



Great Lakes Fruit, Vegetable & Farm Market EXPO Michigan Greenhouse Growers EXPO

December 4-6, 2018

DeVos Place Convention Center, Grand Rapids, MI



42 Hard Cider

Where: Grand Gallery Room D

MI Recertification Credits: 1 (1C, COMM CORE, PRIV CORE)

CCA Credits: CM (2)

Moderator: Emily Pochubay, Michigan State University

- 9:00 AM** **Cider Apple Variety Profiles and Orchard Management for Reduced Labor**
- Carol Miles, Washington State University
- 9:25 AM** **Cider Choice Test Experiment Using 500 Michigan Consumers**
- Trey Malone, Michigan State University
- 9:50 AM** **Identifying 40 Apple Varieties with Potential for Sustainable Cider Production**
- Michelle Miller, University of Wisconsin
- 10:20 AM** **Experiences Growing Cider Apple Varieties in Michigan**
- Dan Dietrich, Ridgeview Orchards
 - Kevin VerSnyder, VerSnyder's Fruit
 - Ken Engle, Engle Ridge Farm
- 10:45 AM** **Update from the U.S. Association of Cider Makers**
- Paul VanderHeide, Vandermill Ciders
- 11:00 AM** **Session Ends**

CIDER APPLE BLOOM AND PRODUCTIVITY HABIT

WSU Mount Vernon NWREC

Selected varieties with 3 or more years data for all parameters measured

Cultivar	Bloom Density \pm SD ¹	Bloom Habit ²		Productivity Rating \pm SD ¹	Prod. Habit ²
Bramley's Seedling	2.8 \pm 1.3	CON		2.7 \pm 1.2	CON
Bramtot	4.1 \pm 0.8	CON		3.0 \pm 0.6	CON
Breakwell Seedling	4.1 \pm 1.5	CON		3.2 \pm 1.0	CON
Bulmer's Norman	4.6 \pm 0.6	St-CON		3.0 \pm 2.0	BI
Campfield	3.5 \pm 1.0	CON		1.8 \pm 0.6	CON
Chisel Jersey	3.3 \pm 1.4	CON		2.7 \pm 1.0	CON
Golden Russet	4.7 \pm 0.6	St-CON		3.6 \pm 0.4	St-CON
Gravenstein, Red (Worthen)	4.0 \pm 0.7	CON		3.5 \pm 0.3	St-CON
Grimes Golden	4.6 \pm 0.4	St-CON		4.0 \pm 0.4	St-CON
Harrison	3.4 \pm 0.6	St-CON		2.1 \pm 0.5	CON
Kermerrien	3.1 \pm 1.7	BI		2.8 \pm 1.5	BI
Kingston Black	3.3 \pm 1.4	CON		2.7 \pm 1.6	BI
Maude	4.1 \pm 1.3	CON		2.2 \pm 1.0	CON
Redstreak, Hereford	3.6 \pm 0.8	CON		3.2 \pm 1.5	CON
Ross Nonpareil	4.6 \pm 0.6	St-CON		2.4 \pm 1.1	CON
Tramlett's, Geneva	4.3 \pm 0.7	St-CON		2.7 \pm 1.4	CON
Vilberie	3.3 \pm 1.3	CON		2.7 \pm 1.8	BI
Yarlington Mill	3.7 \pm 1.0	CON		3.7 \pm 0.6	St-CON

¹ Rating scale 1-5 where 1 = very sparse, unproductive; 2 = light; 3 = moderate; 4 = abundant; and 5 = snowball/overloaded.

² St-BI = strongly biennial; BI = biennial; CON = consistent; and St-CON = strongly consistent

Cv	Rootstock	No. Trees	Yield lbs/Tree					Avg	SD	Mean Prod Rating
			2017	2016	2015	2014	2013			
Amere de Berthcourt	Bud 9	3	6	43	29	17	13	22	14.59	3.21
Blanc Mollet	Bud 9	1	41	0	67	0	41	30	29.20	3.00
Bouteville	M9	1	14	10	22	2	11	12	7.22	4.00
Bramley's Seedling	M26	1	267	143	118	34	72	127	88.90	3.50
Breakwell Seedling	M26	3	141	133	128	5	59	93	59.22	3.13
Brown Snout	M106	1	208	134	236	- ¹	-	193	52.70	3.50
Cap of Liberty	M106	2	173	0	142	22	135	94	77.85	3.17
Chisel Jersey	M106	3	79	41	54	50	87	62	19.77	3.00
Cimitiere	M9	1	43	0	67	0	50	32	30.49	3.00
Dabinett	M106	5	159	43	121	50	113	97	49.50	3.67
Finkenwerder Herbstprinz	M106 (3) M9 (1)	4	113	56	30	23	45	53	35.71	3.19
Frequin Rouge	M106	5	42	46	77	51	36	50	15.85	3.05
Golden Russet	M26	2	119	100	74	63	8	73	42.34	3.90
Granniwinkle	M106 (3) Bud 9 (1)	4	25	73	17	19	5	28	26.29	3.75
Gravenstein, Red Worthen	M9	2	21	21	17	13	-	18	3.83	4.10
Harry Masters' Jersey	M106	1	155	56	37	96	134	96	50.01	3.92
Hewes' Virginia Crab	M9	1	35	42	19	5	8	22	16.30	3.88
Kermerrien	M106	5	125	8	68	16	62	56	47.02	3.07
Major	M9	1	97	21	98	7	23	49	44.52	3.67
Michelin	M106	1	267	61	149	18	196	138	100.57	3.58
Mott Pink	M9	1	196	59	116	0	80	90	72.58	3.50
Muscat de Bernay	M106	3	56	66	0	-	20	36	30.83	3.67
Peau de Vache	Bud 9	1	37	71	53	38	33	46	15.71	4.17
Redstreak	M106	1	0	0	41	34	20	19	18.92	3.25
Roxbury Russet	Bud 9	1	0	0	18	7	3	6	7.50	3.17
Smith's Cider	Bud 9	1	38	46	37	11	18	30	14.78	3.58
Sweet Alford	M9	1	32	12	43	11	19	23	13.79	3.92
Taliaferro	Bud 9	1	23	19	22	25	6	19	7.58	3.33
Track Zero (Ross Cider)	Bud 9	1	29	137	5	82	48	60	51.34	3.83
Tom Putt	M106 (3) M26 (2)	5	224	-	-	119	122	155	59.77	4.38
Vilberie	M106	1	283	0	371	0	-	164	192.18	3.00
Whidbey	M9	1	30	25	26	11	13	21	8.46	3.75
Yarlington Mill M106	M106	2	-	256	151	60	317	196	113.67	3.67
Zabergau Reinette	M9	1	141	51	168	9	104	95	64.92	3.83

