WASHINGTON STATE
WSGS
GRAPE SOCIETY

Annual Meeting Proceedings

2023

Grandview, WA

https://www.grapesociety.org

WASHINGTON STATE WSGS GRAPE SOCIETY

Annual Meeting & Trade Show

November 16- 17th, 2023

Church of the Nazarene, 500 N. Elm, Grandview, WA 98930

Program

Thursday, November 16 2023 (8:00 a.m. - 5:00 p.m.)

8:00 a.m.	**Registration & Trade Show Open**
8:45 - 9:05 a.m.	**Welcome & WSGS Business Meeting**
9:05 - 9:20 a.m.	**State of the Grapes,** Trent Ball, YVC
9:20 - 9:45 a.m.	**Cost of Production Calculator,** Trent Ball, YVC
9:45 - 10:10 a.m.	**Precision Shoot Thinner: From Research to Reality** Melissa Hansen, WA. Wine Commission
10:10- 10:15 a.m.	**Door Prize Drawing**
10:15 - 10:45 a.m.	**Trade Show Break/ Poster Session/ Cold Hardiness Info. Table**
10:45 - 11:10 a.m.	**Drought Resilience Water Policy, and Water Management,** Scott Revell, Roza Irrigation District
11:10 - 11:35 a.m.	**Back to Basics: Using Canopy Measurements and Extractable Soil Water to Irrigate Different Wine Grape Varieties,** Charles Obiero, WSU
11:35- 12:00 p.m.	**Innovative Solutions for Grape Mealybug Management: Mating Disrup tion in Washington State Vineyards,** Stephen Onayemi, WSU
12:00 - 1:15 p.m.	**Lunch Break and Trade Show**
1:20- 1:35 p.m.	**WSGS Awards Ceremony**
1:35- 1:50 p.m.	**WSU VE Curriculum Update,** Jean Dodson Peterson, WSU
1:50 - 2:20 p.m.	**Basic History of Rootstocks,** Jean Dodson Peterson, WSU
2:20 - 2:55 p.m.	**Pest Management Strategic Plan Update** , Doug Walsh and Michelle Moyer, WSU
2:55 - 3:25 p.m.	**Trade Show Break/ Poster Session/ Cold Hardiness Info. Table**
3:25 - 3:50 p.m.	**Application via Drones for Difficult Vineyards,** Bill Kuper, Ag Drones Northwest
3:50 - 4:15 p.m.	**Biological Efficacy and Cleaning Performance Evaluation of a Pneumatic - Based Solid Set Canopy Delivery System Optimized for VSP Trained Grapevines** Dattatray Bhalekar, WSU
4:15- 4:40 p.m.	**Foliar Nitrogen Application in Eastern WA. Vineyards,** Pierre Davadant, WSU
4:40 – 4:55 p.m.	**Door Prize Drawing**

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Friday, November 17, 2023(8:00 a.m. - 12:00 p.m.)

8:00 a.m.	**Registration & Trade Show Open**
8:10 –8:20 a.m.	**Welcome & Door Prize Drawings– Election Announcement**
8:20 - 8:35a.m.	**AI in Agriculture and the AgAID Project,** Paola Pesantez Cabrera, WSU
8:35- 9:00 a.m.	**Lessons on Developing a Sensor Network in Grapes,** Jake Schrader and Shafik Kiraga
9:00- 9:25 a.m.	**Spotted Lantern Fly Identification and Risk to Agriculture,** Joshua Milnes, WSDA
9:25 - 9:50 a.m.	**Japanese Beetle Update,** Cassie Cichorz, WSDA
9:50 - 10:15 a.m.	**Screening Rootstocks Against the Northern Root-Knot Nematode,** Bernadette Gagnier, WSU
10:15– 10:45 a.m.	**Trade Show Break**
10:45 - 11:10 a.m.	**Connecting Soil Health Metrics to Plant -Parasitic Nematode Suppression in a Model System**, Devin Rippner, USDA
11:10 –11:50 a.m.	**Why it Pays to Manage Safety,** Jeff Lutz, WA. Farm Bureau
11:50 - 12:00 p.m.	**Scholarship Fundraiser Drawing; Door Prizes**
12:00 p.m.	**Adjourn**

2023 Annual Meeting Proceedings

Presentations

2023 State of the Grapes, Trent Ball, YVC

Cost of Production Calculator, Trent Ball, YVC

Drought Resistant, Water Policy and Water Management, Scott Revell, Roza Irrigation District

Back to Basics: Using Canopy Measurements and Extractable Soil Water to Irrigate Different Wine Grape Varieties, Charles Obiero, WSU

Mating Disruption for Grape Mealybugs in WA. State, Stephen Onayemi, WSU

Pest Management Strategic Plan Update, Doug Walsh and Michelle Moyer, WSU

Foliar Nitrogen Application in Eastern WA, Pierre Davadant, WSU

AI in Agriculture and the AgAID project, Paola Pesantez Cabrera, WSU

Screening Rootstocks Against the Northern Root-knot Nematode, Bernadette Gagnier, WSU

2023 Economic Grape Update

Trent Ball

Yakima Valley College

Vineyard & Winery Technology Program

1

U.S. Concord Production- A Review

- 2022 Concord crop
  - 391,900 tons
  - 4% below 10 year average
- Inventories were low prior to 2022 harvest
  - Cash price increased on the East & West
- New York, Pennsylvania, Ohio
  - 2022 crop was down, near 10-year average
- Michigan
  - Record book yields, good sugars
  - Highest crop size since 2016

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Washington Concord Production- 2022

- 157,640 tons
  - Up 53% from 2021
- Budbreak was slightly earlier than normal
- Winter in April
  - Bloom 10 days later than normal
- Harvest was a late start
  - Good sugars and good color
  - Higher than expected yields
- 2022 crop was up
  - Highest since 2019

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2023 Eastern Season

- Michigan
  - Cool summer, delayed sugar development in Concords
  - Higher crop than expected given larger 2022 crop
- NY and Pennsylvania
  - Finger Lakes region had low crop yield
  - Other areas had above average (NY-PA state line)
  - Delayed ripening, forcing a late harvest
    - 14 brix not uncommon
  - Good late fall ripening to drive up Brix levels
    - Better yields than in 2022

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The 2023 Growing Season in WA

- Cool April slowed budbreak
- May was very warm
  - Bloom was early and fast
- Warm summer
  - Good sugars and good color
  - Higher than expected yields
- Good harvest weather, ideal growing season
- 2023 crop was up
  - Highest since 2019

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Concord Grape Juice Industry

- Washington
  - Nation's leading producer
  - Production averaged 173,000 tons 2012-2022
  - 2023 production estimated at 165,433 tons
    - Approximately 19,156 tons of organic Concords
- Tri-State area
  - Largest production area
  - Production averaged 188,000 tons 2012-2022
  - 2023 production estimated at 212,630 tons
    - 191,260 for region in 2022

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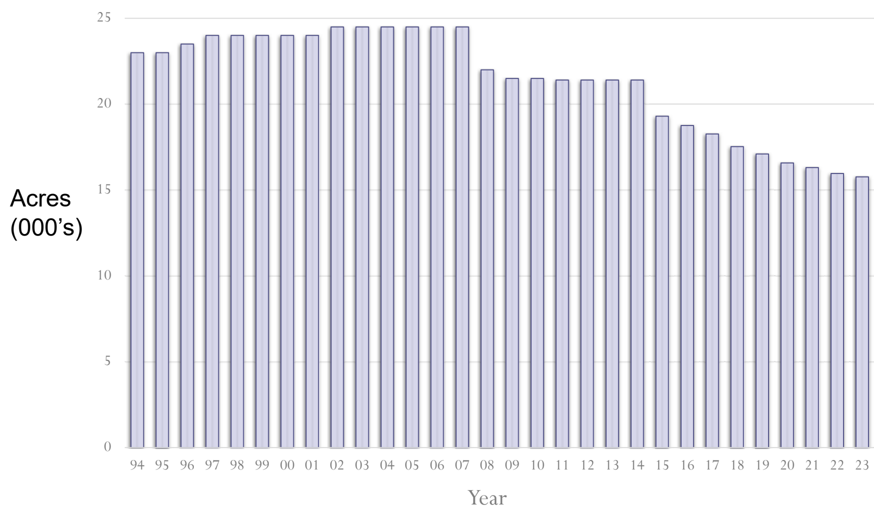
Concord and Niagara Grape Acreage in Washington (2023)

- Concord- 15,766 acres (estimate)
- Niagara- 1,212 acres (estimate)

8

CONCORD GRAPE ACREAGE IN WASHINGTON, 1994-2023



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Concord Grape Production and Prices in Washington and the U.S., 2012-2023

Year	Washington Production (Tons)	U.S. Production (Tons)	Cash Price in Washington ($/ton)
2023	165,452 (est)	415,260 (est)	204
2022	157,639	391,900	407
2021	102,883	338,283	300
2020	135,000	331,000	205
2019	176,237	407,000	170
2018	187,438	398,438	165
2017	176,000	420,190	120
2016	195,000	452,630	120
2015	175,000	401,720	110
2014	260,000	505,180	110
2013	165,000	452,550	225
2012	167,000	303,110	280

NASS data for 2009-2017

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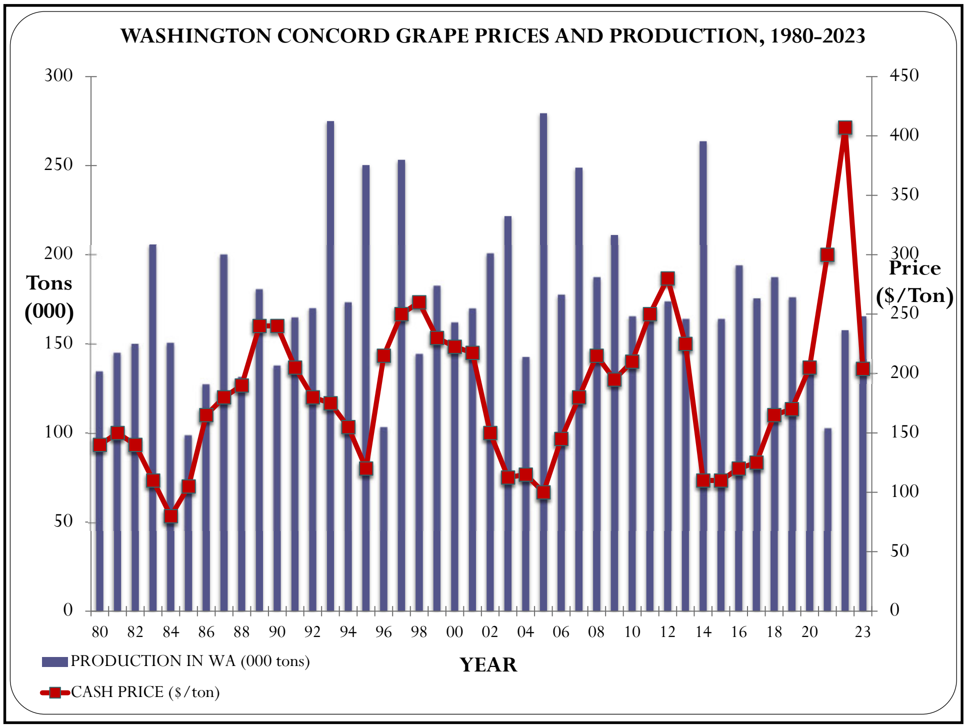
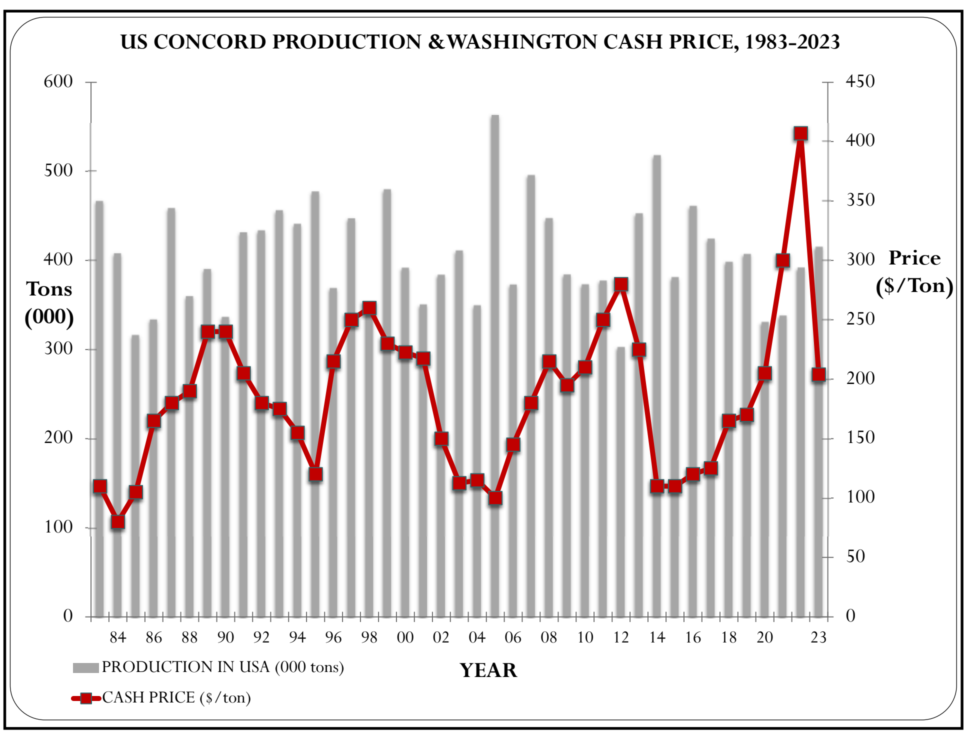
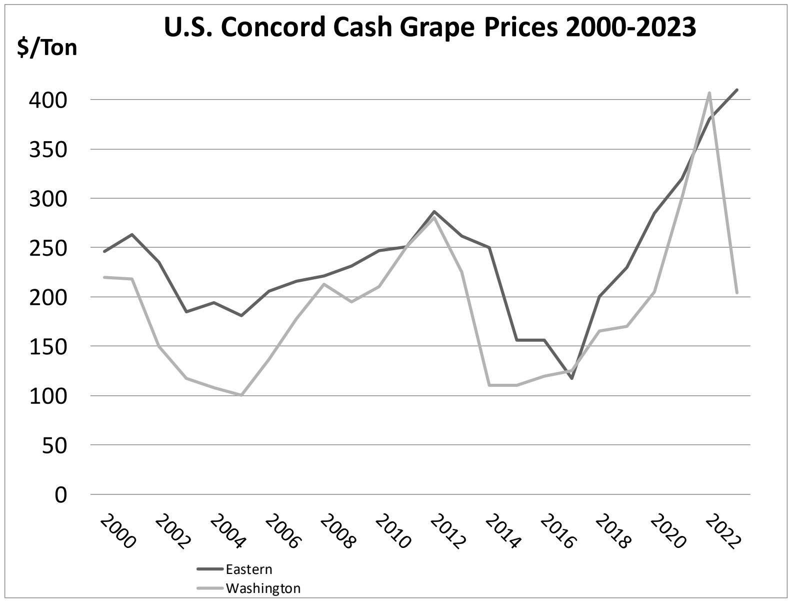

WASHINGTON CONCORD GRAPE PRICES AND PRODUCTION, 1980-2023
Tons (000)
Price ($/Ton)
0
50
100
150
200
250
300
350
400
450
80
82
84
86
88
90
92
94
96
98
00
02
04
06
08
10
12
14
16
18
20
23
YEAR
PRODUCTION IN WA (000 tons)
CASH PRICE ($/ton)

11


US CONCORD PRODUCTION &WASHINGTON CASH PRICE, 1983-2023
Tons (000)
Price ($/Ton)
0
100
200
300
400
500
600
50
150
250
350
450
84
86
88
90
92
94
96
98
00
02
04
06
08
10
12
14
16
18
20
23
YEAR
PRODUCTION IN USA (000 tons)
CASH PRICE ($/ton)

12


U.S. Concord Cash Grape Prices 2000-2023
$/Ton
400
350
300
250
200
150
100
50
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Eastern
Washington

