Cider Apple Production and Evaluation

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http://maritimefruit.wsu.edu

Introduction

Cider (also called ‘hard cider’) is fermented apple juice

Alcohol content is measured as “alcohol by volume” (ABV):

- Ciders worldwide range from 1.2% to 8.5% ABV
- In U.S., cider defined as ≤7% ABV for tax and legal purposes
- New laws proposed to change ABV in U.S.

Cider sales in the U.S. have increased 54% each year from 2007 through 2012

High quality cider made with specialty cider apples:

- High levels of tannin not found in dessert apples
- Limited production in the U.S.

Cider apple production and artisanal cider is a new market opportunity

Research Cider Orchards at WSU

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

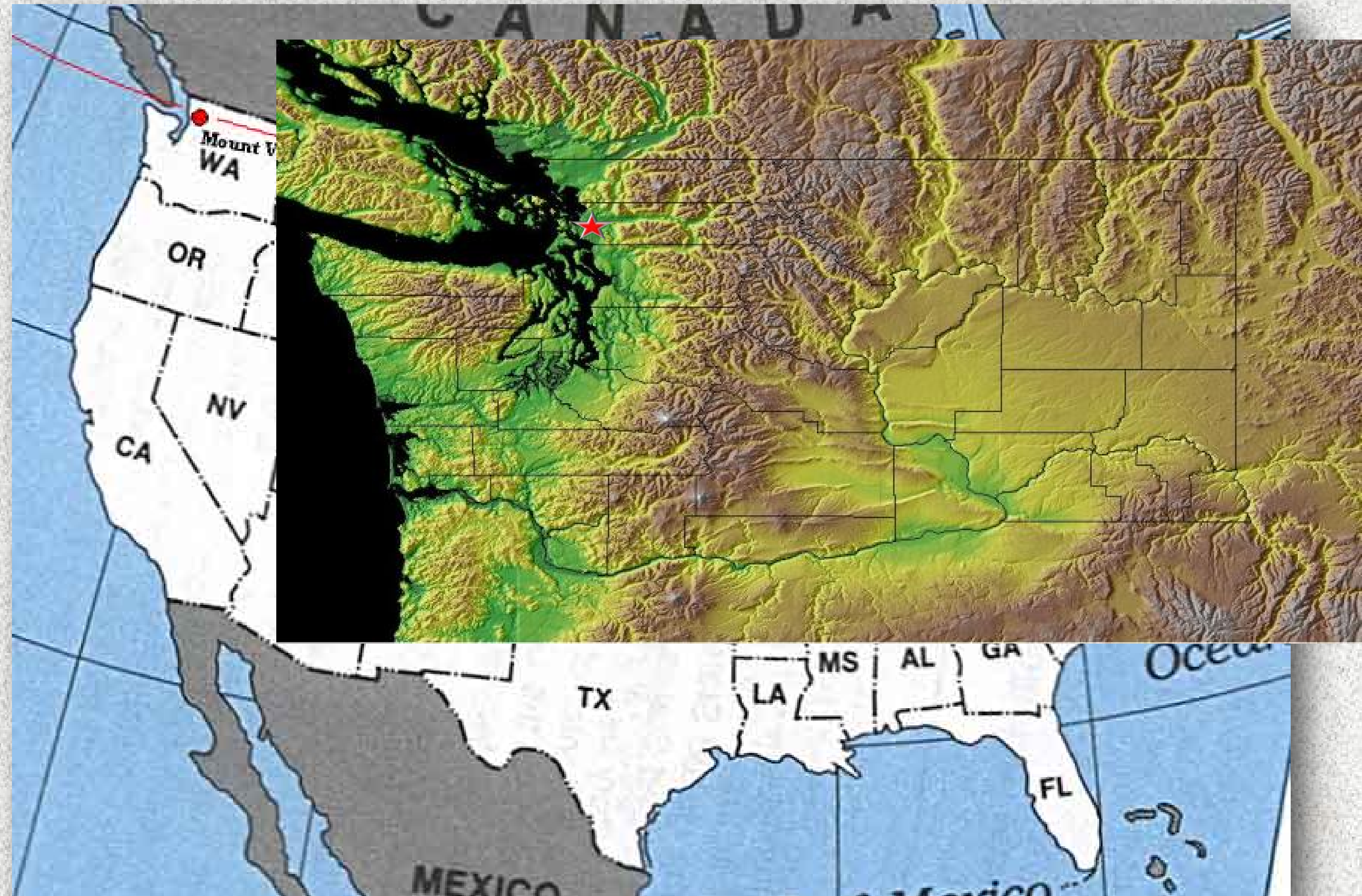
1983 to 1994 – 20 varieties added, observations made on productivity, growth habit, and disease susceptibility