¹- fruit not available for yield measurement

CIDER APPLE VARIETIES on trial at WSU Mount Vernon NWREC 2002 - 2017

Cultivar	English Classification ¹	Rootstock ²	Bloom Date	Bloom Density ³	Productivity Rating ⁴	Harvest Date (2012-2017)	Fruit Size (inch) ⁵	Juice Yield (mL/lb) ⁶	Juice Data				
									Tannin (%) ⁷	Acid (%) ⁸	pH ⁹	Specific Gravity ¹⁰	°Brix ¹¹
Amere de Berthcourt	BSW	Bud 9, M9	5/3	3.5	3.2	9/25	2.12	288	0.34	0.20	4.11	1.049	12.2
Amere Forestier	SW	Bud 9	5/18	2.8	2.9	10/18	2.50	255 b	0.13	0.20	3.93	1.046	11.5
Bedan de Parts	SW/BSW	M9	5/18	2.8	2.0	10/1	2.42	247 b	0.14	0.18	4.43	1.051	10.7
Blanc Mollet	BSW	Bud 9	5/13	2.7	3.0	9/4	1.78	275 b	0.20	0.15	4.31	1.046	11.2
Bouteville	SW	M9	5/8	3.0	4.0	9/11	2.11	458	0.14	0.16	4.55	1.052	12.4
Bramley's Seedling	SW/SH	M26	5/6	3.1	3.1	9/24	3.86	253	0.09	0.11	3.12	1.045	11.2
Bramtot	BSW	M9	5/10	4.1	3.2	9/15	2.21	374	0.50	0.32	4.04	1.057	13.1
Breakwell Seedling	BSH	M26	5/19	3.9	3.1	9/6	2.43	260	0.20	0.72	3.28	1.041	10.1
Brown Snout	SW/BSW	M106, M9, M27	5/22	3.8	3.5	10/18	2.28	281	0.16	0.31	3.64	1.051	12.9
Brown Thorn	SW/BSW	M9	5/19	2.4	2.7	10/8	2.42	253 b	0.16	0.20	4.20	1.048	12.2
Brown's Apple	BSW/SH	M106	5/11	3.5	2.8	9/27	2.74	262 b	0.10	0.74	3.23	1.039	10.2
Bulmer's Norman	BSW/SW	M106	5/8	4.5	2.8	9/12	2.95	247 b	0.20	0.22	4.09	1.046	11.3
Campfield	SW	M106	5/2	3.4	2.2	10/21	2.89	159	0.17	0.23	4.38	1.055	12.8
Cap of Liberty	BSH	M106, Bud 9	5/5	4.2	3.1	10/7	2.26	249	0.20	1.14	3.14	1.047	11.8
Chisel Jersey	BSW	M106	5/19	3.3	3.0	9/29	2.65	232	0.42	0.25	4.31	1.056	13.8
Cimitiere	BSW	M9	5/29	2.7	3.0	10/9	2.09	294 b	0.23	0.13	4.51	1.039	10.1
Cort Pendu Rose	SH	Bud 9	5/19	2.7	2.8	10/11	2.50	348 a	0.11	0.81	3.26	1.048	11.8
Dabinett	BSW	M106	5/19	3.7	3.7	10/14	2.49	242	0.24	0.22	4.41	1.055	13.5
Domaines	BSW	M9, M de Dieppe/M106	4/29	4.1	2.4	9/29	2.73	251	0.26	0.20	4.27	1.050	13.1
Doux Normandie	BSW	M9	5/12	3.7	3.1	10/6	2.43	258	0.29	0.33	3.80	1.047	11.8
Fillbarrel	BSW	M9	5/1	2.7	3.0	10/8	2.58	310	0.19	0.22	3.67	1.045	11.2
Finkenwerder Herbstprinz	SH	M9, M106	5/5	3.8	3.2	9/22	3.42	242	0.07	0.98	3.21	1.055	13.2
Foxwhelp	SH/BSH	M106, M27	5/5	3.8	2.9	10/4	3.18	256	0.17	0.69	3.20	1.048	12.0
Frequin Rouge	BSW	M106	5/7	4.1	3.1	10/2	2.31	251 b	0.30	0.26	4.17	1.047	11.4
Golden Russet	SH	M26	4/29	4.7	3.9	10/3	2.83	219	0.10	0.66	3.58	1.061	15.4
Granniwinkle	SW	Bud 9, M26	4/27	4.3	3.8	9/2	2.71	228	0.08	0.30	3.90	1.045	11.0
Gravenstein, Red (Worthen)	SH	M9	4/24	4.2	4.1	8/28	2.92	235	0.07	0.56	3.49	1.052	12.6
Grimes Golden	SH	M9	4/29	4.6	4.2	10/14	3.11	202	0.07	0.61	3.45	1.052	12.2
Grindstone	SH	Bud 9	4/30	2.7	2.8	10/25	2.74	251	0.10	0.58	3.49	1.061	13.7
Harrison	SH	M106	5/6	3.4	2.3	10/19	2.36	221	0.10	0.64	3.46	1.061	14.6
Harry Masters' Jersey	BSW	M106	5/16	4.1	3.9	10/9	2.59	174	0.21	0.19	4.34	1.051	12.5
Jonagold	SW	M26	4/30	4.8	4.0	9/25	-	-	0.06	0.40	3.60	-	12.1
Jouveaux	SW/BSW	M9	4/29	4.4	2.8	9/28	2.75	180	0.16	0.30	4.01	1.052	13.0
Kermerrien	BSW	M106	5/12	3.0	3.1	10/1	2.41	179	0.32	0.26	3.88	1.050	12.5
Kingston Black	SH	M106	5/13	3.3	2.7	9/30	2.42	170	0.15	0.61	3.51	1.055	13.3
Lambrook Pippin	BSH	M9, M106	5/9	3.1	2.6	10/16	2.54	256	0.36	1.06	3.13	1.054	13.0
Major	BSW	M9	5/13	3.6	3.7	9/7	2.30	275	0.21	0.20	4.23	1.051	12.9
Margil	SH/SW	M9	4/25	4.8	-	9/24	2.50	214	0.07	0.57	3.49	1.049	11.8
Marie Menard	BSW	M9	5/4	3.4	-	9/24	2.42	243	0.42	0.28	4.16	1.057	13.7
Marin Onfroy	BSW	M9	5/25	1.3	-	10/6	2.24	193 a	0.19	0.24	4.30	1.053	13.2
Maude	SH	M9	4/30	4.3	3.1	9/7	2.72	240	0.07	0.49	3.43	1.050	11.6