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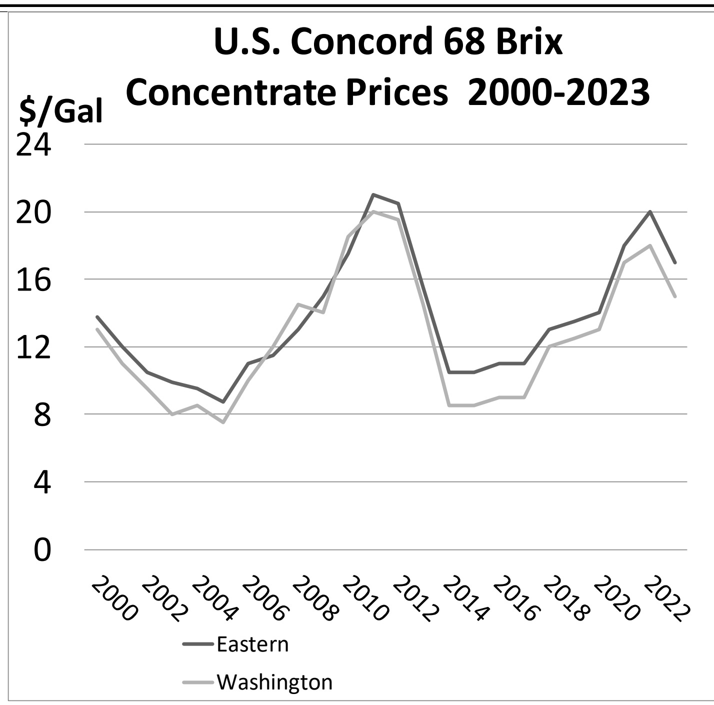
U.S. Concord 68 Brix
Concentrate Prices 2000-2023
$/Gal
24
20
16
12
8
4
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Eastern
Washington

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Washington Niagara Production

Year	Washington Production (Tons)	U.S. Production (Tons)
2023	13,304	41,000 (Est.)
2022	13,498	N/A
2021	10,692	N/A
2020	10,515	N/A
2019	14,411	N/A
2018	18,328	N/A
2017	17,000	58,650
2016	25,000	71,180
2015	14,000	54,050

1,212 acres in WA (estimate)

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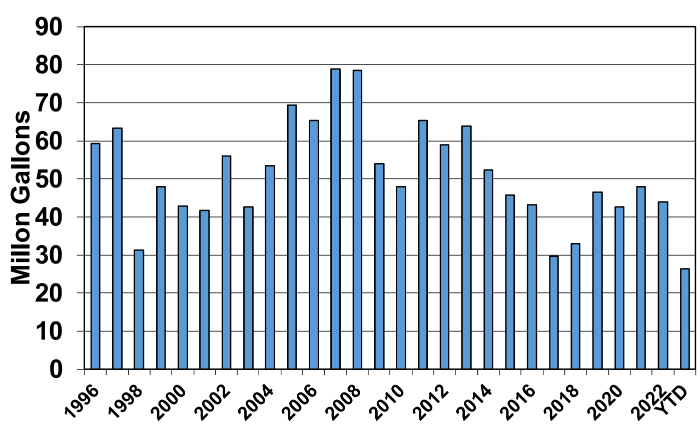
U.S. Grape Juice Imports (1996-2023)



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Pricing of Concord Grapes

1. *Supply and demand conditions*

- Supply
  - Current production
  - Inventories of concentrate/product
  - Imports
- Demand
  - Sale of products
  - Exports
  - Demand for inventories

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Economic Outlook

- Acreage remains consistent
- Some industry inventories are long
- Sales are slow
- Cash price likely to ???

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Wine Grapes

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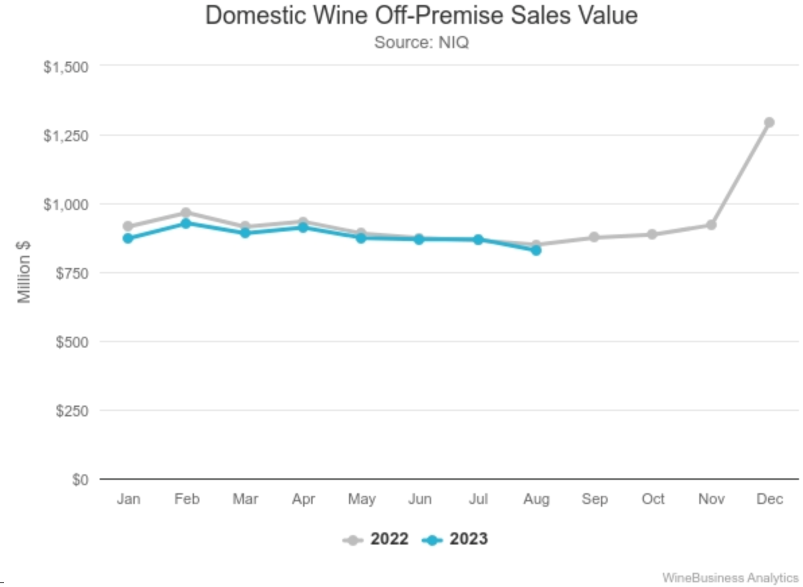
Wine Sales in the U.S.- 2011 to 2021 in millions of gallons

Year	Table Wine	Dessert Wine	Champagne/ Sparkling Wine	Total Wine	Total Retail Value (billion)
2021 (Est.)	880	106	87	1,072	$78.4
2020	796	96	68	1,036	$66.8
2019	761	94	70	968	$74.5
2018	765	95	66	963	$71.4
2017	766	96	63	961	$69.5
2016	752	98	58	947	$65.2
2015	737	96	52	920	$62.5
2014	734	82	47	899	$59.7
2013	738	75	44	895	$56.7
2012	717	72	42	873	$55.6
2011	695	75	41	848	$52.6

20

Wine Sales by Month (2022 – 2023)



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Wine Grape Production

Year	Washington Production (Tons)	California Production (Tons)
2023	151,000	3,600,000
2022	240,000	3,400,000
2021	179,600	3,610,000
2020	178,000	3,411,000
2019	201,000	3,920,000
2018	261,000	4,281,000
2017	229,000	4,016,000
2016	270,000	4,032,000

*WA Crush estimate courtesy of Washington Winegrowers Association

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Thank You!

- Washington Grape Juice Processors
- Greg MaGill at MaGill Brokerage and Consulting
- Dave Momberger at Growers Cooperative
- Steve Cockram at Growers Co-op Grape Juice Co.
- Eric Huddy at AgriAmerica
- Michael Reinke, MSU Extension
- WA Winegrowers Association

Yakima Valley College VINEYARD & WINERY TECHNOLOGY

Trent Ball
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23

Juice Grape Cost of Production Calculator

Presented by: Trent Ball

Vineyard & Winery Technology Program, Chair, YVC and Partner, ***Agri-Business Consultants, LLC.***

1

What is a COP Calculator

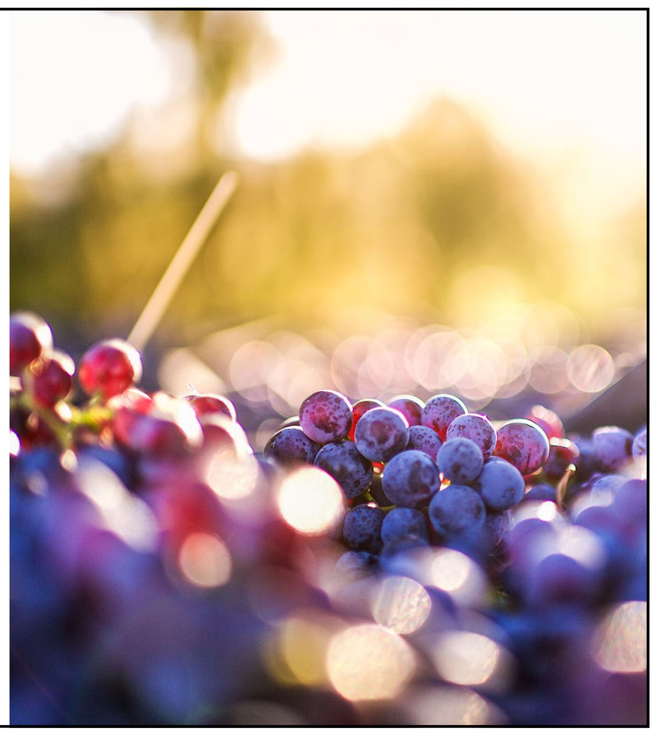
An online budget form where growers input fixed and variable costs to automatically calculate total production costs.

- Can use default industry average data or plug in actual costs
- For use by OR, ID, WA,
- Both conventional and organic practices.

Calculators for grapes:

- Wine Grapes – year 1, year 2, year 3+
- Juice Grapes – year 1, year 2, year 3+

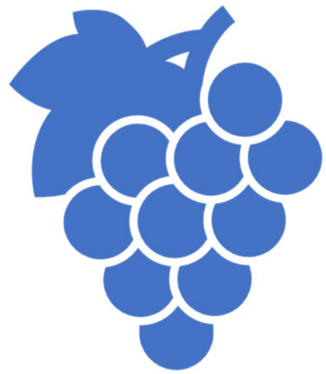
- http://www.nwgrapecalculators.org



2

How do COP Calculators Help?

- Enable growers to calculate their costs of production by variety and market - juice, wine.
- Make computing break even costs easy
- Allow growers to compare their costs with industry averages
- Help growers with financial records and business planning
- Valuable tool for growers entering the industry or changing varietals
- Help growers with their presentations to bankers, lenders and investors



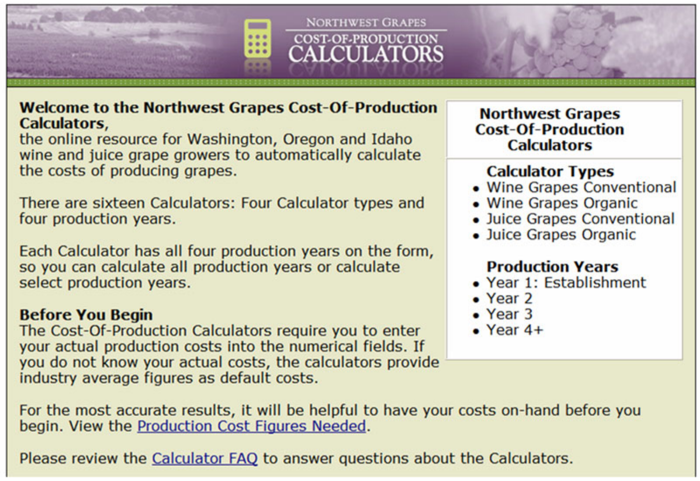
3

What's new in 2023/2024?

- Website interface updated
- Updated prices to 2023/2024 values
- Cultural practices reviewed and updated
  - Land preparation costs
  - Applications versus specific chemicals
- Revenue/Expense Summary
  - 10-year summary of revenue/expenses
- Spreadsheet download instead of web interface only

4

The current website



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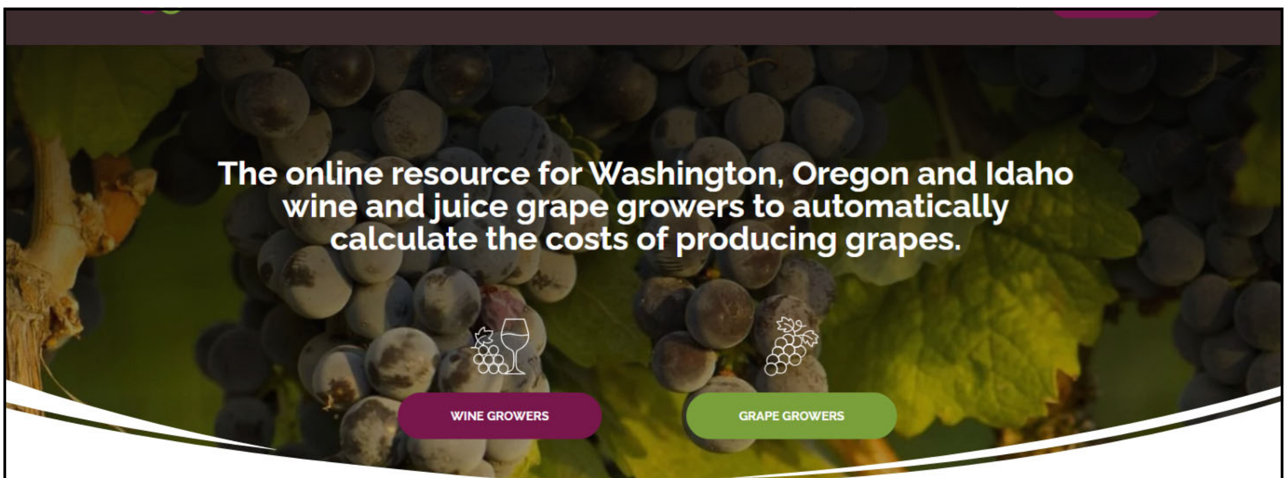

A New Web Interface

- Users enter row and vine spacing. Form calculates plants/acre.
- Users enter their production costs or use default average ranges.
- The Calculator automatically calculates their Total Costs Per Acre.

6

Juice Grapes (Organic or Conventional)

JUICE GRAPES

ORGANIC PRODUCTION

For those embracing organic methods in juice grape farming, our Organic Juice Grape Production Calculator is your go-to resource. Calculate the costs of organic inputs, labor, and certification to gain a comprehensive understanding of your operation. Make data-driven decisions for a more sustainable and profitable juice grape enterprise.

CLICK HERE

JUICE GRAPES

CONVENTIONAL PRODUCTION

Navigate the financial aspects of juice grape cultivation using our specialized calculator. This tool is engineered for grape growers focusing on conventional juice grape production, and includes variables like equipment, labor, and chemical inputs. Use this calculator to optimize your cost structure and maximize profitability.

CLICK HERE

7

From a Web Page to a Spreadsheet

A Little About Yourself:

YOUR NAME *(REQUIRED)*

First Name | Last Name

EMAIL *(REQUIRED)*

Your email address

SUBMIT

Washington, Oregon and Idaho Wine and Grape Growers

A Special Thank You! | How To Reach Us | Quick Links

8

Intro Questions

Juice Grape COP Calculator

Answer the highlighted questions below prior to starting by replacing the default values provided. If you don't know the figures, you may use the default values.

Borrowed and Equity Vineyard Establishment Capital	
Capital borrowed to establish the vineyard (%)	60%
Enter the percentage of the total capital that will be borrowed for the vineyard establshment	
Interest rate on borrowed capital	7%
Investment interest rate (opportunity cost)	7%
The interest expense for the lost opportunity that could have been earned if the equity capital (money) was used elsewhere	
Annual Operating Capital	
Number of months of borrowed capital (Operating)	6
Operating interest rate (%)	6%
Amount of annual borrowed capital (%)	50%
Enter the percentage of annual operating capital that will be borrowed by the operation	
Production	
Estimated yield in year 2 (tons)	0
Estimated yield in year 3 (tons)	5

Intro Questions | Year 1 | Year 2 | Year 3 | Year 4+ | Summary

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Intro Questions

Organic Nutrients/Applications			Identify the applications expected per season below:			
Items	*Units*	*Price($)/Unit*	*Year 1*	*Year 2*	*Year 3*	*Year 4+*
Fertilizer (product cost/application)	/ acre	175	1	1	1	1
Pre-emergent Herbicides (product cost/application)	/ acre	50	1	1	1	1
Post-emergent Herbicide	/ acre	30	1	2	2	2
Fungicide (product cost/application)	/ acre	50	0	0	1	1
Insecticide (product cost/application)	/ acre	8	0	0	1	1
Cultivate	passes	n/a	3	3	3	3
Foliar Nutrient (product cost/application)	/ acre	45	n/a	n/a	n/a	2

Trellis Materials:		
Items	*Units*	*Price($)/Unit*
Wood stakes (markers)	each	0.0972
Plastic ribbon	/ foot	0.01
Staples 2"	/ lb	1.6
#9 Wire soft	/ foot	0.08
#11 Wire HT	/ foot	0.065
#12.5 Wire HT	/ foot	0.05
Crimping tool	each	100
Wire clips	each	0.1

Intro Questions | Year 1 | Year 2 | Year 3 | Year 4+ | Summary

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Year 1

Default values are pre-entered into the fields, to enter your own costs, delete the default and replace with your cost.