1994 – cider apple trial orchard established with over 70 different varieties

2002 to current – varieties evaluated for juice characteristics

2010 – published results in *Hard Cider Production & Orchard Management in the Pacific Northwest* (PNW 621)

Washington State University Mount Vernon Northwestern WA Research and Extension Center



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Overview of WSU Research Program

- Long term evaluation of cider apple juice
- Make and evaluate single-varietal ciders
- Establish trained cider sensory panel
- Compare juice of selected cider apple varieties grown at different WA locations
- Evaluate cider apple mechanical harvest using raspberry and blueberry harvesters
- Measure costs of cider apple production
- Provide cider production education in cooperation with NABC
- Publish results – website, Extension, journal articles

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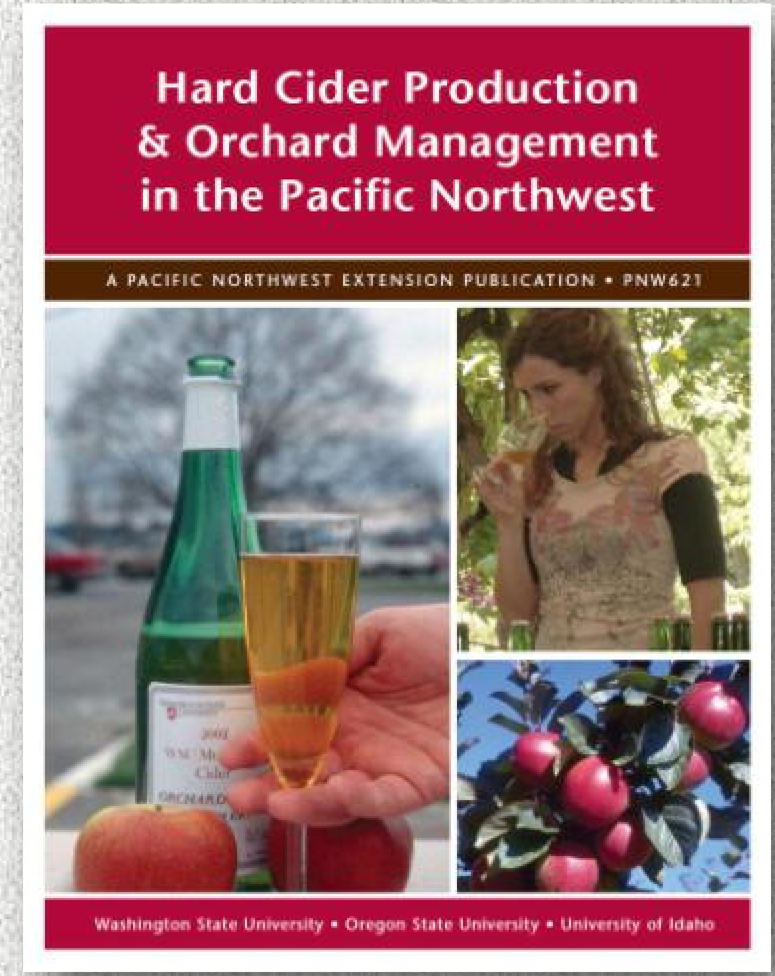
Extension Manual

❖ **Cider production and research at WSU Mount Vernon NWREC summarized in:**



WSU Extension Manual PNW0621 (2010)

Apple Types

Cider apples classified into 4 categories according to acid and tannin content (Long Ashton Research Station, Bristol, England; Barker, 1903).