Medaille D'Or	BSW	M106, M26	5/29	3.2	3.0	10/15	2.15	248	0.82	0.32	4.09	1.059	14.9
Mettais	BSW	M9, M de Dieppe/M106	5/8	3.8	2.7	9/23	2.21	195 b	0.25	0.19	4.49	1.056	12.9
Michelin	SW/BSW	M106	5/12	4.1	3.6	10/12	2.52	166	0.14	0.27	4.09	1.048	11.4
Mott Pink	SH	M9	4/30	4.0	3.5	9/6	2.62	301	0.05	0.76	3.18	1.043	10.5
Muscadet de Dieppe	BSW	M9, M27	5/9	3.1	2.6	9/13	2.63	212	0.21	0.26	4.12	1.057	14.2
Muscat de Bernay	BSW	Bsnout/M106	5/8	3.4	3.7	10/16	2.82	244 b	0.19	0.28	3.94	1.050	11.9
Nehou	BSW	M9	4/19	3.8	-	9/17	2.53	216 b	0.34	0.32	4.10	1.056	14.0
Peau de Vache	SW	Bud 9	5/14	4.3	4.2	10/1	2.67	262	0.14	0.26	4.00	1.048	11.7
Porter's Perfection	BSH	M9	5/2	3.8	-	9/26	2.16	253	0.30	0.93	3.20	1.054	13.0
Redstreak, Hereford	SH	M106	5/9	3.6	3.3	9/7	2.64	532 a	0.09	0.95	3.18	1.048	11.7
Reine des Hatives	SH/BSW	M26, M106	5/9	2.4	2.7	9/29	2.73	244 a	0.17	0.93	3.32	1.044	11.5
Reine des Pommes	BSW	M26	5/5	3.0	2.5	10/1	2.42	233 b	0.52	0.41	3.92	1.063	14.7
Ribston Pippin	SH	M9	4/24	5.0	-	9/13	2.71	258	0.11	0.67	3.37	1.060	13.2
Rosemary Russet	SH	M9	4/25	3.0	-	9/24	2.51	260	0.07	0.86	3.28	1.055	13.0
Ross Nonpareil	SH	M9	4/27	4.4	2.3	9/28	2.53	211 b	0.15	0.68	3.53	1.059	14.0
Roxbury Russet	SH/SW	Bud 9	5/1	3.3	3.2	9/21	2.47	202 a	0.08	0.61	3.50	1.061	15.9
Royal Jersey	BSW	Bud 9	5/22	2.6	2.3	9/25	2.24	227	0.36	0.19	4.17	1.048	11.9
Russet King	SH	M9	4/26	2.4	-	9/26	-	279 a	0.05	0.71	3.48	1.053	12.5
Smith's Cider	SH/SW	Bud 9	5/2	4.0	3.6	10/1	2.94	262	0.08	0.55	3.39	1.050	11.8
Stembridge Jersey	BSW	M9	5/16	2.5	2.2	9/30	2.25	230	0.27	0.37	4.07	1.047	11.4
Stoke Red	BSH	M9	5/19	2.3	3.3	9/30	2.42	286 b	0.28	0.66	3.49	1.045	11.7
Sweet Alford	SW	M9	5/4	4.0	3.9	10/7	2.75	219	0.07	0.16	4.47	1.049	11.8
Sweet Coppin	SW	M9	5/18	2.4	2.7	10/10	2.67	273 b	0.11	0.20	4.03	1.048	11.3
Taliaferro (Colaw)	SH	Bud 9	5/6	2.8	3.3	9/30	2.97	246	0.09	0.77	3.12	1.047	11.4
Taylor's	SW	M106, M9	5/17	3.4	2.8	9/22	2.40	439 b	0.14	0.20	4.29	1.051	12.4
Tom Putt	SH	M106	5/4	4.6	4.4	8/31	3.11	219 b	0.11	0.67	3.38	1.044	10.9
Track Zero ¹²	SW	Bud 9	5/2	3.8	3.8	10/9	2.76	212	0.10	0.18	4.13	1.053	12.3
Tramlett's, Geneva ¹³	SH	M106	5/5	4.0	2.8	9/30	2.52	223	0.17	1.01	3.17	1.044	10.9
Vilberie	BSW	M106, M9	5/24	3.4	2.9	10/19	2.59	279 b	0.41	0.27	3.91	1.044	11.5
Virginia Crab, Hewes	BSH	M9	4/19	4.6	3.9	8/31	1.55	282	0.19	0.91	3.29	1.060	14.8
Whidbey	SH/SW	M9	5/7	3.7	3.8	9/18	3.08	282	0.12	0.69	3.46	1.049	11.9
Yarlington Mill	BSW/SW	M106	5/13	3.7	3.7	9/26	2.74	239	0.21	0.23	4.10	1.048	11.9
Zabergau Reinette	SH	M9	5/2	3.9	3.8	9/25	3.41	252	0.12	0.79	3.46	1.057	13.4

WSU Cider Program <http://www.cider.wsu.edu/>

¹English cider classification system: bittersweet (BSW > 0.20 tannin, < 0.45 acid), bittersharp (BSH > 0.20 tannin, > 0.45 acid), sharp (SH < 0.20 tannin, > 0.45 acid), sweet (SW < 0.20 tannin, < 0.45 acid). Some classifications differ between data recorded at WSU Mount Vernon NWREC and standard English classification; where these differ, the NWREC designation is listed first (e.g. BSH/BSW).

²Rootstock(s) on which a scion was evaluated for the period of observation (e.g. M106, M26); topworked trees indicated by Interstem/Rootstock.

³Bloom density rated subjectively (1-5) where 1 = very sparse bloom, unproductive; 2 = light bloom; 3 = moderate bloom; 4 = abundant bloom; and 5 = snowball bloom; thin early to reduce biennial bearing.

⁴Productivity rating taken annually pre-harvest (2011-2014, 2016-2017), utilizing a subjective rating scale (1-5) where 1 = sparse to no fruit; 2 = light fruiting; 3 = moderate fruiting; 4 = abundant fruiting; and 5 = overloaded fruiting, multiple fruit per spur with loaded branches bending to the ground. '-' indicates insufficient data collection for reporting.

⁵Fruit Size: Large = 3.2-3.9 in., Medium = 2.4-3.1 in., Small = 1.6-2.3 in.; these relative categories were established based on our varietal publication (Miles et al, 2017).

⁶Juice yield of 25 fruit in mL/lb, averaged for 2015, 2016, and 2017 (a = 1 year data, b = 2 years data) as achieved with a MuliMax 30 shredder (2.8-horsepower; Zambelli Enotech, Camisano Vicentino, Italy) and Carezza bladder press (10.5-gal capacity, Enotecnica Pillan, Camisano Vicentino, Italy).

⁷The term "tannin" is used in adaptation of cider literature; expressed as tannic acid equivalents, in percent.

⁸Expressed as malic acid equivalents, in percent.

⁹pH = -log[H⁺]

¹⁰The ratio of the density of the juice to the density of pure water, unitless.

¹¹Degree Brix was measured with a hand refractometer 2002-2008 and with a digital refractometer 2009 to current.

¹²Track Zero is a seedling found by cider maker John Ross in the old trolley yards, Seattle, WA.

¹³'Geneva Tramlett's' is a tentative designation; uncertainty exists whether what was received from USDA Geneva, N.Y. was the true 'Tramlett's Bitter'.

Cider Apple Variety Profiles and Orchard Management for Reduced Labor



Carol Miles
Department of Horticulture
Northwestern Washington Research and Extension Center

Cider Research at WSU

1979 6 cider apple varieties first planted at WSU Mount Vernon NWREC


1983 to 1994 20 varieties added, observations made on productivity, growth habit, and disease susceptibility

1994 Cider apple trial orchard established with over 70 different varieties

2002 to present Varieties evaluated for juice characteristics and yield


2014-16 Planted 65 varieties on G935 rootstock in a replicated research orchard

2015-17 Replicated plantings of 3 varieties on G202 rootstock, 2 varieties on M9, 1 variety on G11 for cultural trials




October 2018

Washington State University Mount Vernon Northwestern WA Research and Extension Center



Cider Variety Characteristics



❖ 74 varieties
 ❖ Orchard spacing:
 12 ft x 15 ft

Bloom and Fruit Load Rating

❖ Bloom Rating

1 = few to no blooms 2 = sparse bloom 3 = moderate bloom, acceptable 4 = profuse bloom 5 = very profuse snowball bloom

❖ Fruit Load Rating

1 = sparse to no fruit 2 = poor set, insufficient commercial production 3 = moderate production, acceptable 4 = full commercial production 5 = overloaded, multiple fruit per spur, branches bend or break

Miles, C., J. King, T. Alexander and E. Scheenstra. 2017. Evaluation of flower, fruit, and juice characteristics of a multinational collection of cider apple cultivars grown in the U.S. Pacific Northwest. HortTech 27:431-439.