Site/Field Preparation

Description	Labor	Machinery	Materials	Services	Total Cost
Land Preparation (rip, plow, etc.)	$ -	$ -	$ -	$ -	$ -
Fumigation	$ -	$ -	$ -	$ -	$ -
Survey and mark	$ 75.85	$ 5.46	$ 2.33	$ -	$ 83.65
Other	$ -	$ -	$ -	$ -	$ -

Install Irrigation System

Description	Labor	Machinery	Materials	Services	Total Cost
Solid set irrigation system	$ -	$ -	$ 2,500.00	$ 2,000.00	$ 4,500.00
Other	$ -	$ -	$ -	$ -	$ -

Plant Vines

Description	Labor	Machinery	Materials	Services	Total Cost
Plant nursery stock	$ 61.50	$ -	$ 1,382.00	$ 38.00	$ 1,481.50
Other	$ -	$ -	$ -	$ -	$ -

Trellis System

Description	Labor	Machinery	Materials	Services	Total Cost
Spread posts and anchors	$ 41.00	$ 8.74	$ 3,136.00	$ -	$ 3,185.74
Install line posts	$ 369.00	$ 131.16	$ -	$ -	$ 500.16
Install end posts	$ 117.88	$ 51.92	$ -	$ -	$ 169.79
Install anchors	$ 61.50	$ 24.59	$ 99.20	$ -	$ 185.29
String wire	$ 133.25	$ -	$ 314.60	$ -	$ 447.85

Intro Questions | Year 1 | Year 2 | Year 3 | Year 4+ | Summary | +

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Description	Labor	Machinery	Materials	Services	Total Cost
Operating Interest	$ -	$ -	$ -	$ 190.98	$ 190.98
Total Variable Costs	$				12,923.10

Cash Costs

Description	Unit	Amount
Loan interest (establishment, equipment, land, etc.)	acre	$ 558.94
Management fee	acre	$ 275.00
Property insurance	acre	$ 60.00
Real Estate Taxes	acre	$ 50.00
Other	acre	$ -
Other	acre	$ -
Total Cash Costs		$943.94

Non-Cash Costs

Description	Unit	Amount
Depreciation	acre	$ 391.04
Machinery and equipment taxes, insurance, housing and interest	acre	$ 499.48
Interest on Investment (Opportunity Cost)	acre	$ 382.93
Total Non-Cash Costs		$1,273.45
Total Fixed Costs		$2,217.39
Total Cost Per Acre		$15,140.49

Values are obtained using the formulas from the bulletin PNW 346 "Pacific Northwest Farm Machinery Costs"

Intro Questions | Year 1 | Year 2 | Year 3 | Year 4+ | Summary | +

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Revenue and Variable Costs

Period	1	2	3	4	5
Yield (tons/acre)	0.00	0.00	5.00	12.00	12.00
Price ($/ton)	$0.00	$375.00	$375.00	$375.00	$375.00
REVENUE ($/acre):					
Grape Sales	$0.00	$0.00	$1,875.00	$4,500.00	$4,500.00
Total Revenue:	$0.00	$0.00	$1,875.00	$4,500.00	$4,500.00
EXPENSES ($/acre):					
VARIABLE COSTS:					
Grow Tubes	$331.68	-	-	-	-
Nursery Stock	$1,382.00	$69.10	-	-	-
Irrigation Install, Equip Rental	$4,578.00	$20.00	$20.00	$20.00	$20.00
Trellis Material/Ties	$3,549.80	$27.58	15.00	$130.00	$130.00
Fertilizer	$175.00	$175.00	$175.00	$265.00	$265.00
Chemicals	$80.00	$110.00	$168.00	$168.00	$168.00
Pruning (Custom pre-prune and ha	-	205.00	287.00	$292.30	$292.30
Custom Harvesting/Hauling	-	-	$325.00	$780.00	$780.00
Canopy Management	-	922.50	278.80	$184.50	$184.50
Labor	$1,475.43	$414.15	$386.75	$489.50	$489.50
Irrigation Electrical/Repairs/Water	$235.00	$235.00	$235.00	$235.00	$235.00
Miscellaneous	$220.00	$200.00	$200.00	$200.00	$200.00
Equipment Fuel/Lube & Repair	$702.88	$227.92	$267.48	$260.71	$260.71
Interest on Op. Cap.	$190.98	$39.09	$35.37	$45.38	$45.38
Total Variable Cost:	$12,923.10	2,645.34	2,393.40	3,070.38	3,070.38

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Fixed Costs and Net Returns

Period	1	2	3	4	5
FIXED COSTS:					
Interest- Loan	$558.94	$686.21	$802.91	$802.91	$802.91
Management Fee	$275.00	$275.00	$275.00	$275.00	$275.00
Property Insurance	$60.00	$60.00	$60.00	$60.00	$60.00
RE Tax	$50.00	$50.00	$50.00	$85.00	$85.00
Depreciation	$350.67	$104.80	$132.41	$129.50	$129.50
Machinery Ownership Cost	$499.48	$95.61	$127.36	$123.95	$123.95
Interest- Opportunity Cost	$382.93	$485.90	$532.69	$532.69	$532.69
Total Fixed Cost:	$2,177.01	$1,757.52	$1,980.36	$2,009.04	$2,009.04
Total Cost:	$15,100.12	$4,402.87	$4,373.76	$5,079.42	$5,079.42
Net Returns above Total Costs	($15,100.12)	($4,402.87)	($2,498.76)	($579.42)	($579.42)
Carryover loss	0	($15,100.12)	($19,502.98)	($22,001.74)	($22,581.17)
Accumulated Expenses	($15,100.12)	($19,502.98)	($22,001.74)	($22,581.17)	($23,160.59)
Net Returns above Cash costs	($13,867.04)	($3,716.56)	($1,706.31)	$206.71	$206.71

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Costs and Returns (Years 1 – 5)

COSTS AND RETURNS PER ACRE					
Period	1	2	3	4	5
Yield (tons/acre)	0.00	0.00	5.00	12.00	12.00
Price ($/ton)	$0.00	$375.00	$375.00	$375.00	$375.00
REVENUE ($/acre):					
Grape Sales	$0.00	$0.00	$1,875.00	$4,500.00	$4,500.00
Other Sales	$0.00	$0.00	$0.00	$0.00	$0.00
Total Revenue:	$0.00	$0.00	$1,875.00	$4,500.00	$4,500.00
Total Variable Cost:	$12,923.10	2,645.34	2,393.40	3,070.38	3,070.38
Total Fixed Cost:	$2,177.01	$1,757.52	$1,980.36	$2,009.04	$2,009.04
Total Cost:	$15,100.12	$4,402.87	$4,373.76	$5,079.42	$5,079.42
Net Returns above Total Costs	($15,100.12)	($4,402.87)	($2,498.76)	($579.42)	($579.42)
Carryover loss	0	($15,100.12)	($19,502.98)	($22,001.74)	($22,581.17)
Accumulated Expenses	($15,100.12)	($19,502.98)	($22,001.74)	($22,581.17)	($23,160.59)
Net Returns above Cash costs	($13,867.04)	($3,716.56)	($1,706.31)	$206.71	$206.71

15

COP Calculators Timeline

16

Questions?

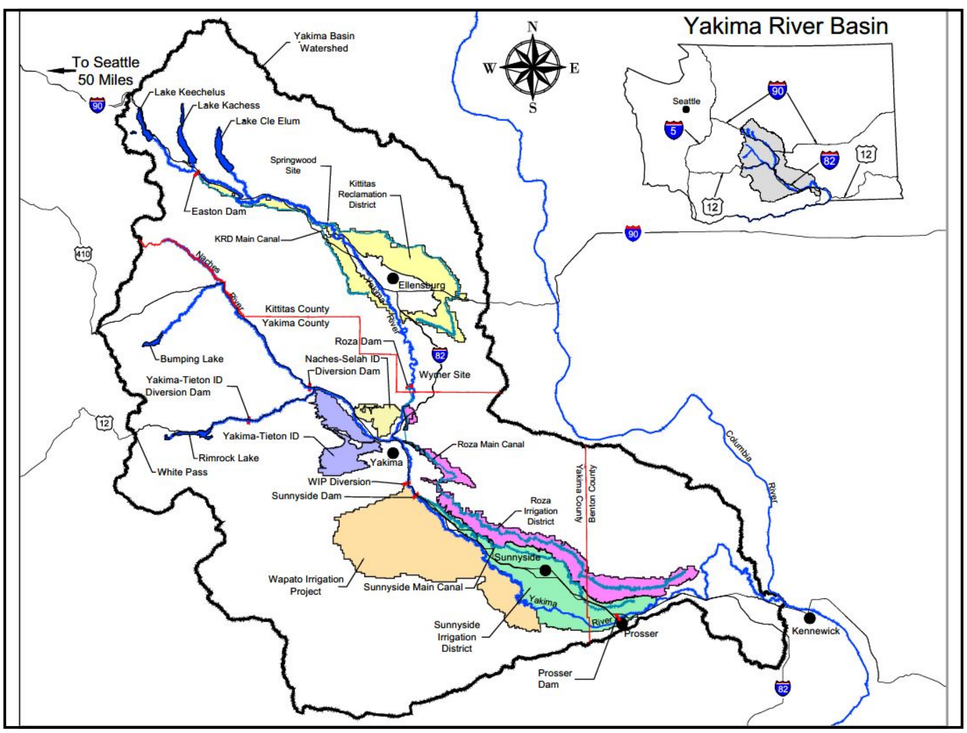
Trent Ball
*Vineyard & Winery Technology Program, Chair, YVC and Partner, **Agri-Business Consultants, LLC.***

tball@yvcc.edu

17

Keechelus Reservoir Oct. 19 at 5%

1



2

Roza Irrigation District Overview

- ✓72,000 irrigated acres over 95 miles w/ 450 miles of canals.
- ✓Total crop value of $1.5 billion +/- on mostly 2nd and 3rd generation family farms.
- ✓300+ miles of canals piped since 1983
- ✓$85M+ in water conservation ($50M+ Roza funded)
- ✓$4.1M drought fund

3

Drought prep at Roza NEVER stops!

Since the 2015 Drought:

✓Piped 70+ miles of canals ($19M Roza funds)

✓New Re-regulation reservoir on-line in 2017 ($31M)

✓$2M+ in sealant applied to concrete lined canal sections

✓7,000 acres of drip irrigation conversions

✓Relationship building with state/fed/tribal partners-especially with people new to their jobs!

4

	Acres 2015	Acres 2021
Irrigation Method		
Rill	1,592	646
Drip	19,980	26,772
Sprinklers-Portable	8,206	8,187
Sprinklers-Permanent	41,236	33,360
No System	1,457	3,550
Total Assessed Acres	72,473	72,517

5

Total Tree Fruit	2015 26,415	2021 25,820
Asparagus	135	158
Grapes	7,179	4,861
Wine Grapes	11,006	10,168
Hops	6,822	9,318
Forage	4,470	3,152
Small Grains	345	150
Blue Berries	1,190	1,598
Row Crops	399	149
Corn (all types)	3,439	6,369
Drought Fallow	2,509	
Transition Fallow	N/A	1,276
Fallow	2,362	2,851
Mint	416	263
Yards (lawns)	1,325	2,144
Pasture	3,513	2,243
Other(Processing Facilities)	941	869
Total Crops	72,473	72,517

6

7

2024 Water Year So Far…

- ✓ 2024 water year began Oct. 1 with 1/3 of the average amount water in storage;
- ✓ As of November we are 200,000 AF behind on storage to date in the Yakima basin
- ✓ Super El Nino weather pattern…While not ideal…generally the stronger the El Nino the better for water supply

8

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ROZA
IRRIGATION DISTRICT

Super El Nino...2024 might be rough…Roza is acting now!

- ✓ Water leases
- ✓ Cloud seeding
- ✓ Piping 5 miles of canals
- ✓ Preparing drought plans with Ecology
- ✓ Relentless planning to optimize reduced supply during shortages

10

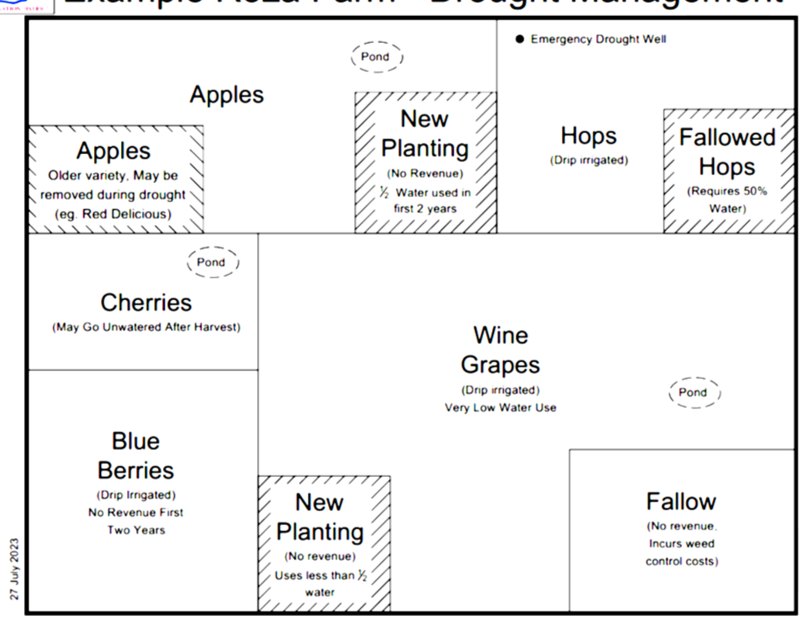
2015

- ✓Full reservoirs
- ✓Average precipitation
- ✓Very little snow

Added up to 44% supply in May and $100M in Roza grower losses in 2023 $

11

Example Roza Farm - Drought Management



Some farms also include pasture and/or row crops which can be fallowed

12

Steps You Can Take:

- ✓ Understand Roza's drought prioritization to cut back early and run as long as possible;
- ✓ Understand and use pooling & lease other Roza water;
- ✓ Monitor your water usage closely and take all the water that your order;
- ✓ Consider fallowing where you can;
- ✓ Communicate with your irrigators and verify their execution of your plans;
- ✓ Contact Ecology about emergency well permits now!!

13

Cloud Seeding Issues

- ✓ Increased Precipitation by 8%-12%
- ✓ Permitting & Licensing Regulations
- ✓ Cost
- ✓ Target Locations
- ✓ Seeding Contractors
- ✓ Liability Issues

14

Roza Drought Response Measures Matrix

ROZA IRRIGATION DISTRICT

Water Supply	Delivery Restrictions*	Canal Shut Down(s)	Roza Pump Backs On	Leases	End season before Sept. 30	Notes Oct 20 +/- is typ. in full yrs.
80%	Yes	No	No	No	No	Restrictions on some days
75%	Yes	No	Yes	No	Possibly	Season ends early
70%	Yes	No	Yes	Possibly	Possibly	Season ends early Leases optional-varies
65%	Yes	No	Yes	Possibly	varies	Leases optional-varies
60%	Yes	Possibly	Yes	Possibly	varies	Leases optional-varies
55%	Yes	Probably	Yes	Yes	varies	7,000 AF from leases & PB
50%	Yes	Yes (15+ days)	Yes	Yes	varies	7,000 AF from leases & PB
45%*	Yes	Yes -2	Yes	Yes	Oct 2*	7,000 AF from leases & PB
40%*	Yes	Yes -2	Yes	Yes	Sept 27*	7,000 AF from leases & PB
35%*	Yes	Yes -2	Yes	Yes	Sept 19*	7,000 AF from leases & PB
30%*	Yes	Yes -2	Yes	Yes	Sept 3*	See note #2
25%	Yes	Yes -2	Yes	Yes	August 11*	See note #2
20%	Yes	Yes -2	Yes	Yes	August	See note #2
15%	Yes	Yes -2	Yes	Yes	August	See note #2
10%	Yes	Yes -2	Yes	Yes	Yes	See note #2
5%	Yes	Yes -2	Yes	Yes	Yes	See note #2

15

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Scott Revell
District Manager
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(509) 840-2721-cell

19

Back to the basics. Using **canopy measurements** and **extractable soil water** to irrigate different winegrape varieties

Charles Obiero
(charles.obiero@wsu.edu)

WSGS November 16th and 17th 2023 Grandview WA

Washington State University
Viticulture and Enology

1

Prologue

https://perchance.org/ai-photo-generator

- **Why variety-specific irrigation?**
- Can we tailor irrigation to specific winegrape varieties? (**Our approach**)
- **Lessons learned**
- Where we go from here……

2

2

Think about these

- **What comes to mind when you visualize a vine's canopy?**
- **Is soil type even relevant for a thirsty vine?**

3

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Why is variety-specific irrigation important?

a. One-size-fits-all irrigation management

- ➢ WA growers use a **well-developed irrigation strategy** through RDI **customized to fit** either red or white winegrape varieties

Further, current irrigation strategies

- ➢ Visual observations of **canopy growth** and **fruit development**
- ➢ **ET** data from weather stations, coupled with a **kc** roughly reflecting **canopy size**
- ➢ Intermittent or continuous monitoring of **soil moisture** depletion and refilling
- ➢ Periodic measurements of **plant water status** using pressure chambers or porometers

https://perchance.org/ai-photo-generator

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4

But what do we see?