Type	Tannin (%)	Acid (%)
Sharp	< 0.2 Low tannin	> 0.45 High acid
Bittersharp	> 0.2 High tannin	> 0.45 High acid
Bittersweet	> 0.2 High tannin	< 0.45 Low acid
Sweet	< 0.2 Low tannin	< 0.45 Low acid

The Role of Tannins in Quality Cider

When fermented, high tannin varieties produce complex flavors, body, and astringency needed to make a balanced cider.

In blending, high tannin varieties add viscosity and satisfying mouth feel to ciders made primarily with dessert apples, which tend to be thin and bland.

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Examples of Apple Varieties

Some common cider varieties and dessert varieties within each type

Sharp	Bittersharp	Bittersweet	Sweet
Brown's Apple	Cap of Liberty	Bedan	Michelin
Tom Putt	Domaines	Chisel Jersey	Peau de Vache
Breakwell Sdlg.	Foxwhelp	Dabinett	Pomme Gris
Frederick	Hewes VA Crab	Frequin Rouge	LeBret (Sweet Alford)
Harrison	Kingston Black	Harry Masters' J.	Sweet Coppin
Smith's Cider	Lambrooke Pip.	Reine des Pommes	Taylor's
Bramley's Sdlg.	Stoke Red	Porter's Perfection	Baldwin
Golden Russet	Pearmain, Worcester	Vilberie	Ben Davis
Gravenstein	Dolgo Crab	Yarlington Mill	Gala
Jonagold	Hagloe Crab	Newtown Pippin	Fuji
Roxbury Russet		Red Astrachan	

Obtaining Fruit

- Commercial dessert orchards with cull fruit
- Specialty cider orchards
- Purchase raw bulk juice or reconstituted juice
- Start your own orchard for cider apple production

Sorting & Washing

- Process fruit immediately after picking, or leave for a month or so to soften (“sweating”)
- Remove rotten fruit and wash before milling

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Grinding/Milling

Kickapoo Orchard, Inc., Gay Mills, WI

Commercial hammer mill (left), batch type grinder mill (right)

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Batch & Continuous Presses

- **Small batch mill and press (above left)**
- **Hydraulic batch press (above right)**
- **Commercial continuous press (right)**