Cider Variety Characteristics

Cultivar	English Classification ¹	Rootstock ²	Bloom Date	Bloom Density ³	Productivity Rating ⁴	Harvest Date (2012-2013)	Fruit Size (inch)	Juice Yield (mL/lt)	Juice Data				
									Tannin (%)	Acid (%)	pH	Specific Gravity	
Amour de Berthoult	BW	Bud 9	5/1	3.5	3.2	9/25	2.12	288	0.34	0.20	4.11	1.049	12.2
Amour de France	BW	Bud 9	5/18	2.8	2.9	10/18	2.00	292.5	0.33	0.20	3.93	1.046	11.5
Baldur de Paris	BW	Bud 9	5/18	2.8	2.9	10/11	2.42	347.0	0.34	0.18	4.43	1.051	11.7
Blanc Malin	BW	Bud 9	5/23	2.7	3.0	9/4	1.78	275.5	0.20	0.15	4.31	1.046	11.2
Bonheur	SW	M9	5/8	3.0	4.0	9/11	2.11	448	0.24	0.20	4.58	1.052	12.4
Brandy Seedling	SW/SW	M9	5/6	3.1	3.1	9/24	3.86	253	0.28	0.13	3.12	1.045	11.2
Bruno	BW	M9	5/20	4.1	3.2	9/15	2.21	374	0.50	0.10	4.04	1.057	13.1
Crusade Seedling	BH	M9	5/29	3.9	3.1	9/6	2.43	290	0.20	0.12	3.28	1.041	11.1
Dawn Snow	SW/SW	M9/M, M9, M27	5/22	3.8	3.5	10/18	2.28	281	0.36	0.15	3.64	1.051	12.9
Dean Thom	SW/SW	M9	5/29	2.4	2.7	10/8	2.42	203.5	0.35	0.20	4.30	1.048	12.2
Deer's Head	BW/SW	M9/M	5/21	3.5	2.8	9/27	2.14	262.5	0.28	0.16	3.73	1.059	13.3
Deer's Norman	BW/SW	M9/M	5/8	4.5	2.8	9/12	2.95	347.5	0.20	0.22	4.09	1.046	11.3
Empire	SW	M9/M	5/2	3.4	2.2	10/21	2.89	159	0.17	0.23	4.18	1.055	12.8
Empire Liberty	BH	M9/M, Bud 9	5/5	4.2	3.1	10/7	2.26	248	0.20	0.14	3.14	1.047	11.8
Empire Liberty	BW	M9/M	5/19	3.1	3.0	9/29	2.05	152	0.42	0.25	4.12	1.056	13.8
Empire	BW	M9	5/20	2.7	3.0	10/9	2.00	294.0	0.23	0.13	4.15	1.049	11.1
Empire Rose	SH	Bud 9	5/29	2.7	2.8	10/11	2.50	348.0	0.11	0.85	3.26	1.048	11.8
Empire	BW	M9/M	5/20	3.7	3.7	10/14	2.40	242	0.24	0.20	4.41	1.055	13.5
Empire	BW	M9, M24, Dragee/M9/M	4/29	4.1	2.4	9/29	2.73	251	0.26	0.20	4.27	1.050	13.1
Empire Normandie	BW	M9	5/12	3.7	3.1	10/6	2.43	258	0.25	0.15	3.80	1.047	11.8
Empire	BW	M9	5/1	2.7	3.0	10/8	2.04	150	0.29	0.22	3.67	1.045	11.2
Empire Normandie	SH	M9, M9/M	9/5	3.8	3.2	9/22	3.42	242	0.07	0.98	3.21	1.055	13.2
Empire	SW/SW	M9/M, M27	5/5	3.8	2.9	10/4	3.18	256	0.17	0.69	3.20	1.048	12.0
Empire Rose	BW	M9/M	5/7	4.1	3.1	10/2	3.01	263.0	0.30	0.30	4.17	1.047	11.4

74 Varieties grown at WSU Mount Vernon NWREC from 2003-2017 www.cider.wsu.edu


Apple Classification

Sharp	Sweet	Bittersharp	Bittersweet
Low tannin < 0.2	Low tannin < 0.2	High tannin > 0.2	High tannin > 0.2
High acid > 0.45	Low acid < 0.45	High acid > 0.45	Low acid < 0.45




Kingston Black

Golden Russet
Mott Pink
Redstreak
Zabergau Reinette




Campfield

Bouteville
Granniwinkle
Peau de Vache
Sweet Alford



Hewes VA Crab

Breakwell Sdlg.
Cap of Liberty
Lambrook Pippin
Porter's Perfection




Harry Masters' Jersey

Dabinett
Frequin Rouge
Kermerrien
Medaille D'Or


Biennial Bearing

Cultivar	Bloom Density ± SD ¹	Bloom Habit ²	Productivity Rating ± SD ¹	Prod. Habit ²
Bramley's Seedling	2.8 ± 1.3	CON	2.7 ± 1.2	CON
Bramtot	4.1 ± 0.8	CON	3.0 ± 0.6	CON
Breakwell Seedling	4.1 ± 1.5	CON	3.2 ± 1.0	CON
Bulmer's Norman	4.6 ± 0.6	St-CON	3.0 ± 2.0	BI
Campfield	3.5 ± 1.0	CON	1.8 ± 0.6	CON
Chisel Jersey	3.3 ± 1.4	CON	2.7 ± 1.0	CON
Golden Russet	4.7 ± 0.6	St-CON	3.6 ± 0.4	St-CON
Gravenstein, Red (Worthen)	4.0 ± 0.7	CON	3.5 ± 0.3	St-CON
Grimes Golden	4.6 ± 0.4	St-CON	4.0 ± 0.4	St-CON
Harrison	3.4 ± 0.6	St-CON	2.1 ± 0.5	CON
Kermerrien	3.1 ± 1.7	BI	2.8 ± 1.5	BI
Kingston Black	3.3 ± 1.4	CON	2.7 ± 1.6	BI
Maude	4.1 ± 1.3	CON	2.2 ± 1.0	CON
Redstreak, Hereford	3.6 ± 0.8	CON	3.2 ± 1.5	CON
Ross Nonpareil	4.6 ± 0.6	St-CON	2.4 ± 1.1	CON
Tramlett's, Geneva ³	4.3 ± 0.7	St-CON	2.7 ± 1.4	CON
Vilberie	3.3 ± 1.3	CON	2.7 ± 1.8	BI
Yarlington Mill	3.7 ± 1.0	CON	3.7 ± 0.6	St-CON

