DNF	0.24	14.6	14.3	DNF	14.0	4.25	4.48	DNF	3.84	1.60	1.82	DNF	2.30
Muscat de Berney	0.18	-	-	0.32	12.4	-	-	12.0	4.01	-	-	3.68	3.10	-	-	2.57
Nehou	-	0.40	-	0.61	-	16.5	-	14.2	-	3.96	-	4.56	-	2.73	-	3.10
Peau de Vache	-	0.17	DNF	0.19	-	10.7	DNF	11.0	-	4.18	DNF	3.71	-	1.93	DNF	3.00
Redstreak	-	0.09	DNF	0.15	-	11.2	DNF	12.0	-	3.08	DNF	2.99	-	8.84	DNF	8.74
Reine des Hatives	DNF	0.42	-	DNF	DNF	11.5	-	DNF	DNF	3.00	-	DNF	DNF	9.11	-	DNF
Reine des Pommes	0.82	-	DNF	0.67	15.3	-	DNF	14.9	3.92	-	DNF	4.21	4.20	-	DNF	3.38
Ribston Pippin	0.14	-	0.26	DNF	13.6	-	17.6	DNF	3.32	-	3.77	DNF	7.20	-	4.80	DNF
Ross Nonpareil	-	0.50	-	-	-	16.1	-	-	-	3.82	-	-	-	3.48	-	-
Roxbury Russet	0.05	0.08	DNF	0.11	15.8	14.4	DNF	16.4	3.49	3.73	DNF	3.31	6.50	4.23	DNF	4.77
Royal Jersey	-	0.54	-	0.45	-	12.5	-	12.2	-	4.03	-	4.13	-	1.88	-	1.50
Smith's Cider	DNF	0.08	DNF	0.12	DNF	11.7	DNF	11.0	DNF	3.64	DNF	3.15	DNF	4.30	DNF	4.28
Stembridge Jersey	DNF	0.32	-	0.48	DNF	9.4	-	12.9	DNF	4.00	-	4.69	DNF	1.66	-	2.41
Stoke Red	DNF	0.24	-	0.43	DNF	10.6	-	13.2	DNF	3.46	-	4.04	DNF	4.66	-	6.22
Sweet Alford	-	0.10	-	0.15	-	10.1	-	11.0	-	4.20	-	4.77	-	1.34	-	1.34
Sweet Coppin	-	0.13	-	-	-	11.3	-	-	-	3.92	-	-	-	2.20	-	-
Taliaferro	DNF	0.09	-	0.19	DNF	11.1	-	10.2	DNF	3.25	-	2.87	DNF	6.73	-	6.81
Taylor's	0.19	0.12	-	-	14.3	12.3	-	-	4.42	4.36	-	-	2.30	1.50	-	-
Tom Putt	-	0.10	0.22	0.16	-	10.7	11.8	11.0	-	3.14	3.37	3.77	-	6.51	6.54	6.27
Track Zero (Ross)	0.09	0.13	DNF	0.17	14.2	13.1	DNF	12.0	4.17	4.10	DNF	3.97	2.20	1.66	DNF	1.61
Vilberie	-	0.43	0.58	0.91	-	9.3	11.5	12.0	-	3.80	4.13	3.60	-	1.82	2.57	3.43
Whidbey	-	0.16	DNF	0.15	-	10.6	DNF	11.9	-	3.67	DNF	3.96	-	3.75	DNF	4.88
Yarlington Mill	0.17	0.22	0.29	0.38	11.7	12.6	14.0	14.0	4.03	3.76	3.97	4.97	1.90	1.88	2.73	1.72
Zabergau Reinette	0.18	0.12	DNF	0.16	16.4	13.6	DNF	11.9	3.47	3.45	DNF	3.85	8.50	5.09	DNF	6.27

<sup>1</sup>DNF = Did not fruit

<sup>2</sup>Blank (-) indicates data not collected (young trees, dessert apples tested only once, insufficient fruit, etc.)

<sup>3</sup>dessert apple