Pronounced vigor differences

$ET_c = K_c \times ET_o$

ET_c = crop evapotranspiration

K_c = crop coefficient

ET_o = reference crop evapotranspiration

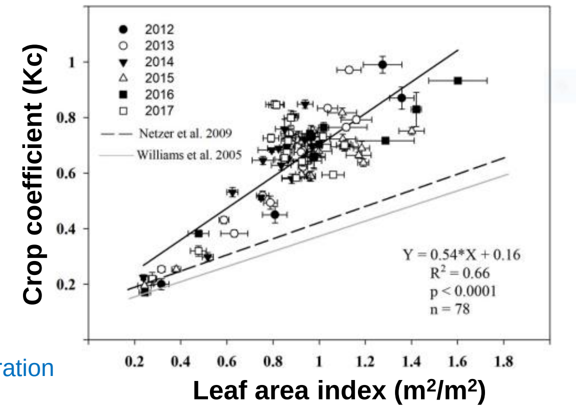

Fig. 4. Relationship between leaf area index (LAI) and crop coefficient (K_c). Each point is the mean LAI of six vines, and the mean K_c of weekly water consumption of six lysimeters. Vertical and horizontal bars denote one standard error. Measured from 2012 to 2017 in a 'Cabernet Sauvignon' vineyard, Kida Israel.

Munitz et al. 2009. Water consumption, crop coefficient and leaf area relations of C. Sauvignon vineyard.

Why is variety-specific irrigation important...

b. Different vines diverse wine styles

Red wine	White wine
• Smaller berries	• Berry size not relevant
• More sugar >24% Brix	• <24% Brix
• High phenolics (tannins and anthocyanins) good color and flavor	• High phenolics more bitter tastes and reduced aroma

https://perchance.org/ai-photo-generator

What should we do?

Throw in the towel?

OR

Adapt?

Save Earth: There is no planet B - Cover

7

7

Can we tailor **irrigation to specific winegrape varieties?**

- A field trial conducted in **2021** and **2022** in a drip-irrigated research vineyard planted in 2010 at WSU Prosser
- **30 varieties** fully irrigated through bloom, then subjected to two drydown cycles to create a gradual soil water deficit
- **First cycle** began at **fruit set** and the **second at veraison** following irrigation to **near field capacity**.
- **Canopy size** at **fruit set** and **at veraison**
- **Bi-weekly** measurements of soil moisture (**neutron probe**) and Ψleaf (**pressure chamber**)

Red winegrapes	White winegrapes
Barbera	**Albariño**
Cabernet franc	**Aligoté**
Cabernet Sauvignon	**Riesling**
Durif	Auxerrois
Grenache	Chenin blanc
Lemberger	Gewürztraminer
Malbec	Green Veltliner
Merlot	**Chardonnay**
Mourvèdre	**Melon**
Nebbiolo	Muscat blanc
Petit Verdot	Pinot blanc
Pinot noir	Pinot gris
Sangiovese	**Sauvignon blanc**
Tempranillo	**Sémillon**
Zinfandel	Viognier

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Soil moisture drydown and **daily maximum temperatures** during the field trials

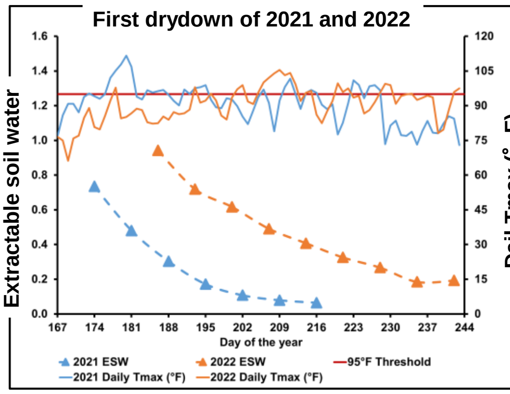
➢ <u>To normalize the influence of soil type</u>, volumetric water content (**VWC**) was converted to extractable soil water (**ESW**), defined as the relative water content normalized to field capacity (**FC**) and permanent wilting point (**PWP**):

ESW = (VWC-PWP)/(FC-PWP)

Where: VWC at FC is 30% and PWP 7%.

➢ **Faster drydown in 2021 than in 2022**. 42 days in 2021 for the soil to dry to below **0.1 ESW** compared to 70 days in 2022 in which soils only dried to about **0.15 ESW**.

➢ **Drier and hotter 2021 season compared to 2022**. **28 days of 95F** and above Daily Tmax during the first drydown of 2021 compared to only **25** in 2022.



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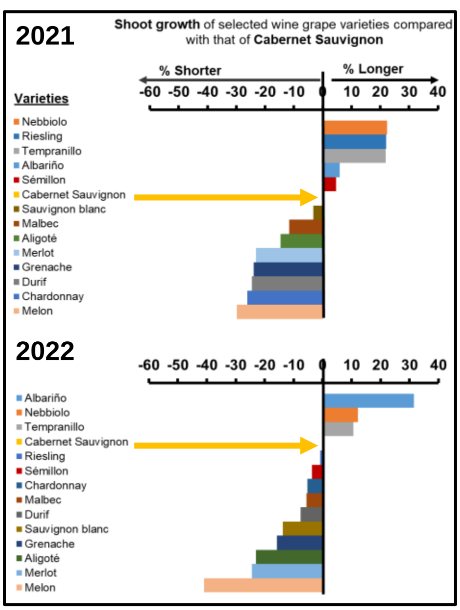
Canopy growth



The varieties differed in shoot growth, and this was consistent in the two growing seasons

- **Nebbiolo, Tempranillo, and Albariño = more vigorous** compared with any of the five major varieties grown in Washington
- **Durif, Aligoté, and Melon** were the **least vigorous**.
- **Bigger** = **10% to 30% longer shoots**, and **smaller = 10% to 40% shorter shoots**, compared with **Cabernet Sauvignon**.

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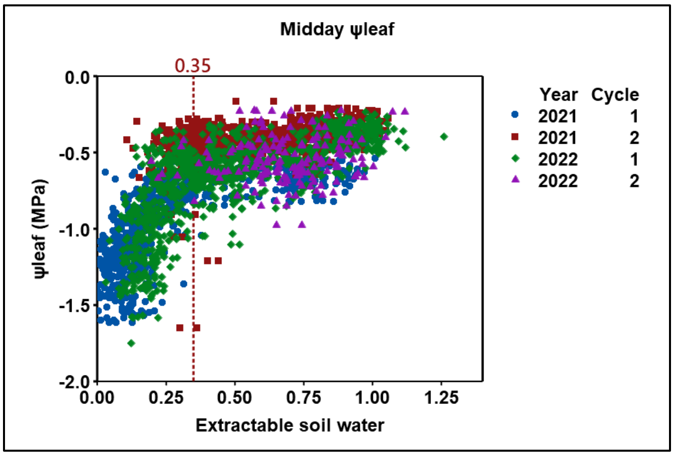
Response to water deficit

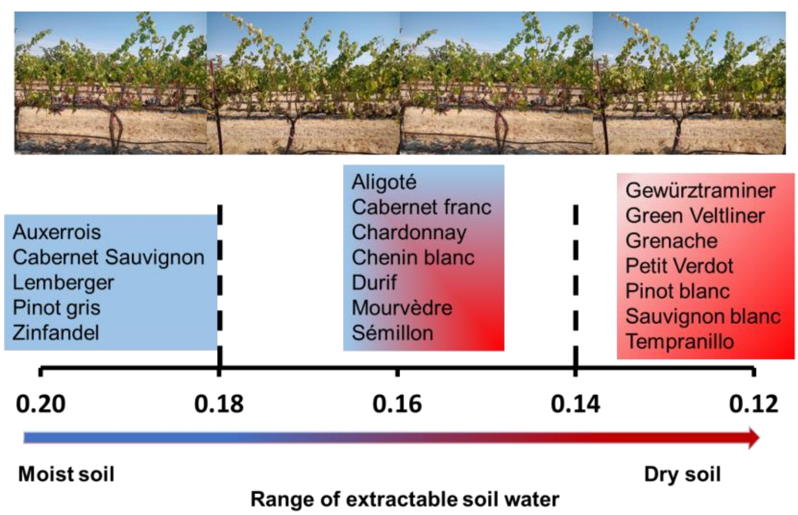


Response of midday Ψleaf to soil moisture deficit

- All varieties maintained their Midday Ψleaf (i.e., were **isohydric)** as the soil dried down but lowered Midday Ψleaf (i.e., became **anisohydric)** below **0.35 ESW** thresholds

- Even those with “known” contrasting responses to water stress **(Grenache** and **Sémillon)** responded similarly.

ESW @ -1 MPa Midday Ψleaf of selected varieties

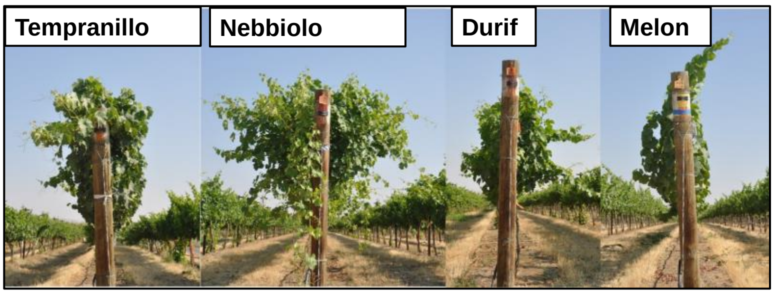


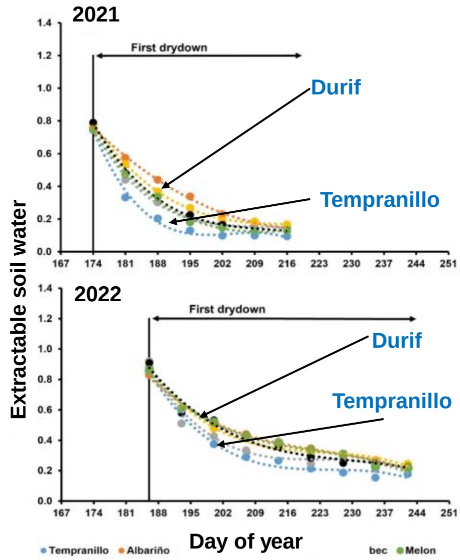
- Winegrape varieties have different soil moisture thresholds at which they “feel” water stress.

First lesson learned from our research

Shoot/canopy growth-based tool

- **Winegrapes have varied canopies**. Vigorous varieties dry the soil more quickly and might need more frequent irrigation once control of shoot growth has been achieved, especially during heat waves.





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What comes to mind when I visualize a vine's canopy

https://perchance.org/ai-photo-generator

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Second lesson learned from our research…

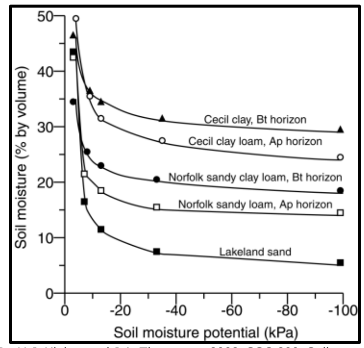
ESW based-tool

- **Winegrapes have different ESW thresholds at -1MPa midday Ψleaf.** There are those with higher (above 0.18), medium (0.18-0.14), and lower (below 0.14) ESW thresholds at which water stress starts.

- **The catch!** Know your soil's **field capacity** and **permanent wilting point**.

Do thirsty vines even care about the soil type?

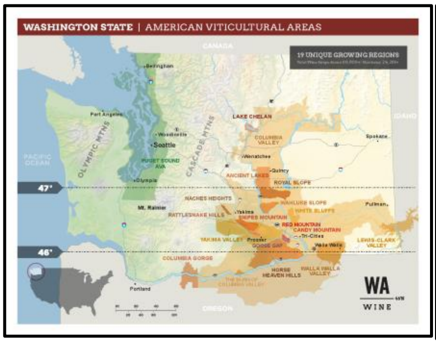
No. Emphasis on **plant available water**. But soil type determines the amount of **water available**, and the **energy needed to extract it**.

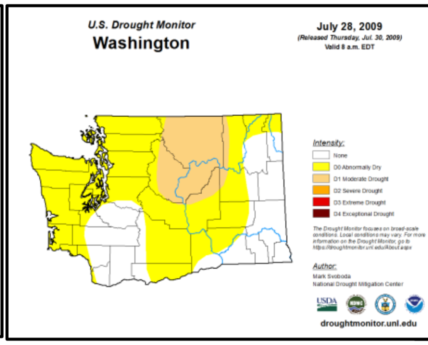


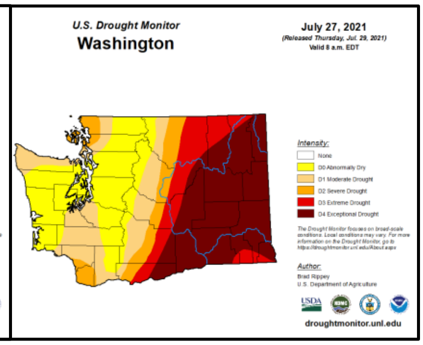
King, L.D., H.J. Kleiss, and J.A. Thompson. 2003. SSC 200: Soil Science Laboratory Manual. North Carolina State University, Raleigh, NC, USA.

Other tools…Instincts or Experiential!

Where do we go from here?