Juice Yield per Variety



MultiMax 30
Zambelli Enotech,
Camisano Vicentino,
Italy



Carezza
Enotecnica Pillan,
Camisano Vicentino,
Italy

- ❖ 25 fruit
- ❖ Shredded
- ❖ Pressed

mL juice / lb fruit	lbs fruit / gal. juice
150	25
200	19
250	15
300	13
350	11


Variety Fruit Yield

Cultivar	No. Trees	Rootstock	Yrs of Data	Avg Yield per Tree (lbs)	SD	Mean Prod. Rating
Yarlington Mill	2	M106	4	196	114	3.67
Tom Putt	5	M106 (3) M26 (2)	3	155	60	4.38
Michelin	1	M106	5	138	101	3.58
Bramley's Seedling	1	M26	5	127	89	3.50
Dabinett	5	M106	5	97	49	3.67
Harry Masters' Jersey	1	M106	5	96	50	3.92
Zabergau Reinette	1	M9	5	95	65	3.83
Cap of Liberty	2	M106	4	94	78	3.17
Breakwell Seedling	3	M26	5	93	59	3.13
Mott Pink	1	M9	4	90	73	3.50
Golden Russet	2	M26	5	73	42	3.90
Chisel Jersey	3	M106	5	62	20	3.00
Track Zero (Ross Cider)	1	Bud 9	5	60	51	3.83
Kermerrien	5	M106	5	56	47	3.07
Finkenwerder Herbstprinz	4	M106 (3) M9 (1)	5	53	36	3.19
Frequin Rouge	5	M106	5	50	16	3.05
Major	1	M9	5	49	45	3.67

Data collected 2013-2017 All cultivars had productivity rating ≥ 3.0

Fruit and Juice Yields

- ❖ Average cider apple yield: 68 lbs/tree
- ❖ Orchard 12 ft x 15 ft has 225 trees
- ❖ Yield per acre:
 - 15,300 lbs
 - 364 bu (42 lbs/bu)
 - 17 bins (900 lbs/bin)
- ❖ 15 lbs. fruit produce 1 gal. cider
- ❖ 2,194 gallons per acre

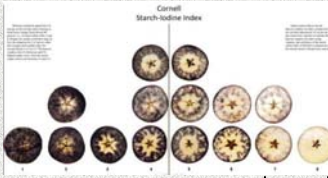


Kermerrien/ M106 rootstock

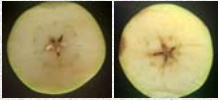
Source: Based on data from 34 cultivars grown on Malling series rootstocks at WSU Mount Vernon NWREC

Cider Research: Fruit Maturity


❖ Evaluating cider apple fruit to determine time of harvest



Cornell March-Index



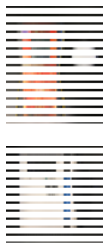
cider apples



WASHINGTON STATE UNIVERSITY **Cider Research: Fruit Maturity**

Test new technologies to develop a protocol for harvesting cider apple fruit at optimal quality

- ❖ Non-destructive fruit quality instruments:
 - **DA Meter** measures change in chlorophyll content of the mesocarp (flesh), which can be used as maturity indicator
 - **Produce Quality Meter** measures near infrared light interaction with molecular components inside fruit to quantify user-selected characteristics of fruit quality
- ❖ Destructive fruit quality measurements
 - Starch iodine index reading
 - Dry matter content
 - Juice quality: soluble solids content (°Brix), titratable acidity, pH, titratable tannin
- ❖ **Measurements:** 2 weeks before, during, and after historic harvest date
 - Harvest 20 fruit per 3 single tree replicates




WASHINGTON STATE UNIVERSITY **Cider Research: Fruit Maturity**



WASHINGTON STATE UNIVERSITY **Cider Apple Harvest**

Cider apples are:

- ❖ Generally smaller than dessert apples (avg. 2.6 in.)
- ❖ Mechanically harvested in Europe
- ❖ Hand picked in the U.S.:
 - Shallow rootstocks, small trunk diameter, and smaller alleys limit equipment use



Ashmead's Kernel (2) Yarlington Mill Newtown Pippin Golden Russet Harry Masters' Jersey
 Dabinett Harrison Kingston Black Brown Snout (2)

WASHINGTON STATE UNIVERSITY **Cider Orchards in Washington**



Tieton Cider Works 3 ft x 12 ft = 1,210 trees per acre

WASHINGTON STATE UNIVERSITY **Medium Density Orchard**



6 ft x 12 ft = 605 trees per acre

WASHINGTON STATE UNIVERSITY **Mechanical Management**

Thinning



R.J. Anderson

Hedging



LaGasse Works

WASHINGTON STATE UNIVERSITY **Reduced Pruning Labor**

WASHINGTON STATE UNIVERSITY **Shake-and-Catch Harvester**

Littau Harvester - cherries

WASHINGTON STATE UNIVERSITY **Cider Apple Mechanical Harvest**

Alexander et al. 2018. HortTech. 28:35-43.
 Alexander et al. 2016. HortTech. 26:614-619.
 Miles and King. 2014. HortTech. 24:519-526.

Littau OR0012

WASHINGTON STATE UNIVERSITY **Varietal Cider Evaluations**

Lallemand DV-10 Champagne yeast **Fermentation** **Bottling**

Sensory analysis

WASHINGTON STATE UNIVERSITY **Varietal Cider Evaluations**

Variety	Description	Color	Aroma	Overall
Blanc Mollet	Mild to mod. bitter French bittersweet	Deep gold	Caramel, pear & Jolly Rancher with wood, biscuit & tropical fruits	Medium bodied , light flavors & aromatics. Medium length finish with bitter & mildly astringent aftertaste.
Chisel Jersey	Full English bittersweet	Golden amber	Bittersweet apple, phenolic, citrus, floral, spicy, earthy & woody	Barnyard character typical of English farmhouse cider; pronounced bitterness. Very long tannic, astringent finish.
Golden Russet	Medium sharp russet dessert apple	Straw	Estery, green apple, candy apple, honey, cidery & tropical fruits	Full-bodied, alcoholic, complex aromatics, good acid. Medium length. Excellent base for dessert apple cider blend.
Granniwinkle	Old American moderately sharp cider apple	Straw	Estery, floral, tropical fruit, confectionary, woody, green apple, cidery	Clean, crisp and fruity, light bodied, short finish . Refreshing aftertaste of melon, currant, honey and dried fruit; potential Champagne cider.

37 single varietal ciders made and evaluated www.cider.wsu.edu

WASHINGTON STATE UNIVERSITY **Cider Education Courses**

Two courses available:

- ❖ **Cider & Perry Production - A Foundation**
 4-day course involving lectures, workshops and tastings, focused on the main principles and methods of cider production
- ❖ **Cider & Perry Production - Building Expertise**
 4-day master course focused on quality production, marketing and distribution of cider

An informal survey by the NABC found that 80% of cider makers in the U.S. have taken the Foundation course

WASHINGTON STATE UNIVERSITY

Extension Manuals

Hard Cider Production & Orchard Management in the Pacific Northwest

A PACIFIC NORTHWEST EXTENSION PUBLICATION # PN062




Washington State University • Oregon State University • University of Idaho

WASHINGTON STATE UNIVERSITY EXTENSION



ESTABLISHING A CIDER APPLE ORCHARD FOR MECHANIZED MANAGEMENT

By
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www.cider.wsu.edu

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Cider Apple Orchard Budgets

- ❖ Develop enterprise budgets for small, medium and large-scale orchards suitable for mechanical pruning and mechanical harvest.

2014 Cost estimation of establishing a cider apple orchard in Western WA

2016 Cost estimation of establishing a cider apple orchard in Eastern WA

Feasibility of Different Harvest Methods for Cider Apples: Case Study for Western WA



2013 Cost Estimation of Establishing a Cider Apple Orchard in Western Washington

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET # 10001

Policy:

1. This document is intended to provide information to growers and researchers regarding the costs of establishing a cider apple orchard in Western Washington. It is not intended to be used as a financial statement or as a basis for financial decisions.