Kickapoo Orchard, Inc., Gay Mills, WI >

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Pressing

- Add rice hulls and/or enzymes during pressing to increase juice extraction

WSU Research Equipment

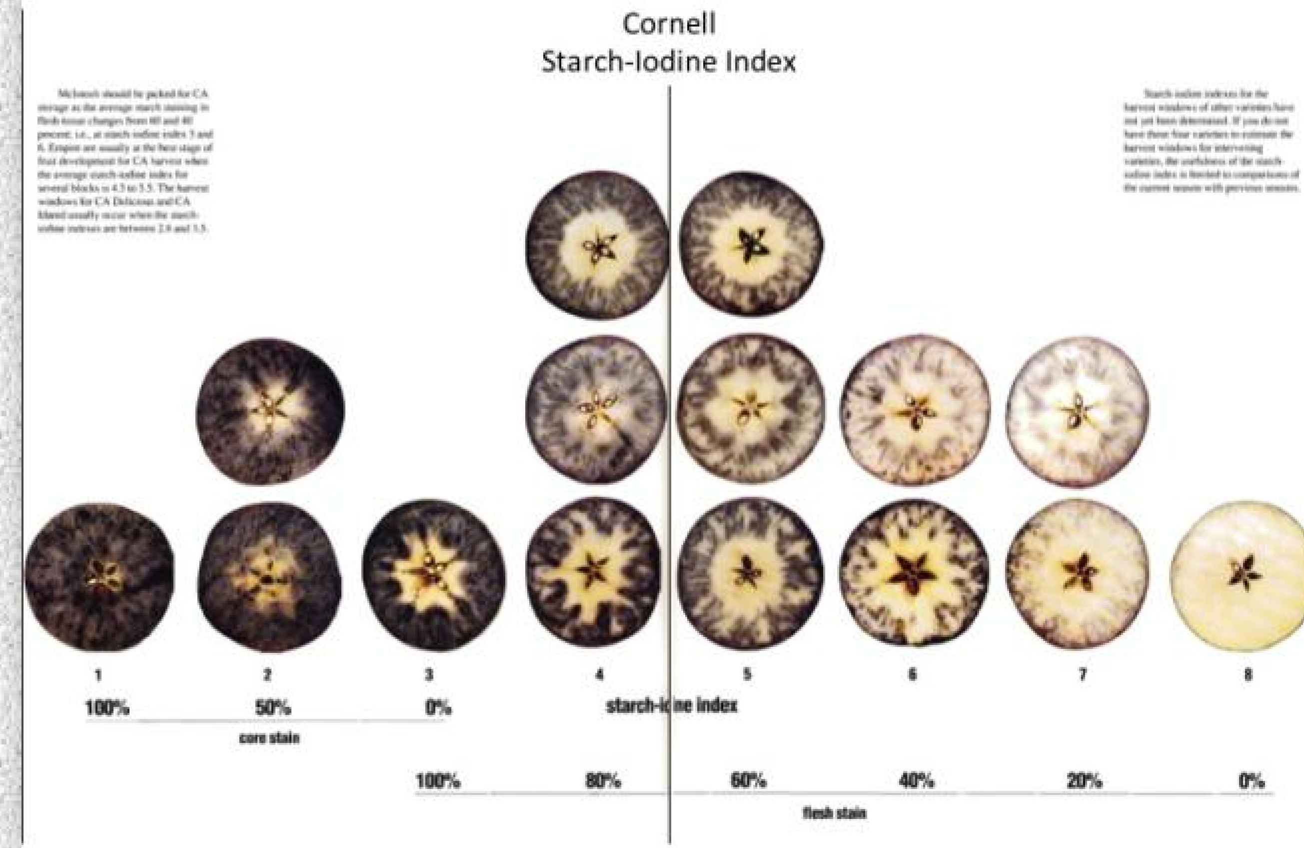
- Apple shredder (Zambelli Enotech MuliMax 60)
- Bladder press (40-Liter Enotechnica Pillan)
- Improved efficiency and cleanup between samples

Apple Shredder

Bladder Press

Evaluating Fruit and Juice

- Before harvest, evaluate ripeness using the starch conversion test



Blanpied, G.D. and S.J. Silsby. 1992, Predicting Harvest Date Windows for Apples. Cornell Cooperative Extension. Informational Bulletin 221.

WSU Juice Analysis Methods

- At harvest, collect 15-25 ripe fruit for each variety
- Mill fruit and press juice
- Collect 500 ml juice sample
- Analysis:
  - %tannins
  - °Brix
  - pH
  - malic acid (g/l)
  - specific gravity

Juice analysis in the WSU cider laboratory

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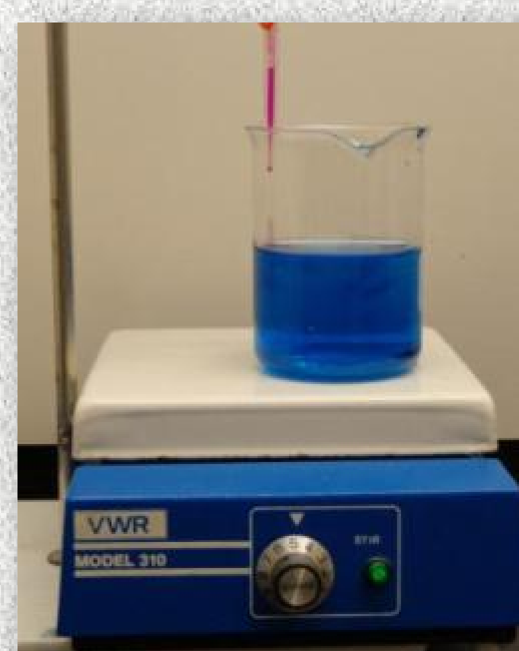
% Tannins