Water economy, market demands and the future of winegrape industry

- **4R's** - Right amount, right place, right time and right variety

17

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Acknowledgements

Our sponsors

Washington State Grape and Wine Research Program

Washington State University

Alan, Lynn, Monique, Jennifer, Charity, Donovan

Keller's team

18

Innovative Solutions for Grape Mealybug Management: Mating Disruption in Washington State Vineyards

Stephen Onayemi
PhD Candidate

Advisor: Dr. Doug Walsh

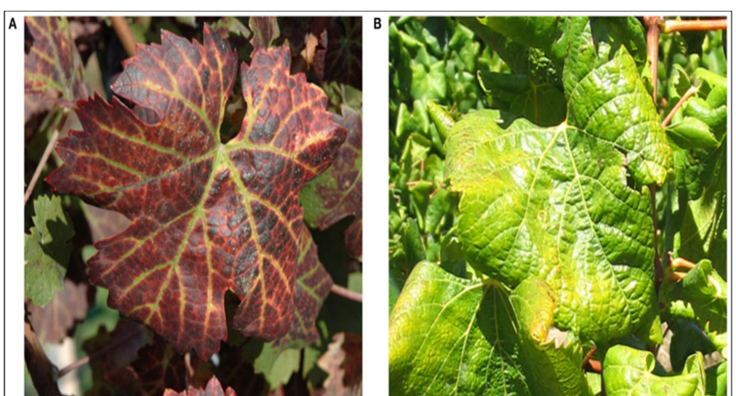
Department of Entomology
Washington State University
IAREC, Prosser

November 16, 2023

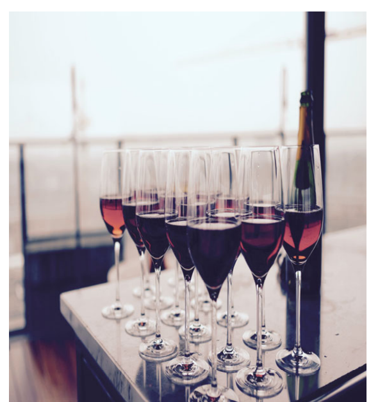
WASHINGTON STATE WSGS GRAPE SOCIETY

1

Washington State is the second-largest wine producing state in the US with over $8 billion annual revenue (WSWC 2021)



Visual symptoms of Grape Leafroll Disease (GLD)



Wine from red grapes

2

2

Common mealybug species that transmit Grape Leafroll-associated Viruses (GLRaVs) (Daane et al. 2008; O'Hearn and Walsh 2018)

Vine Mealybug

Grape Mealybug

Obscure Mealybug

Longtailed mealybugs

Photo credits: Daane et al. 2008

3

3

Grape mealybugs (GMB) are the primary vectors of grapevine leafroll associated viruses (GLRaVs) (Jarugula et al. 2010)

4

4

Even with toxic doses of systemic insecticides, grape mealybugs have a transmission rate of 10-20% (O'Hearn and Walsh 2021)

GMB male (30x)

GMB female (10x)

5

5

Even with toxic doses of systemic insecticides, grape mealybugs have a transmission rate of 10-20% (O'Hearn and Walsh 2021)

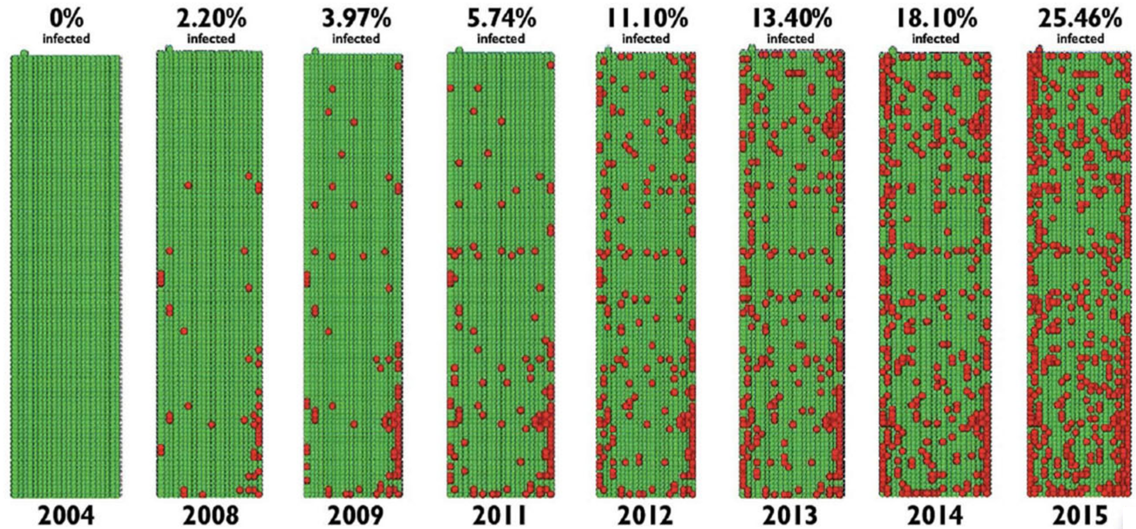
GMB male (30x)

GMB crawler (30x)

6

6

Here is a block of Syrah grapes planted with certified materials in 2004 with virus spread between 2008 and 2015.



Source: Dr. Doug Walsh and Dr.Naidu Rayapati (WSU)

7

Goal: Use mating disruption as an alternative IPM strategy to slow down the spread of GLRaVs.

Twist-tie dispenser

CIDETRAK ® dispenser

8

8

Goal: Use mating disruption as an alternative IPM strategy to slow down the spread of GLRaVs

Delta trap

Pheromone lure

Deploying the trap

9

9

Hypothesis: Mating disruption using pheromone dispensers will achieve a near shut-down of the capture of male *Ps. maritimus*

10

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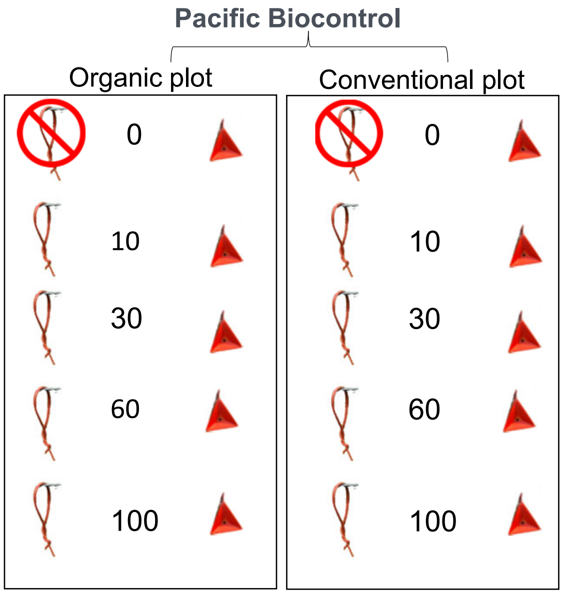
Materials and Methods: a preliminary study on mating disruption was done May – Oct. 2021 using Pacific Biocontrol dispensers



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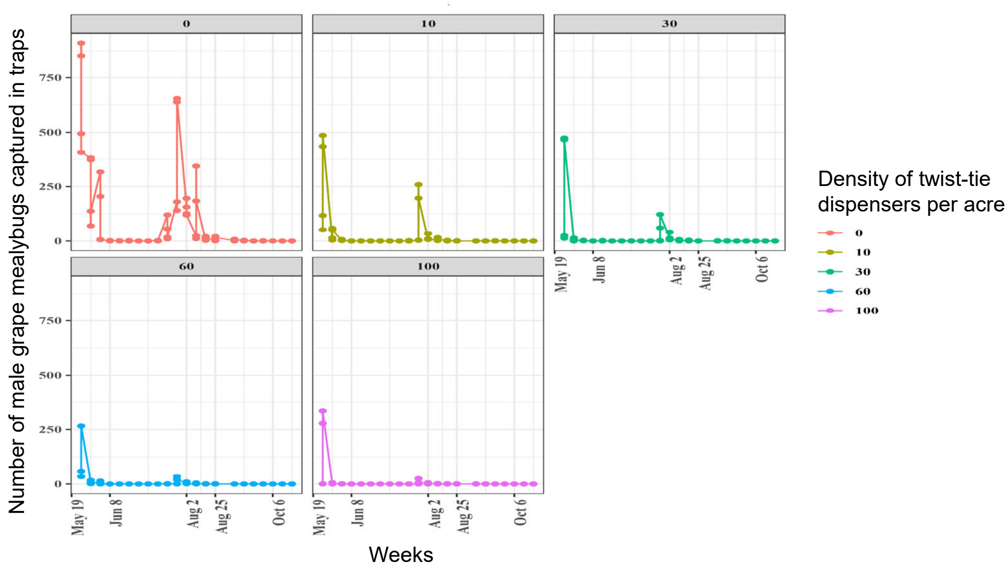
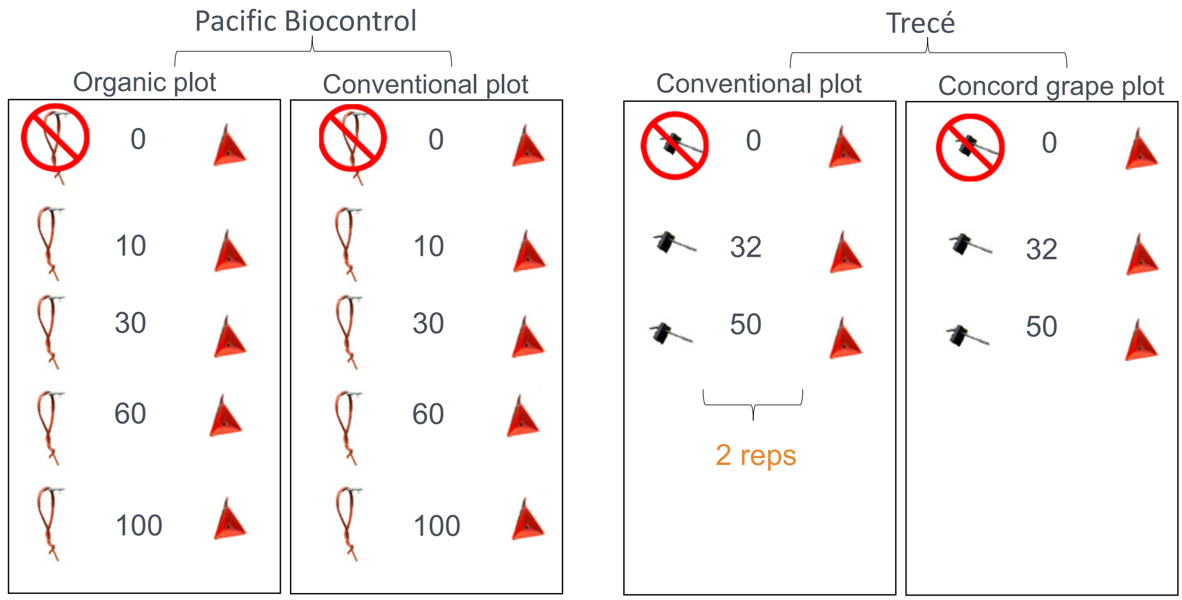
Results: The pheromone dispensers achieved a near-zero capture shut down of male grape mealybug population



Sum of male grape mealybugs trap counts on conventional and organic grapevine plots – May/June & July/Aug 2021 (2 generations)

12

Materials and Methods: a study on mating disruption was done April – Oct. 2022 with Pacific Biocontrol and Trecé dispensers



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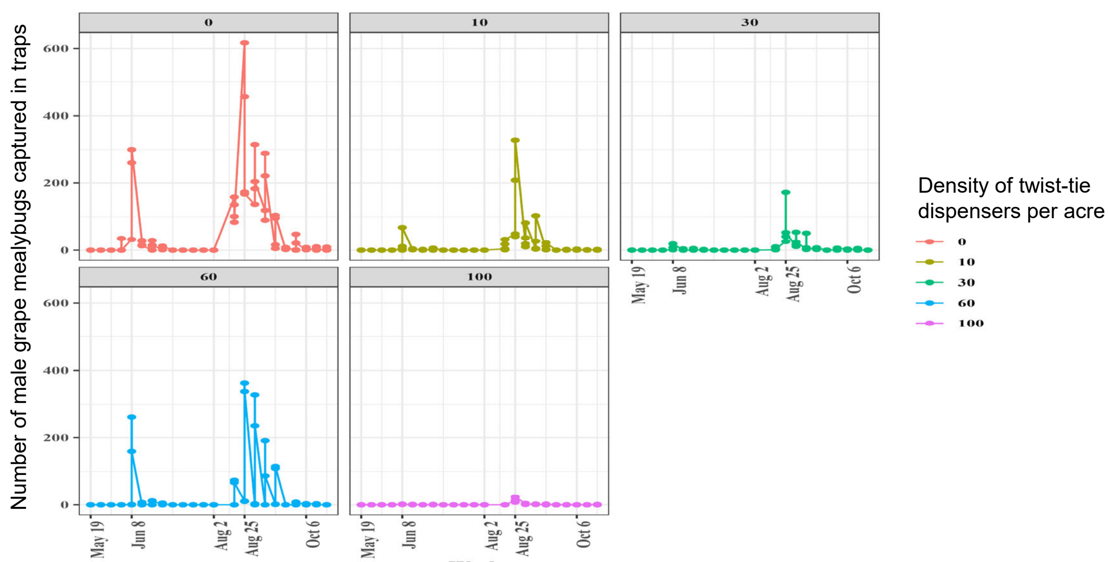
Results: The pheromone dispensers achieved a near-zero capture shut down of male grape mealybug population



Sum of male grape mealybugs trap counts on conventional and organic grapevine plots in 2022

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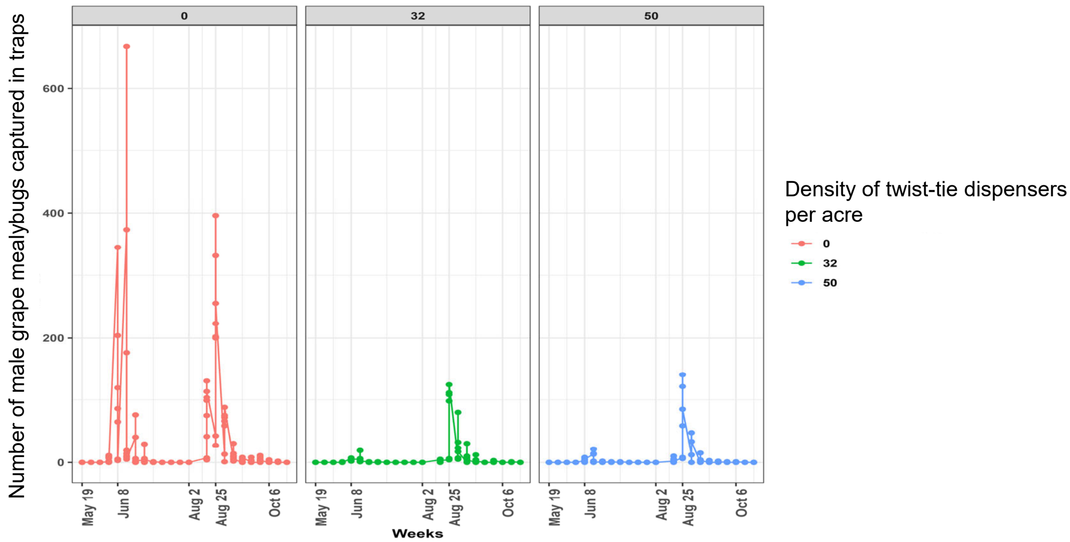
14

Results: The pheromone dispensers achieved a near-zero capture shut down of male grape mealybug population



Male grape mealybugs trap counts on conventional and Concord grapevine plots in 2022

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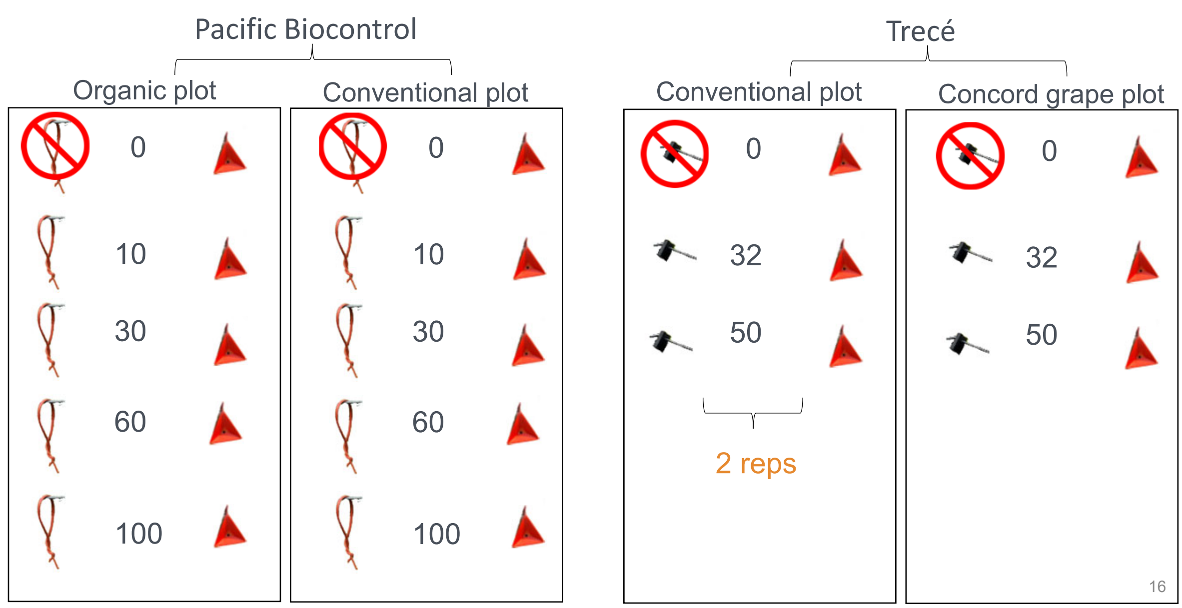
15