2. The information in this document is based on data collected from growers in Western Washington who have established cider apple orchards in recent years.

3. The information in this document is based on data collected from growers in Western Washington who have established cider apple orchards in recent years.

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Acknowledgements

Collaborators:

- Suzette Galinato - WSU School of Economic Sciences
- Carolyn Ross - WSU School of Food Science
- Tom Collins – WSU Viticulture and Enology
- Desmond Layne – WSU Horticulture

Funders:

Washington State Dept. of Agriculture
 WSU ARC Emerging Research Issues
 Northwest Agriculture Business Center
 WSU Center for Sustaining Agriculture & Natural Resources (CSANR)
 Northwest Cider Association
 Northwest Agricultural Research Foundation



www.cider.wsu.edu

Training system is tall spindle, 12' x 3' using conduit. Rootstock is Bud 9 and G.41. Tip bearers should be planted further apart in the row. DO NOT HEAD TREES AT PLANTING. Too much top growth, need trees to settle down and bear fruit.

It may be necessary to tie down branches to induce production and use PGRs.

Fire Blight can be a serious problem because many varieties will bloom during the season even with fruit on. Consider using copper on a regular basis.

In 2018, Actigard was injected four times in addition to normal Kasumin and Strep sprays. Consider including other biocontrols.

Many varieties tend to be biennial. Some will remain biennial no matter what.

Planning on mechanical harvest using a modified over-the-row harvester.

WAIT TO HARVEST WHEN APPLES ARE RIPE

T = tannic/acid, B = base cider, C = culinary

1 = early, 2 = mid, 3 = late, 4 = later

Flowers Ripens

Bearer

				Flowers	Ripens	Bearer	
<i>Ashmead's Kernel</i>	Bittersweet	T/C	sweet sharp / pie apple / very late season	3	4	spur	English
Baldwin	Sharp	B/C	once most popular apple in U.S. / pie apple / good flavor	2	3	spur	US - northeast
<i>Binet Rouge</i>	Bittersweet	T	precocious / good taste / sweet, high Brix / low juice production	2	4	spur	French
<i>Brown Snout</i>	Bittersweet	T	<i>easily prone to fire blight / need full season control</i>	4	3	spur	English
<i>Calville Blanc</i>	Bittersweet	C	exaggerated ribbing / precocious / gourmet baking and pie apple	2	4	spur	France
<i>Chisel Jersey</i>	Bittersweet	T	precocious / high tannins / water core?	3	4	spur	English
Cortland	Bittersweet	B	McIntosh offspring	2	2	tip	US - NY
<i>Dabinett</i>	Bittersweet	T	seedling of Chisel Jersey	4	3	spur	English
Enterprise	Sharp	B	disease resistant / large apples / precocious	2	4	spur / tip	US
Esopus Spitzenburg	Sweet	B/C	tree vigor questionable / store 1 month	2	3	spur	US - NY
Franklin	Bittersweet		new / compare to Kingston Black / still evaluating planted 2018		3		US - northeast
<i>Golden Russet</i>	Sharp	T	good bearer / many uses / sweet sharp	1	3	tip	English
Harrison	Sharp		American Revolution / single variety cider	2	3	tip	US
Harry Masters Jersey	Bittersweet		early heavy drop / precocious	3	4	tip	English
Herefordshire Redstreak	Bittersweet		still evaluating	3	4	tip	English
Kingston Black	Bittersweet		Early water core - Sorbitol (non-fermentable) / tie down	3	4	spur	English
Medaille D'or	Bittersweet		very late out of dormancy / fire blight	4	3	spur	France
Northfield Beauty	Sharp	B	big apples / ripe in late August / do not store well - turn soft (mush)	2	1		CA from VT
<i>Porter's Perfection</i>	Bittersweet	T	heavy cropping / biennial	2	4	spur	English
Red Haralson	Sweet	T	precocious / developed in Minnesota / still evaluating	3	3	spur	US
Tremlett's Bitter	Bittersweet		Geneva Tremlett's is bittersweet / mealy?	2	3	spur	English
<i>Wickson</i>	Sweet	T	crab apple / high acid / good in cider / bears well	2	3	spur	VT to CA
Winesap	Sharp	T	Stayman is a little sweeter	2	3	spur	US - eastern
<i>Yarlington Mill</i>	Bittersweet	T	precocious / good in cider	2	3	spur	English

Varieties in **bold** definitely produce good cider apples in northwest Michigan. Varieties in *italics* may be of higher monetary value.

The varieties which are struck out will be grafted over

Varieties at Northwest Michigan Horticultural Research Station

1 = early, 2 = mid, 3 = late, 4 = later

Flowers

Ripens

Bearer

Adams Pearmain		low or no yield				
Ashmead's Kernel		may have some winter injury				
Binet Rouge		low juice production?				
Bramley's Seedling	Sharp	very large green apples / slow to start bearing	3	3	spur	English
Champlain		low or no yield				
Court Royal		poor quality fruit				
Cox Orange Pinnin		poor quality fruit				
Dabinett		may have some winter injury				
Dafflin		low or no yield				
Domains		low or no yield				
Fenouillet Gris		low or no yield				
Fenouillet de Ribours		low or no yield				
GoldRush	Sweet	disease resistant / similar to Golden Delicious / heavy cropping	4	4	spur	US, Purdue
Harry Masters Jersey						
Hudson Golden Gem	Sweet	some disease resistance	2	3	spur	US, Oregon
Kerry Pinnin		poor tree health				
Kingston Black		not recommended for northern Michigan				
Liberty	Sharp	disease resistant	2	3	spur	US, NY
Major		poor quality fruit				
Marin Guyfray		low or no yield				
Mettais	Bittersweet			3		French
Michellin	Bittersweet	precocious / some resistance to scab	3	3		French
Muscadet de Dieppe		poor quality fruit				
Old Non Parreil		poor quality fruit				
Red Stoke		poor tree health				

https://www.canr.msu.edu/uploads/files/Research_Center/NW_Mich_Hort/Training_Pruning_Varities/HardCiderVar2012Expo.pdf

Check out the Cornell University cider apple website.

COMPARING APPLES TO APPLES: PARTICIPATORY RESEARCH FOR ARTISANAL CIDER PRODUCERS

Matt Raboin, Nick Smith, Julie Dawson,
Elly Voigt and Michelle Miller
NCR-SARE ONC17-030 and David Borne Foundation
Great Lakes Expo, December 2018



UW-Madison
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AGRICULTURAL SYSTEMS
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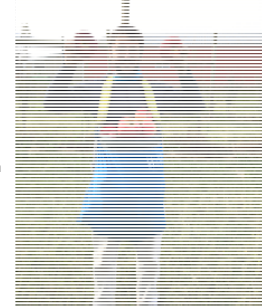
NORTH CENTRAL
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Advancing sustainable
agriculture since 1988!