❖ **Tannins measured using Lowenthal method of permanganate titration:**

- **Standard procedure used at Long Ashton Research Station**
- **Can compare WSU data with English data**
- **WSU on-line training video: How to Test Tannin Levels in Apple Juice Using Lowenthal Permanganate Titration**



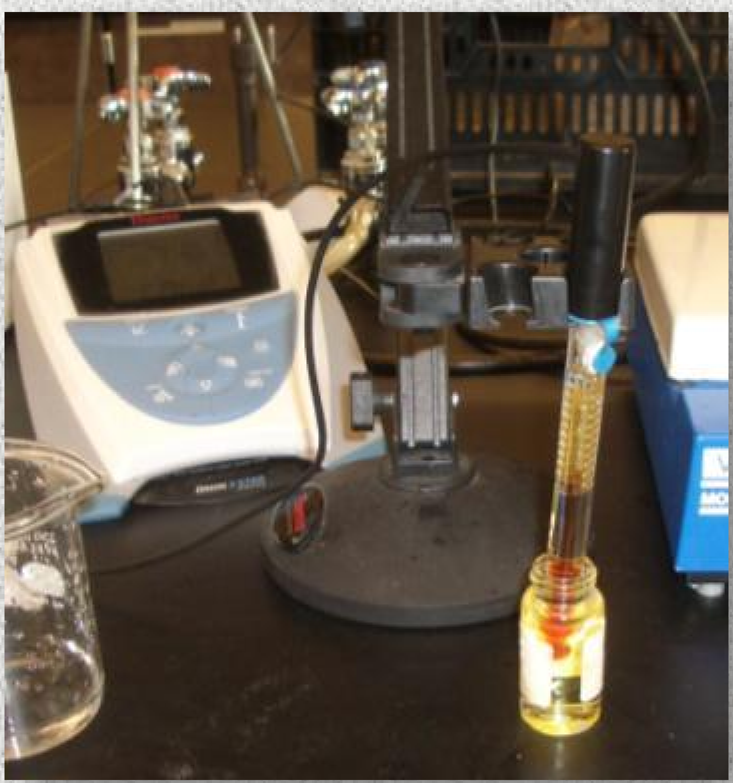
Cider juice at start of titration (blue) and at final point (yellow)

ºBrix and pH

- ºBrix – place 2-3 drops juice sample onto refractometer
- pH – measure 100 ml juice sample with digital pH meter

< Digital refractometer

Digital pH meter >



Malic Acid (g/l)

- **Titrate with 0.2 M solution of sodium hydroxide (NaOH) to 8.1 pH**
- **Record volume of solution used**
- **Calculate malic acid using the equation:**

$$\text{Malic acid } (g \cdot l^{-1}) = \text{ml NaOH} \times 0.536$$

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Cider Juice Analysis

Table 1. **Summary of juice analysis for cider apple varieties grown at WSU Mount Vernon NWREC from 2003-2012 (data not collected in 2007).**

		Tannin %		Malic Acid g/l		ºBrix		pH	
Cultivar	Yrs Eval.	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Amere de Berthcourt	3	0.48	0.20	1.90	0.53	12.9	1.55	4.31	0.14
Breakwell Seedling	5	0.27	0.22	7.82	3.27	10.9	0.97	3.23	0.13
Brown Snout	7	0.19	0.06	3.37	0.84	13.5	1.77	3.87	0.16
Dabinett	8	0.29	0.18	2.55	1.30	14.0	1.18	4.37	0.25
Golden Russet	5	0.13	0.05	6.64	0.91	16.9	1.33	3.67	0.25
Harrison	3	0.16	0.03	7.77	2.58	15.8	0.21	3.37	0.39
Kermerrien	6	0.37	0.09	2.44	0.21	13.2	1.22	3.76	0.25
Kingston Black	7	0.17	0.11	6.45	1.04	13.4	1.39	3.45	0.19
Medaille D'Or	4	1.05	0.49	3.43	0.48	15.8	1.73	4.19	0.18

National Cider Conference

February 5-7 2014

Chicago

www.ciderconference.com

Cider Apple Mechanical Harvest

- Many cider apple varieties small-fruited, take up to 4 times longer to hand pick than dessert apples
- Mechanized harvest of cider apples common in Europe
- Mechanized harvest reduces harvest labor, primary cost consideration
- Shake-and-sweep harvest not suitable for trellised cider apple orchards