Materials and Methods: a study on mating disruption was done April – Oct. 2023 with Pacific Biocontrol and Trecé dispensers



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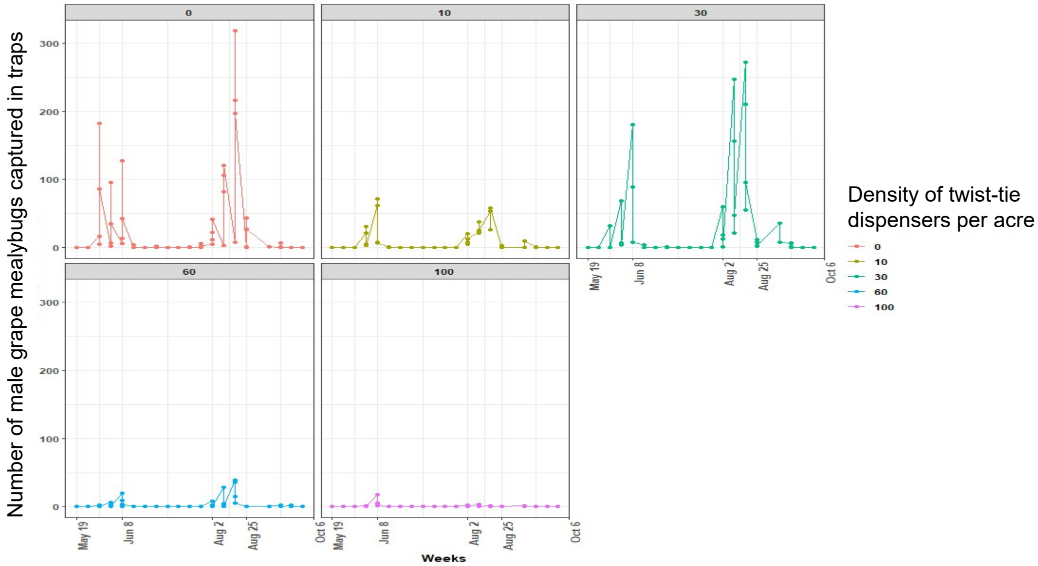
16

Results: The pheromone dispensers achieved a near-zero capture shut down of male grape mealybug population



Sum of male grape mealybugs trap counts on conventional and organic grapevine plots in 2023

17

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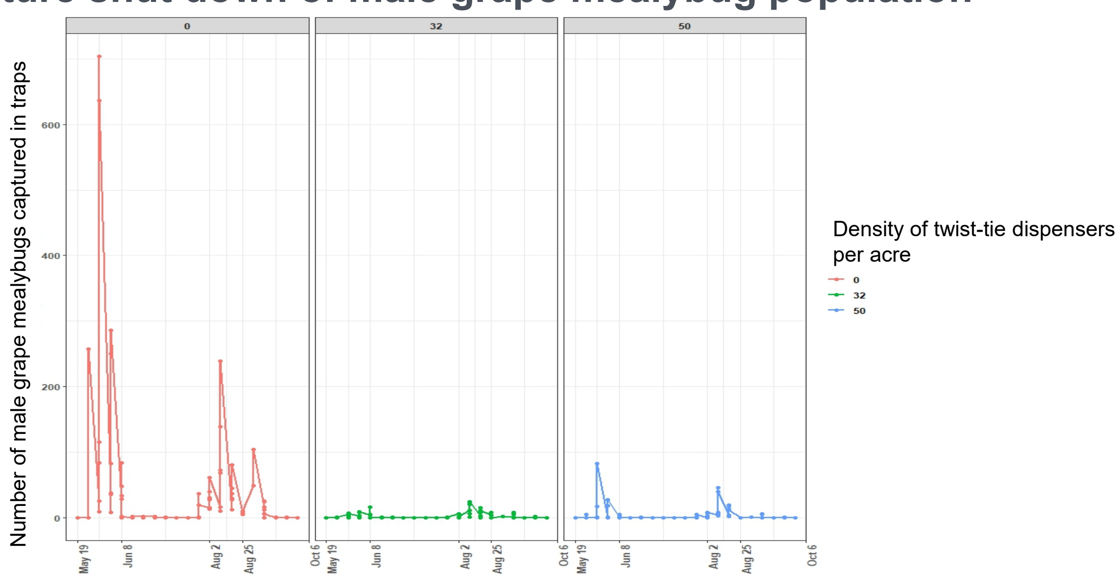

Male grape mealybugs trap counts on conventional and Concord grapevine plots in 2023

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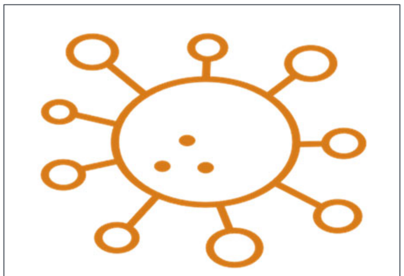
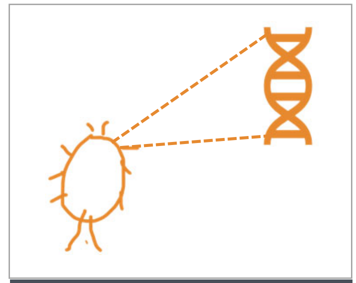
18

Conclusion: Mating disruption is a promising alternative IPM strategy that could slow down the spread of GLRaVs.


Mealybug-vectored Viruses


Protect Beneficials; Prevent pests


Insecticide Resistance Development

19

19

Acknowledgements

WA 46°N WINE

WSDA Specialty Crop Block Grant Program

WASHINGTON WINE INDUSTRY FOUNDATION

Washington State COMMISSION ON PESTICIDE REGISTRATION

Pacific Biocontrol
The Market Leaders in Pheromone Mating Disruption

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20

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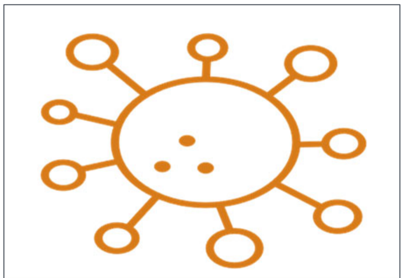
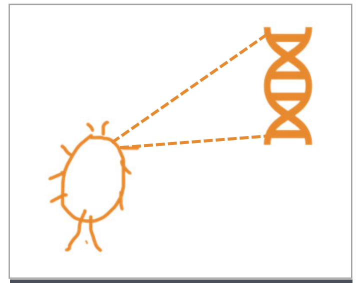


Mealybug-vectored Viruses

Protect Beneficials; Prevent pests



Insecticide Resistance Development

QUESTIONS?

21

21

Pest Management Strategic Plan Update

Doug Walsh and
Michelle Moyer
WSU-IAREC

Changes over the past 30 years in vineyard IPM needs

1

Pest Management Strategic Plans

- Address pest management needs and priorities for individual commodities in a particular state or region. The plans take a pest-by-pest approach to identifying the current management practices (chemical and nonchemical) and those under development
- PMSPs were originally designed to detail a specific crop's pest management practices and research and Extension needs concisely, with the Environmental Protection Agency being the key user of the documents in making regulatory decisions

2

PMSPs morphed out of Crop Profiles

Crop Profile for Strawberries in California

Prepared: October, 1999

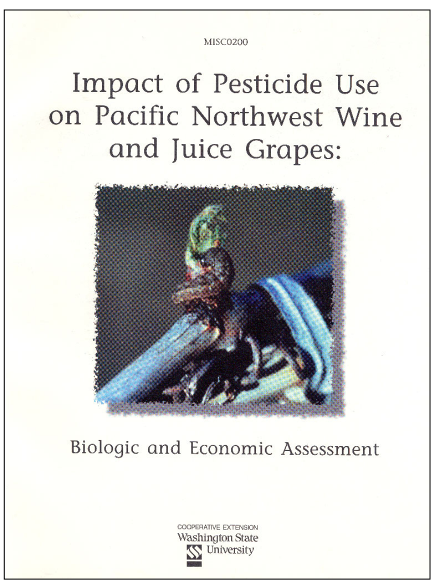
General Production Information

- **California's Contribution to Production:** California produces more than 80% of the fresh market and processed strawberries grown in the United States on about 50% of the country's strawberry acreage. California produces about 20% of the world's production (1, 2, 7).

- **Exportation:** California exports about 20% of its strawberry production, accounting for 20% of the world's exported berries. California's primary export destinations are Canada, Japan, and Mexico (1).

Crop profiles morphed into 100-page boat anchor reports that nobody would ever read. I spent years working on this one in the 1990s. PMSPs are supposed to be more concise….

3



The first incidence of a PMSP-like document I know about was this document published by Ann Morrell and Alan Schreiber in 1995.

These authors claimed that the PNW wine grape industries would collapse without the continued availability of chlorpyrifos and dimethoate.

Both are now banned, but chlorpyrifos may have one last gasp. It'll be settled in court.

4

In 2005 my group was responsible for a hard copy mailed survey of grape producers in Washington.

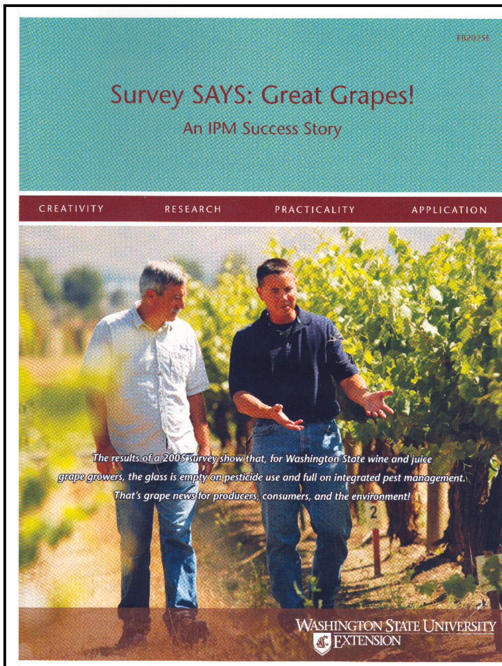
Washington State
Grape Pest Management Practices Survey - 2005

Endorsed by:
Washington State University,
Washington State Concord Grape Research Council, and
Washington Association of Wine Grape Growers

Dear Grape Growers:

Following you will find a survey of pest management practices which is being mailed to all of the grape growers in Washington State. This study has been reviewed and approved for human subject participation by Washington State University Institutional Review Board. You will be asked to provide information on your 2005 grape acreage, pesticide usage, scouting practices, and what kinds of resources are most useful to you and your operation. This information

5



We documented that insecticide/ miticide use dropped by 85% between 1995 and 2005.

Most of it was chlorpyrifos and several miticides.

We had developed several new strategies that helped but a new product was registered.

BAYER
ADMIRE

6

Pest Management Strategic Plan for Washington State Wine Grape Production

2014 REVISION

Lead Authors: Michelle Moyer and Sally O'Neal

Summary of a Workshop Held
July 2, 2014
Prosser, WA

Issued
September 8, 2014

7

This document identifies research, regulatory, and educational needs critical to sustaining the Washington State Wine Grape industry now and in the future.

This project was funded in part by the USDA National Institute of Food and Agriculture through the Western Integrated Pest Management Center. Additional funding and support for the preparation of this document were provided by the Washington Wine Industry Foundation, Washington State University, and the USDA National Institute of Food and Agriculture Extension Integrated Pest Management Program.

Western IPM Center

Washington wine industry Foundation

Washington State University

USDA United States Department of Agriculture National Institute of Food and Agriculture

For questions regarding this Pest Management Strategic Plan (PMSP), contact:

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EXECUTIVE SUMMARY
Work Group Members

The following individuals were present at the July 2, 2014 workshop and/or contributed in a significant manner to the development of this Pest Management Strategic Plan

Justin Andrews, McKinley Springs Vineyards
Perry Beale, Washington State Department of Agriculture
Rick Boydston, USDA-Agricultural Research Service
Joe Cotta, Ste. Michelle Wine Estates
Rick Hamman, Hogue Ranches
Richard Hoff, Ste. Michelle Wine Estates
Damon LaLonde, Vinagium
Lacey Lybeck, Milbrandt Vineyards
Kelly McLain, Washington State Department of Agriculture
Mike Means, Ste. Michelle Wine Estates
Michelle Moyer, Washington State University
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Naidu Rayapati, Washington State University
Tom Thornton, Cloud Mountain Farm
Derek Way, Sagemoor Vineyards
Doug Walsh, Washington State University
James Whitelatch, Claar Wine Group
Inga Zasada, USDA-Agricultural Research Service

Contributing Work Group Members Not In Attendance
Gary Ballard, WSU Clean Plant Center Northwest
Gwen Hoheisel,WSU Extension
David James, Washington State University
James McFerran, Vine & Wine Consulting LLC

Others In Attendance
Matt Baur, Associate Director, Western IPM Center
Jim Farrar, Director, Western IPM Center
Sally O'Neal, Senior Communications Specialist, Washington State University
Vicky Scharlau, Executive Director, Washington Wine Industry Foundation
and Washington Association of Wine Grape Growers

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Previous PMSP - 2004

- A Pest Management Strategic Plan (PMSP) workshop was held March 17, 2004, in Pasco, Washington. The resulting PMSP document was released May 27, 2004.
- At the time of the 2004 PMSP workshop, the Washington State wine grape industry faced a number of challenges ranging from the losses of dimethoate (an essential control for several insect pests including thrips, for which no alternate control was available) and fenamiphos (Nemacur, an essential control for nematodes).
- The removal of the tolerance for dimethoate did not impact the Washington wine grape industry as was feared. Alternate cultural and chemical controls were made available and were economically feasible.
- The loss of fenamiphos as a post-plant nematode management option had left the industry with few available methods to manage nematodes after vineyard planting.
- There are several registered products for post-plant use on grapevines; however, the efficacy of these products and methods to maximize efficacy have not been extensively evaluated for nematode control.
- Glyphosate continues to provide the majority of weed control in Washington vineyards, but several effective preemergent herbicides and desiccant herbicides have been registered for use in vineyards in recent years. Some efforts in vineyard floor management have been investigated, but supplemental moisture is typically required.

10

Outputs & Outcomes 2004 to 2014-Research

- Determine virus-vector relationships
  - Naidu and I were co-PDs with other grape scientists on a USDA-NIFA SCRI grant.
  - Grapevine Leafroll Disease by Rayapati, O'Neal and Walsh, WSU EB2027E, ©2008,
  - Four scientific journal articles (Bahder et al. 2013a, 2013b, 2013c, and Daane et al. 2011) further detail recent research.
  - Determine virus-vector relationships
- Field Guide for Integrated Pest Management in Pacific Northwest Vineyards, edited by Moyer and O'Neal, PNW644, ©2013.

11

Outputs & Outcomes 2004 to 2014-Research

- Refine disease modeling, including powdery mildew and Botrytis bunch rot
  - Powdery Mildew in Eastern Washington Commercial Grape Production: Biology and Disease Management by Moyer and Grove, WSU EM058E, ©2012.
  - Powdery Mildew in Western Washington Commercial Grape Production: Biology and Disease Management by Moyer and Grove, WSU EM059E, ©2012.
  - Botrytis Bunch Rot in Commercial Washington Grape Production: Biology and Disease Management by Moyer and Grove, WSU FS046E, ©2011.
  - Austin, Grove, Meyers, and Wilcox entitled "Powdery Mildew Severity as a Function of Canopy Density: Associated Impacts on Sunlight Penetration and Spray Coverage" was published in the American Journal of Enology and Viticulture (62:23-28) in 2011.