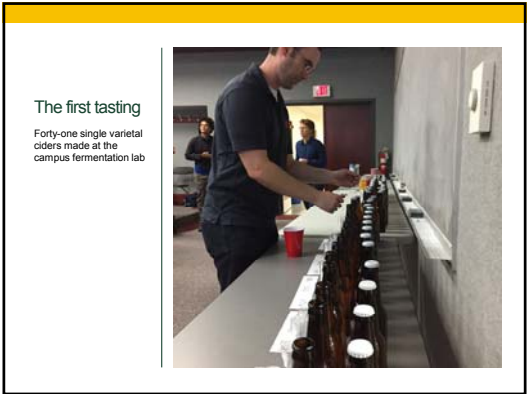
COMPARING APPLES TO APPLES: PARTICIPATORY RESEARCH FOR ARTISANAL CIDER PRODUCERS

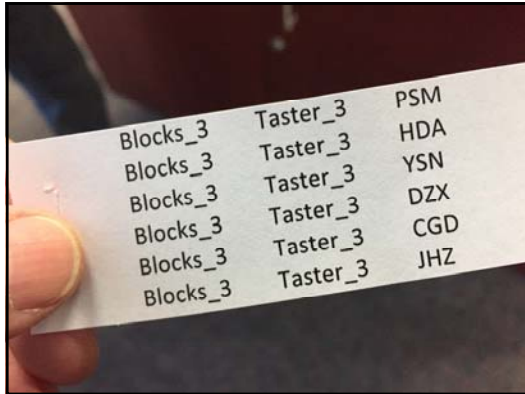
single varietal hard cider apple
flavor research, using lab and
sensory measures

Challenges when comparing apples

- Different management practices, growing conditions, timing of harvest
- Year to year variations
- Apples might give different flavors in a blend than they do on their own (e.g. some of the high pH apples were easily oxidized on their own and flavors typical of oxidation dominated their profile)
- Different yeasts and fermentation conditions might alter perceptions of one variety vs. another







Tasting is hard!

The first tasting we wanted data on all forty apple varieties, so each taster tried six ciders in two rounds, for a total of 12 different ciders.

From this first tasting, we've grouped apples by flavor category and narrowed the tasting.

which are more subjective components of cider preference.

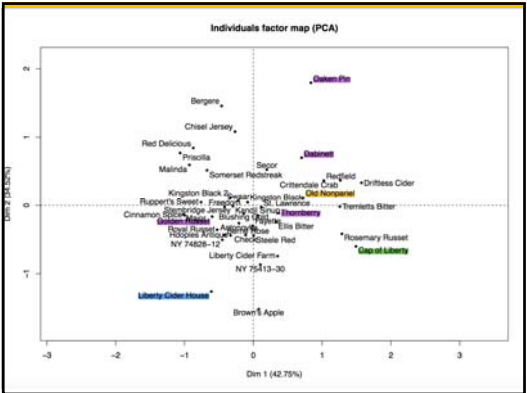
Use a 1-5 score for each category below:
 White boxes: 1 = low 2 = moderately low 3 = moderate 4 = moderately high 5 = high
 Grey boxes: 1 = poor 2 = mediocre 3 = acceptable 4 = good 5 = excellent

- For each flavor category, note the strength of that particular flavor component
- For appearance and mouthfeel, rate how appealing each variety is.
- For overall flavor, give your global appreciation (1-5) of the flavor of each variety, excluding the appearance category.
- For unusual flavors, note any particularly strong flavors or anything that tastes "off" and write what the taste is in the box.

Variety Code	1	2	3	4	5
Sweetness					
Acidity					
Astringency					
Bitterness					
Intensity					
Strength					
Alcohol Level					
Appearance					
Mouthfeel					
Overall flavor					
Unusual					

Lots of data

1	Wigwagmt One	4	PSW	13	3.53	2.77	7.1	727
2	Magr	5	ZSH	13	4.38	1.78	2.4	1335
3	Cap of Libert	6	XYM	14	3.18	10.8	14.5	
4	Stembridge J	7	HDA	14	3.53	2.6	3.5	361
5	Kandil Sinup	8	EVC	10	3.53	3.95	5.3	401
6	Somerset Re	9	XXD	13	4.24	1.45	1.9	1708
7	Thornberry	10	CGD	14	3.34	7.83	10.5	1094
8	Bergere	11	TKL	12.5	4.19	1.5	2	2288
9	Ellis Bitter	12	UVQ	13	3.45	5.6	7.5	665
10	Tremletts Bit	13	LYR	11	3.07	8.43	11.3	1339
11	Secor	14	GRV	12.5	3.52	4.23	5.7	545
12	Cinnamon Sc	15	GWC	12.5	3.76	3.28	4.4	444
13	Liberty Cider	16	KJL	10.5	3.31	6	8	612
14	Steele Red	17	ZUX	13	3.43	5.8	7.8	610
15	Rupperts Sw	18	FMC	13	3.73	2.75	3.7	901
16	Fayette	19	VLV	12.5	3.41	4.22	5.7	1322
17	Swaar?	20	WRP	13	3.46	5.67	7.6	708
18	Crittendale C	21	MWD	14.5	3.46	5.67	7.6	2643
19	Hooples Anti	22	IVF	17.5	3.53	4.95	6.6	858
20	Red Delicious	23	MDB	11	3.98	1.55	2.1	586
21	Freedom	24	ZDK	11.5	3.67	2.6	3.5	931
22	Berne Rose	25	UVQ	11	3.46	3.6	4.8	808



Royal Russet	
2017 Fruit Analysis	
Brix	15.5
pH	3.49
HL NAC6h	4.9
Acidity	8.8
Phenolics	300
Dominant 1st	Sweetness (3) This true Russet will keep in store until May. Gains Spout with age. Will cook in its early picking date. Flesh yellow. Those using a true Russet will find this more palatable with age.
Firm	5/6 Originating in England and first recorded over 400 years ago, this variety bears small apples packed with flavor. Fruit has a firm, tender flesh with a sweet, yet sharp, flavor and are generally oblate flat with yellowish green skin typically completely covered in brown laces.
Firm Note	
Tasting Note	

Save the date!
Hard Cider Apple Grafting Workshop
April 21, 2018, 1-4 pm
UW-Madison
DC Smith Greenhouse,
465 Babcock Drive

UW-Madison
 CENTER for INTEGRATED AGRICULTURAL SYSTEMS
 www.ias.wisc.edu

Featuring hard cider apple stock, chosen based on preferred flavor profiles. Led by Amaya Atucha, UW-Madison Horticulture Department, and four experienced cider apple growers. Free parking is available across the street. To register, visit <https://tinyurl.com/AppleGraftingWorkshop>. Advance registration is required.