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European Harvest Equipment

Tuthill Temperley, UK

Weston & Sons Cider, UK

Tree Shaker

Molaignes, France (G. Holder)

Harvesters/ Sweepers

Mechanical Harvest at WSU NWREC

- Dwarf and semi-dwarf rootstocks can be damaged by trunk shakers
- Modern apple trellising systems are conducive to small-fruit harvesters
- Small-fruit harvesters sit idle in Western WA during time of cider apple harvest

Small Fruit Harvester

Littau OR0012

NWREC Study Design

- Variety - Brown Snout
- 2002 planted, 2003 grafted
- Two rootstocks - M9 & M27
- 4 replications, 9 trees/plot, 2 treatments
  - Hand & mechanical harvest
  - Juice analysis fresh and stored (3 wk 2011, 2 & 4 wk 2012)

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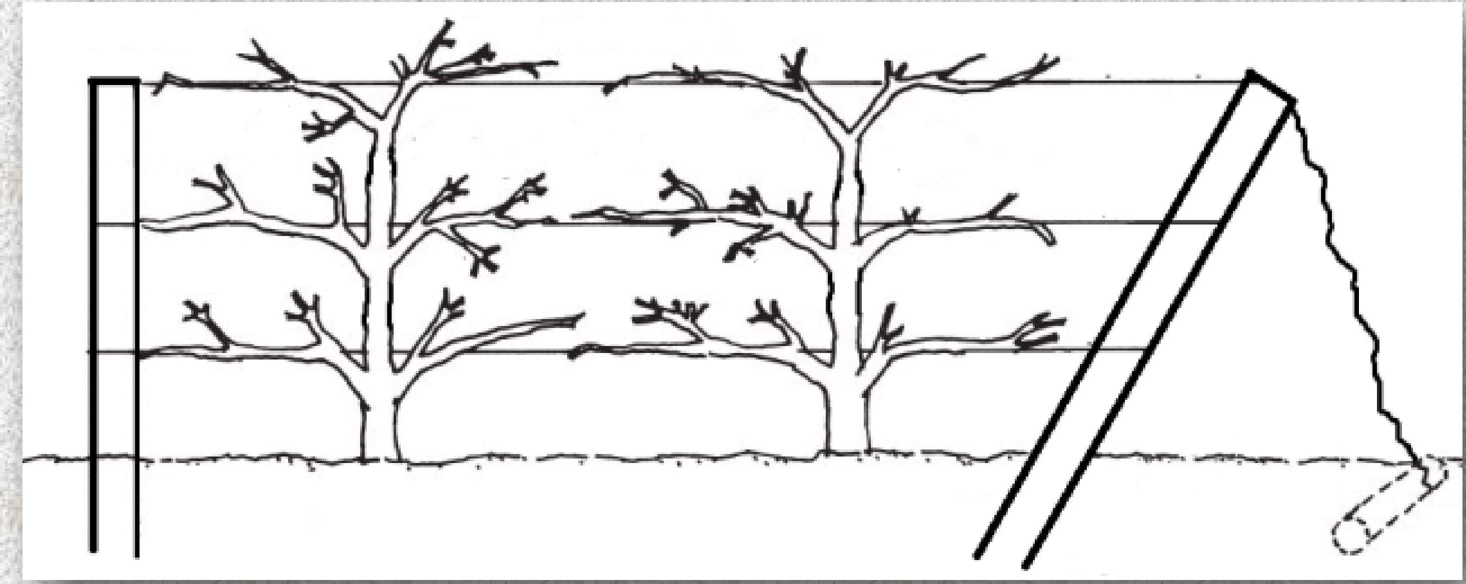
Training System

- Low trellis – end posts and mid posts 6.5 ft
- Bottom wire 2 ft, middle wire 4 ft, top wire 6 ft
- Center spindle, branches loosely tied wire, branches extend 6-8 in. into the row each side



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Data Collection

- **Fruit harvest weight**
- **Harvest time**
- **Post harvest tree damage**
- **Juice Brix, pH, % tannin, malic acid**

Fresh **Stored**



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Mechanical Harvest

Before

After

No effect due to rootstock (P > 0.05) - data pooled

Fruit Weight Per Plot

Table 1. Fruit yield (kg) and harvest efficiency (%) for hand and mechanical harvest of 'Brown Snout' in 2011 and 2012 at WSU Mount Vernon NWREC.