12

Outputs & Outcomes 2004 to 2014-Research

- Study cover crop management and IPM impacts on all pests.
  - Cover crop management has been studied and results were communicated in the annual updates of the WSU Pest Management Guide for Grapes in Washington edited by Hoheisel and Moyer, EB0762.
  - A publication dedicated to this topic, Cover Crops as a Floor Management Strategy for Pacific Northwest Vineyards, by Olmstead, WSU EB2010, was released in 2006.

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Outputs & Outcomes 2004 to 2014-Research

- Develop economic thresholds for insects, mites, and nematodes.
  - Thresholds or guidelines have been elucidated for leafhopper (15 per leaf) and spider mites (30 per leaf in an otherwise healthy vineyard).
  - For nematodes, only estimated damage thresholds are established, but additional research is currently underway to better understand how these thresholds relate to impacts on vine development in the inland Pacific Northwest.
  - Established and emerging thresholds/guidelines are available in the WSU Pest Management Guide for Grapes in Washington, which is updated annually.
  - And the Field Guide for Integrated Pest Management in Pacific Northwest Vineyards.

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Outputs & Outcomes 2004 to 2014-Regulatory

- Address quarantine issues, including:
    - Phylloxera quarantine, need new surveys (WSDA)
    - Root stock tests were and are underway
    - Virus quarantines, need new surveys (WSDA)
    - Vine mealybug inclusion in current quarantine description

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Outputs & Outcomes 2004 to 2014-Regulatory

- Register pesticides
    - Herbicide: flumioxazin (Chateau) - done
    - Insecticides: zeta-cypermethrin and lambda cyhalothrin - done
    - Fungicides: cyprodinil + fludioxonil and cyprodinil + difenoconazole
    - All of these were registered between 2004 And 2014

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Outputs & Outcomes 2004 to 2014-Education

- Develop scouting guide
  - Field Guide for Integrated Pest Management in Pacific Northwest Vineyards, edited by Moyer and O'Neal, PNW644, was released in 2013
  - Its companion Pocket Version/Version de Bolsillo (bilingual in English and Spanish), PNW654, was released in late May 2014
- Emphasize importance of certified planting material and proper importation protocols
- Teach a systems-based approach to pest management
- Emphasize importance of sanitation (equipment, plants, workers, etc.) for prevention of pests in the field

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Outcomes 2004-2014

- We can conclude that substantial improvements in vineyard integrated pest management were made between 2004 and 2014 in Washington State vineyards.
- These two PMSPs (2004 and 2014) provide us with strong documentation of these improvements.
- Now we need to complete another PMSP in 2024 to document improvements or failures since 2014.

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2014 - Priority List of Critical Needs- Research - Plant Pathology

- Better understanding of vineyard replant issues
  - Plant-parasitic nematodes
  - Impact on vine establishment
- Identification of resistant planting material
- Fungal/oomycete diseases
- Alternative fumigants and preplant soil-borne disease and nematode management tactics
- Fumigant application methodologies (techniques to improve efficacy)
- Virus spread to new plantings via planting stock, residual roots of infected vines, and other means

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2014 - Priority List of Critical Needs- Research - Plant Pathology

- Foliar/fruit/trunk diseases
  - Continued refinement of powdery mildew management, including application strategies to enhance coverage and resistance management
  - Enhance AgWeatherNet capability to identify and alert users to primary inoculation periods for powdery mildew
  - Monitoring and managing emerging trunk diseases including Eutypa and Botryosphaeria

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2014 - Priority List of Critical Needs- Research - Plant Pathology- Virology

- Virus diseases (leafroll, redblotch, rugose wood complex, soil-borne viruses such as fanleaf) continue to be major production constraints; continue research into various aspects of virus diseases
  - Remain vigilant about new and emerging diseases
  - Develop a viable assessment tool, based on virus impacts on vine health, fruit yield and quality, to determine economic turning point between managing and replacing virus-infected vineyards
  - Investigate potential arthropod vectors of redblotch disease
  - Continue research on the epidemiology of virus diseases for improved management tactics

21

2014 - Priority List of Critical Needs- Research - Entomology

- Determine best monitoring and management strategies for new and emerging arthropod pests including Willamette mite, blister mite, and brown marmorated stinkbug
- Continue vigilance regarding phylloxera and be prepared to manage it
- Investigate potential arthropod vectors of redblotch disease

22

2014 - Priority List of Critical Needs-Research - Weed Science

- Advances in weed control, including
  - Effective alternative management for weeds in general
  - Best time to cease glyphosate usage to avoid translocation in the grapevine
  - Wider range of weed management tools needed to combat development of glyphosate resistance in key weed pests
  - Lack of vineyard-specific research or scientists dedicated to vineyard weed management

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2014 - Priority List of Critical Needs - Research - Other

- Resistance management: fungicides, herbicides, insecticides, and acaricides
- Pest management in organic systems
- Develop sustainable native plant ground covers/refugia to enhance IPM
- Mechanization of processes such as pruning and other cultural activities to address anticipated labor shortages
- Improvement of best management practices (BMPs) for application technologies, to include sprayer calibration; improved sensor technology for sprayers
- Modeling to determine the impact of climate change and subsequently increased life cycles of some pests on resistance development

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2014 - Priority List of Critical Needs - Regulatory

- Maintenance of currently registered insecticides, particularly neonicotinyls
- Seek registration of fungicides for control of Euytpa, including thiophanate-methyl (Topsin)*, myclobutanil (Rally)*, tetraconazole (Mettle)**, and, potentially, other fungicides (*SLN in California; ** Registered in California)
- Manpower needed to enforce quarantines and clean plant systems, including monitoring “big-box” retailers
- Strengthen certification programs to prevent introduction of viral and other diseases, insect pests and vectors, and nematodes
- Washington State Department of Agriculture (WSDA) wishes to work with growers on a site-specific water monitoring program

25

2014 - Priority List of Critical Needs- Education - Pesticide Education

- Educate growers on maximum residue levels (MRLs), particularly those producers who might be interested in entering the export market
- Continue application technology education: sprayer calibration, adjusting for environmental conditions, BMPs
- Emphasize sanitation at all crop stages
- Continue education about pesticide resistance management, particularly with respect to fungicide rotation and glyphosate resistance
- Improved understanding of “tree row volume” vs. “per acre” application

26

2014 - Priority List of Critical Needs- Education - Monitoring/ scouting training

- Better education on Eutypa identification
- Improved understanding and management of mealybugs and scale insects
- Monitoring for newer arthropod pests such as brown marmorated stinkbug and phylloxera
- Training for interns on scouting

27

2014 - Priority List of Critical Needs- Education - Virology

- Keep growers apprised of emerging and re-emerging virus diseases
- Educate growers on nature and diagnosis of virus diseases, as well as their economic impacts, epidemiology, and management
- Expand education on sampling and virus testing
- Emphasize BMPs for preventing spread of viruses and controlling their vectors

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2014 - Priority List of Critical Needs- Education - Other

- Managing crown gall at the nursery and vineyard level, with the growing risk of extreme cold events as a result of climate change.
- Current developments/education in vineyard weed control is a problem since the state lacks weed scientists with vineyard knowledge
- Better understanding of options for vertebrate pest management
- Expand user base of AgWeatherNet toward additional funding for more stations
- Resistance management with respect to fungicides, herbicides, and acaricides
- Help growers understand optimum/appropriate fertilization as determined by testing tissue samples, avoiding the use of unnecessary chemicals and understanding that plant nutrition can impact the pest complex

29

What's different between now and 2014?

- Ultraviolet light for pest and disease control
- Mating disruption for mealybug management
- Pesticide resistance, insecticides, fungicides
- Maximum Residue Limits - set by wineries
- Grape phylloxera – everywhere

- A new PMSP will answer this question.

30

Conclusions

- We have learned a lot about streamlining the PMSP process since 2014, doing away with the 1-1/2-day workshop in favor of a 2-step process
- We'll likely be sending out a hybrid (paper and/or web-based survey) in 2014
- We will compile the results of the survey and organize a focused workgroup and assign tasks
- Having an updated PMSP will make us substantially more competitive for USDA grants moving forward through the next 10 years

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Foliar Nitrogen Application in Eastern WA Vineyards

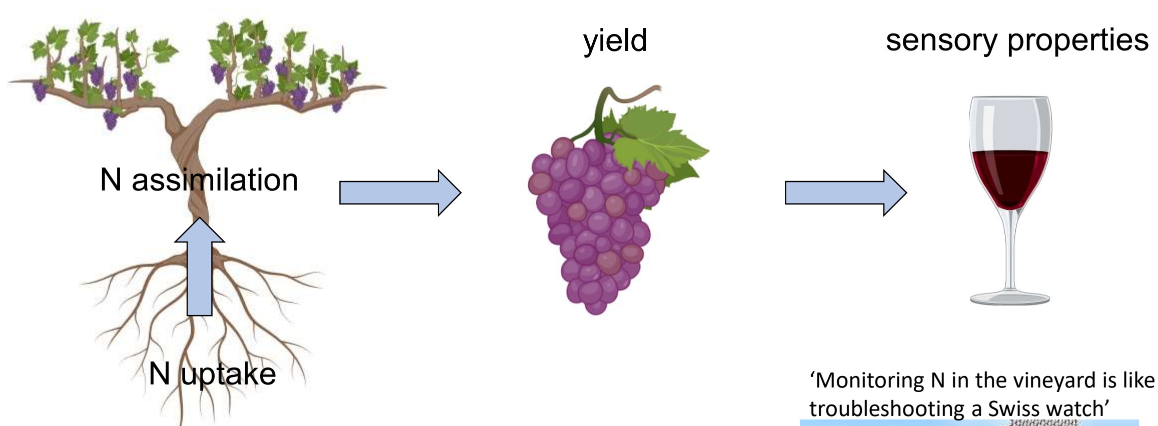
HiRes Vineyard NUTRITION

WASHINGTON STATE UNIVERSITY

Washington State Grape Society meeting 2023
Pierre Davadant, PhD Candidate
pierre.davadant@wsu.edu

1

Background on nitrogen (N)

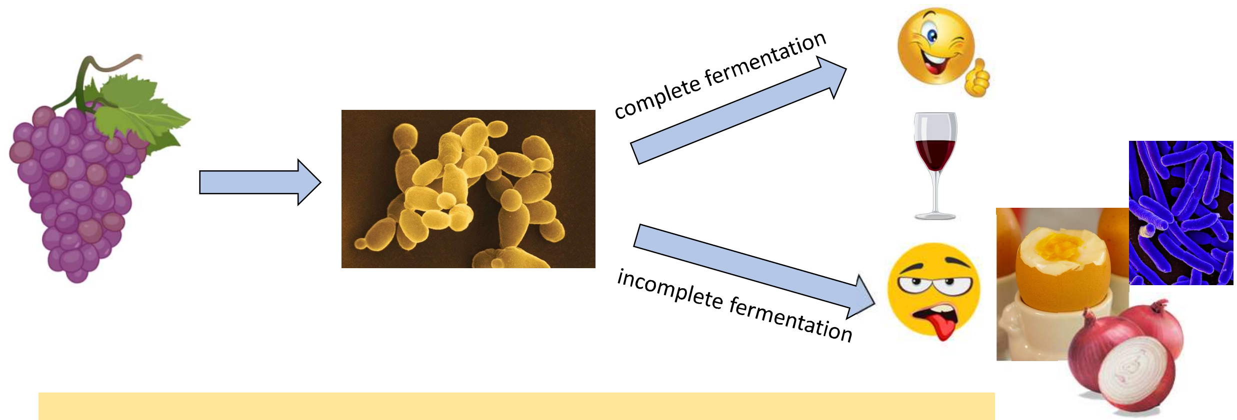


- N balance is crucial for yield and quality
- Applying the right N dose is complicated
- 40-60 lb. N/A

'Monitoring N in the vineyard is like troubleshooting a Swiss watch'

2

YAN : yeast assimilable nitrogen



- Low YAN puts wine at risk
- Wineries must supplement N to be above 140 mg/L
- Fruit rich in N versus DAP addition?

3

Low YAN in eastern WA vineyards

Survey of Biotin, Pantothenic Acid, and Assimilable Nitrogen in Winegrapes from the Pacific Northwest

Hagen et al, 2008

WA vineyards

Vineyard/cultivar	YAN (mg/L)[b] 2001	2002	2003
Vineyard A			
Chardonnay	$213^{a,x}$	$132^{dfgh,y}$	$132^{ab,y}$
Riesling	$46^{c,xy}$	$84^{h,x}$	$26^{fg,y}$
Cabernet Sauvignon	$73^{bc,y}$	$179^{bcdefg,x}$	$67^{cdefg,y}$
Merlot	$69^{bc,xy}$	$121^{fgh,x}$	$42^{efg,y}$
Syrah	$194^{a,x}$	$234^{bc,x}$	$128^{ab,y}$
Vineyard B			
Chardonnay	$224^{a,y}$	$336^{a,x}$	$77^{abcdefg,z}$
Riesling	$94^{bc,xy}$	$143^{defgh,x}$	$81^{bcdef,y}$
Merlot	$102^{bc,y}$	$258^{b,x}$	$52^{defg,z}$
Vineyard C			
Cabernet Sauvignon	$64^{bc,y}$	$216^{bce,x}$	$94^{abcde,y}$
Syrah	$76^{bc,x}$	$133^{defgh,x}$	$120^{abc,x}$
Vineyard D			
Chardonnay	$115^{ab,xy}$	$184^{cdefg,x}$	$91^{abcde,y}$
Riesling	nd	$109^{gh,x}$	$60^{defg,x}$
Cabernet Sauvignon	$185^{a,xy}$	$227^{bcde,x}$	$141^{a,y}$
Merlot	$57^{bc,y}$	$131^{dfgh,x}$	$25^{g,y}$
Syrah	$195^{a,x}$	$170^{cdefg,x}$	$135^{ab,x}$
Vineyard E			
Chardonnay	$203^{a,x}$	$198^{bcdef,x}$	$120^{abc,y}$
Cabernet Sauvignon	$103^{b,x}$	$170^{bcdefgh,x}$	$102^{abcd,x}$
Merlot	$71^{bc,y}$	$135^{defgh,x}$	$56^{defg,y}$
Syrah	$99^{bc,x}$	$74^{h,x}$	$69^{cdefg,x}$
Vineyard F			
Riesling	$96^{bc,y}$	$157^{cdefgh,x}$	$134^{ab,xy}$

- mean YAN = 124 mg/L in PNW vineyards
- YAN varies across years and varieties
- Low YAN in WA vineyards

4

N application across the season

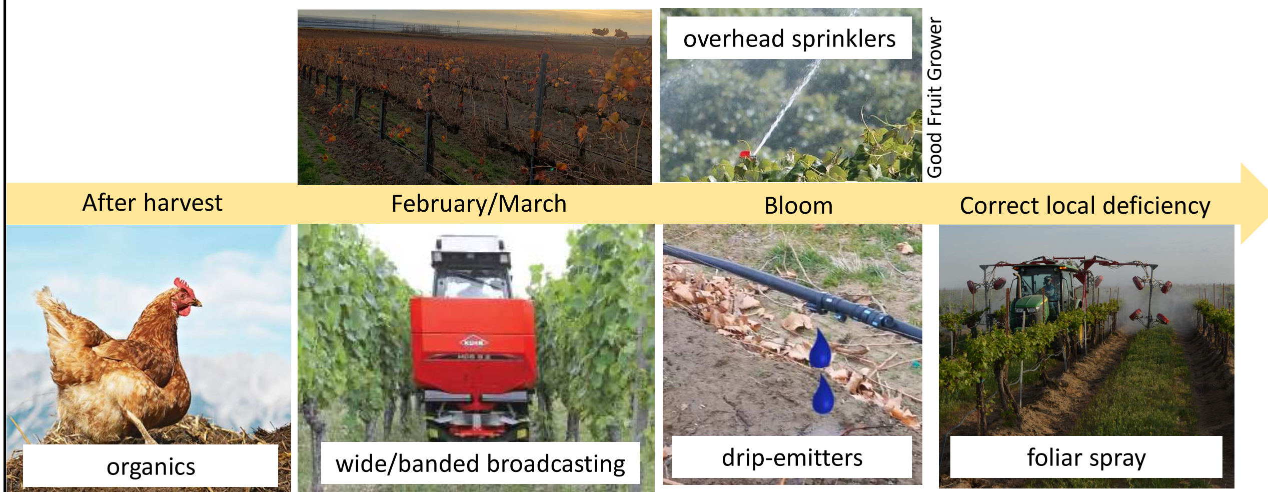


Photo credit: Michelle Moyer

5

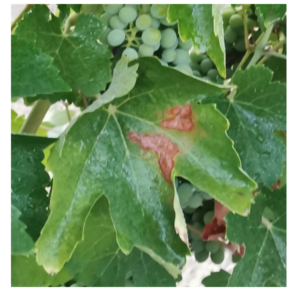
Alternative to explore: Foliar Nitrogen at Véraison