Apples to Glass – 2019-2021

- Varietal results available
- Four state grower / researcher partnership: Washington, Michigan, Vermont, Wisconsin
- Consumer intercept surveys in 2019
- Hard cider supply chain and distribution research
- Economics of hard cider apple production
- Local Food Economics Toolkit assessment
- Orchard walks

Cider Production

- Apples placed in refrigerator upon reception at Babcock hall
- Apples photographed, crushed and pressed
 - ~1 gallon per varietal
 - No maceration enzyme
- 40 ppm SO2
- Placed in cooler to settle



Cider Production



Cider Production - Fermentation/Bottling

- After settling
 - Racked off of lees
 - 0.4 g/l Superfood (BSG Wine)
- Yeast
 - SafCider (Fermentis)
 - 0.3 g/l yeast rehydrated in Startup (0.3g/l)
- Fermented at 60 F for 2 weeks
- Chilled to 35F to settle yeast
- Racked off of yeast lees
 - 40 ppm SO₂
 - Bottled
- Stored at 5C

Cider Production



Lab analysis and results

- Juice:
 - Titratable Acidity (MAE) - 1.6 g/L to 14.5 g/L (ideal range 4.5-7.5) Too high = sour; too low = spoilage likely
 - Brix – 10 to 18 Brix (ideal range 11-15). An estimate of potential fermentation and alcohol content
 - pH – 2.99 to 4.43 (ideal range 3.2-3.8). Too high = microbial infection; too low = sour flavor
- Cider
 - Total Phenolics (Folin-Ciocalteu) - 361 GAE to 3,021 GAE (ideal level ~2,000 GAE)

Analytical Results

Varietal	Titrateable Acid
Dabinett	1.6
Chisel Jersey	1.7
Somerset Redstreak	1.9
Bergere	2.0
Red Delicious	2.1
Thornberry	10.5
Old Nonpariel	10.7
Tremletts Bitter	11.3
Rosemary Russet	13.9
Cap of Liberty	14.5

Analytical Results

Varietal	Brix
Kandil Sinup	10.0
Antonovka	10.0
Driftless Cider	10.5
Liberty	10.5
St. Lawrence	10.5
Brown's Apple	11.0
Tremletts Bitter	11.0
Red Delicious	11.0
Berne Rose	11.0
Freedom	11.5

Analytical Results

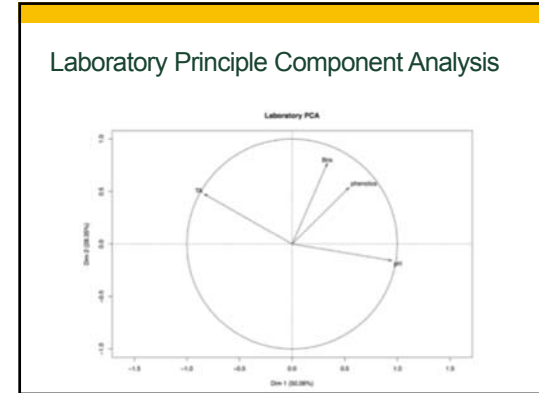
Varietal	Brix
Priscilla	14.0
Crittendale Crab	14.5
Liberty Cider Farm	14.5
Kingston Black	15.0
NY 74828-12	15.0
Royal Russet	15.5
Oaken Pin	16.0
Golden Russet	17.0
Hooples Antique	17.5
Dabinett	18.0

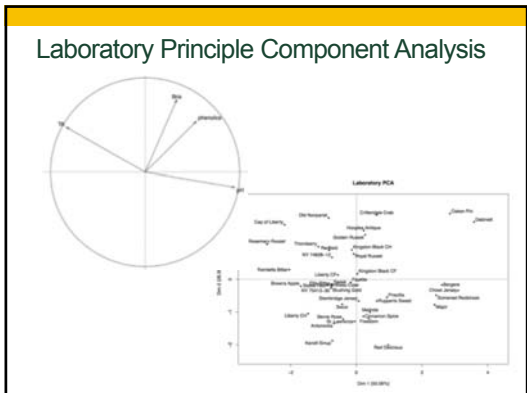
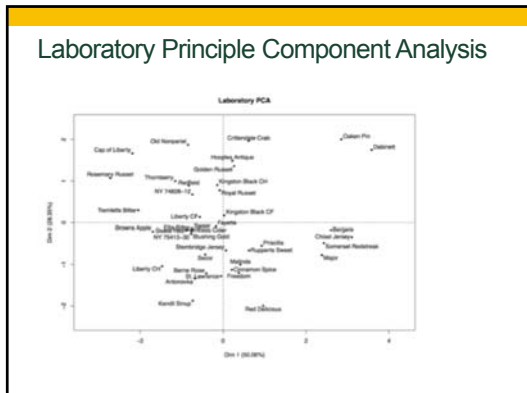
Analytical Results

Varietal	pH
Rosemary Russet	2.99
Tremletts Bitter	3.07
Cap of Liberty	3.18
Driftless Cider	3.19
Old Nonpariel	3.21
Bergere	4.19
Somerset Redstreak	4.24
Dabinett	4.32
Major	4.38
Chisel Jersey	4.43

Analytical Results

Varietal	Total Phenolics
Stembridge Jersey	361
Kandil Sinup	401
Cinnamon Spice	444
Secor	545
Red Delicious	586
Dabinett	2,256
Chisel Jersey	2260
Bergere	2288
Crittendale Crab	2643
Oaken Pin	3,0210

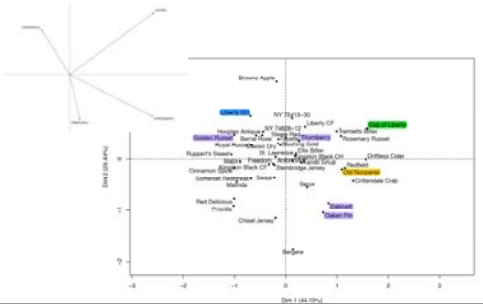




Sensory Analysis

- Ciders evaluated on a variety of characteristics:
 - Sweetness
 - Appearance
 - Acidity
 - Astringency
 - Bitterness
 - Mouthfeel
 - Flavor Intensity
 - Flavor
 - Overall Preference

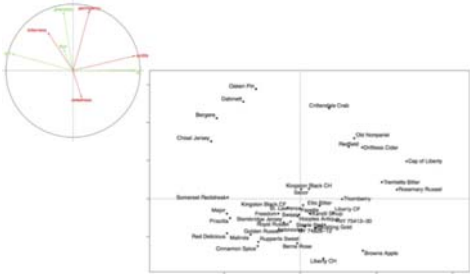
Tasting PCA



Summary

- Astringency:
 - Oaken Pin, Driftless Cider, Bergere, Cap of Liberty
- Bitterness:
 - Oaken Pin, Chisel Jersey, Dabinett, Bergere, Redfield
- Mouthfeel:
 - Liberty, Old Nonpareil, Kandil Sinap, Kingston Black, Ellis Bitter
- Intensity:
 - Cap of Liberty, Redfield, Kingston Black, Tremlett's Bitter
- Overall:
 - Liberty, Kingston Black, Ellis Bitter, Tremlett's Bitter, Steele Red

Comparing lab and sensory PCAs



Findings

Apples

- Ellis Bitter? Oaken Pin?
- Apple flavor is highly variable as is taste preference
- Many apple varieties land in the "balanced" zone
- IDed varieties that may add specific characteristics to finished ciders

PCA comparisons

- Tasting results similar across all tasting events
- Lab results may serve as a proxy for taste characteristics, phenolics /brix (astringency, bitterness, strength) and TA (acidity).
- Dabinett and flavor interaction?

Same varieties, two different orchards

Differences between two Liberty ciders

- Brix (10.5 / 14.5)
- TA (8 / 5.6)
- Sweetness (2.6 / 2.1)
- Appearance (3.1 / 4)

Differences between two Kingston Black ciders

- No significant differences in lab tests
- Intensity (3.8 / 3.1)
- Overall perception (2.9 / 3.5)

Taste profiles and preferences vary

Favorite	Least favorite
<ul style="list-style-type: none"> Sweet or balanced Acid (TA) Negatively correlated with phenolics (associated with bitter, astringent, alcohol content) 	<ul style="list-style-type: none"> Correlated with bitterness Negatively correlated with TA (people like sour)



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The Cider Farm

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Full report on-line at:

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