Harvest Type	Fruit Weight (kg)						Harvest efficiency (%)[2]	
	Harvest		Post harvest[1]		Total harvest			
	2011	2012	2011	2012	2011	2012	2011	2012
Hand	107.7	28.5	0	0	107.7	28.5	100 a	100 a
Machine	73.6	20.4	22.3	4.0	96.0	24.3	89 b	85 b
P-value	*0.11*	*0.53*	*0.007*	*0.06*	*0.59*	*0.77*	*0.001*	*0.0003*

[1] Post harvest includes remaining fruit on tree and groundfalls

[2] Harvest efficiency is 'total harvest' divided by 'harvest'

Mechanical 'harvest' is 70% of hand 'harvest'

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Picking Time

Harvest Method	Total labor hours/acre (hrs)		Cost/acre($)	
	2011	2012	2011	2012
Hand	34.5 a	11.8	554 a	212
Machine	4.2 b	5.4	81 b	104
P-Value	*0.0005*	*0.16*	*0.008*	*0.18*

Labor $12/hr; driver $18/hr
- includes taxes and unemployment

Tree Damage

Harvest Type	Spur damage[1]		Limb damage[1]		Fruit damaged by cuts (%)[2]		Fruit cut in half (%)[2]	
	2011	2012	2011	2012	2011	2012	2011	2012
Hand	1.1	7. 0	0.1	0.9	0 b	0 b	0 b	0 b
Machine	2.2	14.3	0.6	1.0	11.8 a	8.5 a	4.5 a	3.5 a
P-value	*0.46*	*0.1*	*0.25*	*0.9*	*0.006*	*0.004*	*0.02*	*0.002*

[1] per tree [2] per 100 fruit

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Fresh Juice Analysis

Harvest Method	°Brix	pH	Specific Gravity	Malic Acid[1]	Tannin %
Hand	11.88	3.85	1.05	2.91	0.19
Machine	12.19	3.88	1.05	3.20	0.19
P-value	*0.31*	*0.49*	*0.45*	*0.15*	*0.78*

[1] Malic acid measured in grams/liter

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Stored Juice Analysis

	Crush Time	°Brix	pH	Specific Gravity	Malic Acid[1]	Tannin %
2011	**At harvest**	10.86 b	3.82	1.04 b	2.22	0.15
	3 weeks	12.05 a	3.81	1.05 a	2.34	0.49
	P-value	*0.0002*	*0.63*	*0.0001*	*0.18*	*0.21*
2012	**At harvest**	13.19 b	3.91 a	1.05 c	3.89 b	0.24
	2 weeks	14.76 a	3.79 b	1.06 b	4.30 ab	0.26
	4 weeks	15.51 a	3.85 ab	1.07 a	4.56 a	0.23
	P-value	*0.0003*	*0.07*	*<0.0001*	*0.09*	*0.27*

[1] **Malic acid measured in grams/liter**

Summary of Harvest Study

- Mechanical harvest efficiency 87%, on average
- Picking cost 7 times lower in 2011 (high yield year) and 2 times lower in 2012 (low yield year)
- Tree damage doubled with mechanical harvest, but still relatively low
- 100% bruising, 10% cut, and 4% sliced fruit with mechanical harvest
- No difference in fresh juice quality; higher sugar and specific gravity in stored fruit

2013 Mechanical Harvest Research

BEI harvester

Increase Tree Density

Trellis Rows

Oregon State University

Fruiting Wall

University of Massachusetts
(J. Clements)

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WSDA Washington State Department of Agriculture
Specialty Crop Block Grant Program

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Northwest Agricultural Research Foundation