Photo credit: Michelle Moyer

6

What we already know

What?	urea (46-0-0)
How much?	• Nitrogen 3*5 lb/A (total 15 lbs/A) • Water 120-gal/A • Surfactant 0.1-0.5% vol surfactant
Where?	on both sides of the canopy
When?	early AM/late PM : high RH%, low temperature

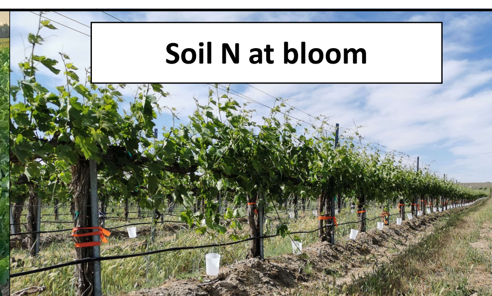


Urea toxicity symptom

- Quick absorption
- Increase aroma
- Does not increase vigor
- Increase YAN

- Risk of leaf burning
- Uncertainty about phenolics

7



Team:
Dr. Nataliya Shcherbatyuk
Pierre Davadant

15 lbs N/A

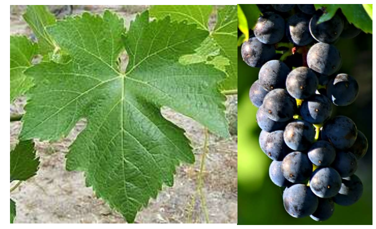
0
20
40
80
lbs N/A

2021-2024
Syrah
Columbia Crest

Field experiment: commercial vineyard

8

Results



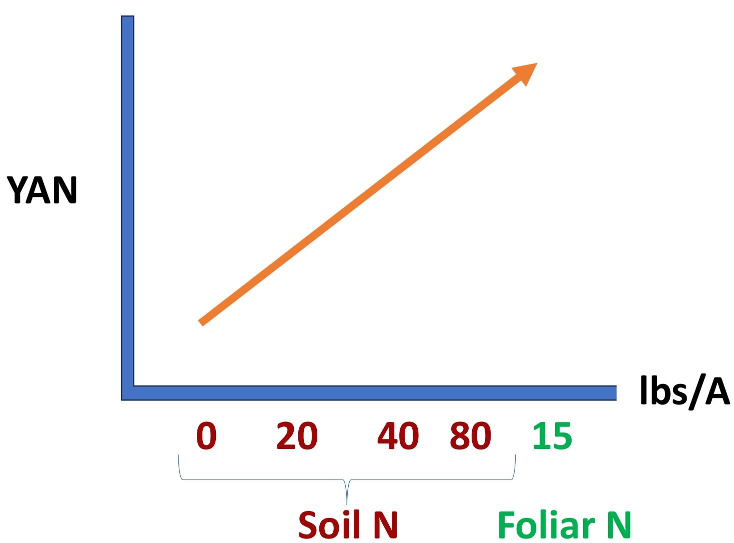
- No differences in pruning weights (2022)
- No differences in yield (2021, 2022, 2023)
- % nitrogen increased in tissues (2022):

		Soil-applied N (lbs/A) at bloom			Foliar at véraison
	0	20	40	80	15
Blades, 50% veraison					
Berries, harvest					
Rachis, harvest					

Take-home :
Foliar N was the most efficient treatment at increasing % nitrogen in leaf blades at veraison and in the fruit at harvest without increasing the growth

9

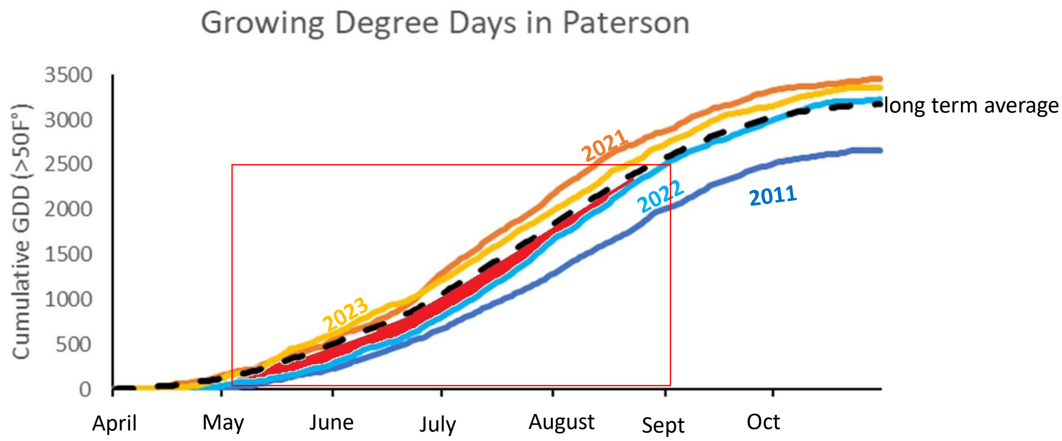
Foliar nitrogen is effective at increasing fruit YAN



Take-home :
- Foliar N increased YAN
- YAN <150ppm
- YAN varies annually

10

Are temperature and YAN linked?



Take-home : Lower temperature might decrease YAN

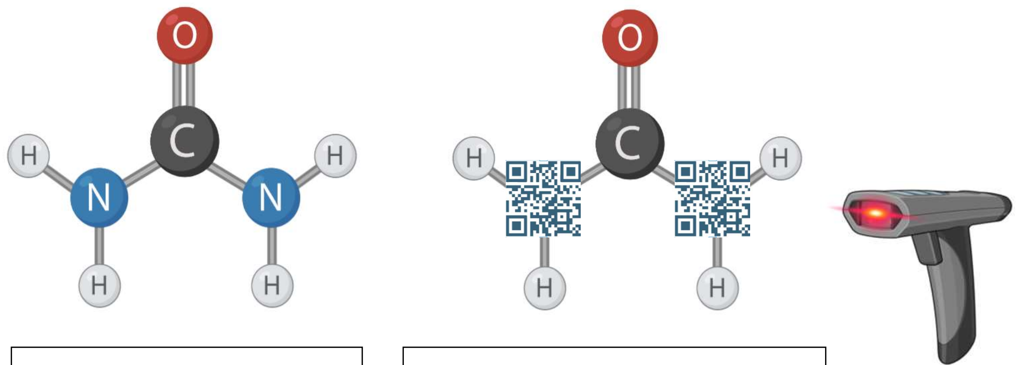
Source: WSU-AgWeatherNet

11

Pot experiment: where should N be applied?

12

Spraying labelled nitrogen



normal urea

labelled urea

13

Nitrogen applied on the fruit stays in the fruit

Take-home:

- Fruit-applied nitrogen increased YAN
- Leaf-applied nitrogen increased nutrient reserves
- Canopy-applied nitrogen increases both YAN and nutrient reserves

14

Conclusion

- **Foliar N increased %N** in leaves and fruit without increasing growth
- Foliar application at véraison is **effective at increasing YAN**
- **No effect on vigor or yield**, tannins to be confirmed
- Combine low dose soil N at bloom + foliar N at véraison

  => increase YAN and lower total N fertilizers
- Increase sustainability and face changes in agricultural legislation

15

USDA NIFA

WA WINE 46°N

Ste Michelle WINE ESTATES

VALLEY WIDE COOPERATIVE

Thank you!

HiRes Vineyard NUTRITION

Acknowledgements:

- Dr. Markus Keller's lab team
- Dr. Jim Harbertson and his team
- Dr. Lee Kalcsits

16

The AgAID Institute

The USDA NIFA AI Institute for Transforming Workforce and Decision Support

Paola Pesantez-Cabrera, Ph.D.

11/17/2023, Grandview, WA

WASHINGTON STATE WSGS GRAPE SOCIETY

Supported by:

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NATIONAL AI INSTITUTE for Exceptional Education

AI Institute for Advances in Optimization

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AI SDM

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ATHENA

AI INSTITUTE IN DYNAMIC SYSTEMS

ICICLE

IFML

EngageAI Institute

INVITE

iSAT

TILOS

TRAILS
Trustworthy AI in Law & Society

Who we are among the NIFA-funded AI Institutes?

AI-CLIMATE

Lead: U. Minnesota
- Climate-smart Ag, Carbon
- Forestry

AgAID Institute

Lead: Washington State U.
- Water, Labor, Farm Operations
- Specialty crops

AIFARMS
Artificial Intelligence for Future Agricultural Resilience, Management, and Sustainability

Lead: U. Illinois Urbana-Champaign
- Future Ag, Resilience, Edge Computing, Sustainability
- Commodity crops and livestock

AIFS
AI INSTITUTE FOOD SYSTEMS

Lead: U California, Davis
- Food systems, supply chain, nutrition
- Post-harvest

AIIRA
AI Institute for Resilient Agriculture

Lead: Iowa State U.
- Resilient Ag, Digital twins for plants, Breeding
- Commodity crops

AgAID Institute Core Members

Washington State University · Oregon State University · Heritage University · Kansas State University · University of California Merced · University of Virginia · Wenatchee Valley College · IBM Research · innov8.ag (Empowering Growers with Data)

Specialty cropping systems on focus so far








Grapes

Tree fruits
Apples and Cherries

Nut trees
Almonds & Pistachios

Berries
Blueberries (starting)

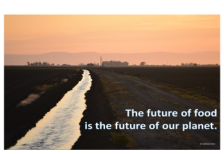
AgAID Institute – Three major areas of impact for Ag

How can AI help agriculture secure the future in food production?

Water

- Water scarcity and drought
- Climate change

Challenge: Water allocation



Orchard/vineyard operations management

- Extreme weather events can cause severe crop damage and loss (e.g., frost, heat stress)

Challenge: Support management decisions based on data

Labor

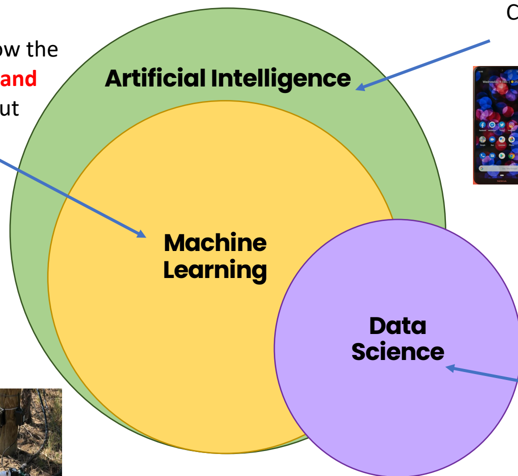
- Increasing production costs, and shortage in unskilled and skilled labor

Challenge: Amplifying human skills and machine efficiency through a close human-AI partnership.

What is Artificial Intelligence?

Create **models/systems** that allow the machine to **automatically learn and improve from experience** without being rigidly programmed

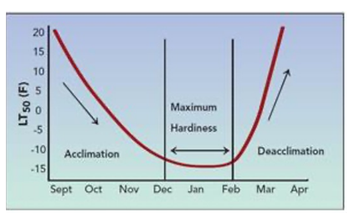
Model is a mathematical or computational **representation of a real process** that helps us make decisions **based on** patterns and relationships in the **data**



Create **intelligent machines** that imitate human reasoning and behavior

Discipline that focuses on **collecting, cleaning, analyzing and interpreting data** with the aim of extracting useful information and making informed decisions

Grapes Cold Hardiness Prediction



LT_{50} = temperature at which 50% of grape buds freeze/die

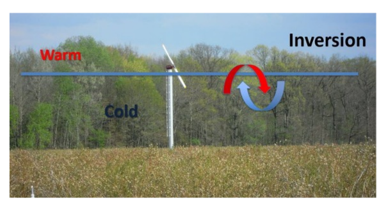
- Decreases during first part of dormancy (acclimation)
- Increases during last part of dormancy (deacclimation)

Not easily measured by farmers.

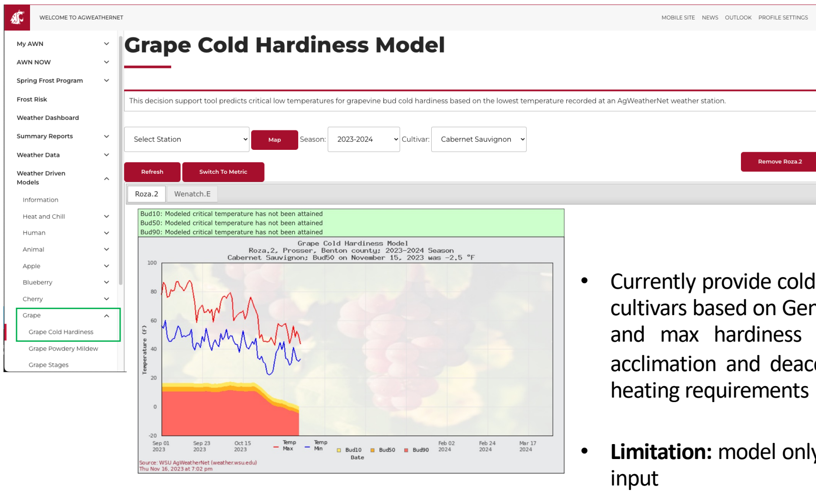
Farmers can use predictions of LT_{50} to decide whether to conduct frost mitigation operations on a given day

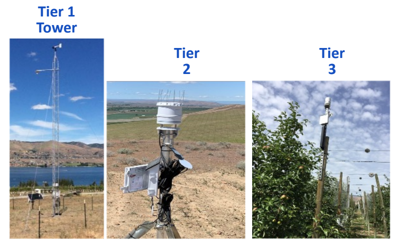
Frost Mitigation

Very expensive to carry out!



Grapes Cold Hardiness Prediction from Temperature Data

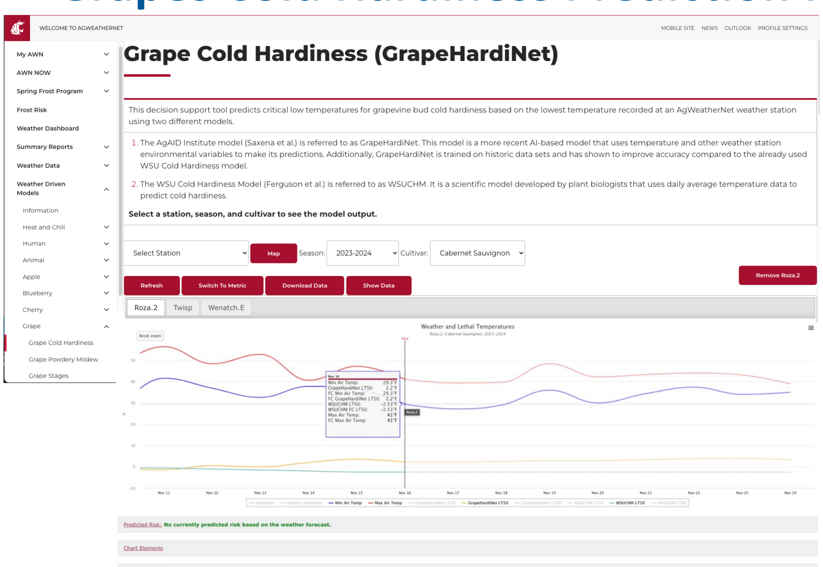




- Currently provide cold hardiness estimates for different cultivars based on Genotype-specific parameters: initial and max hardiness (DTA), temperature thresholds, acclimation and deacclimation rates, and chilling and heating requirements
- **Limitation:** model only use mean daily temperatures as input

https://weather.wsu.edu/

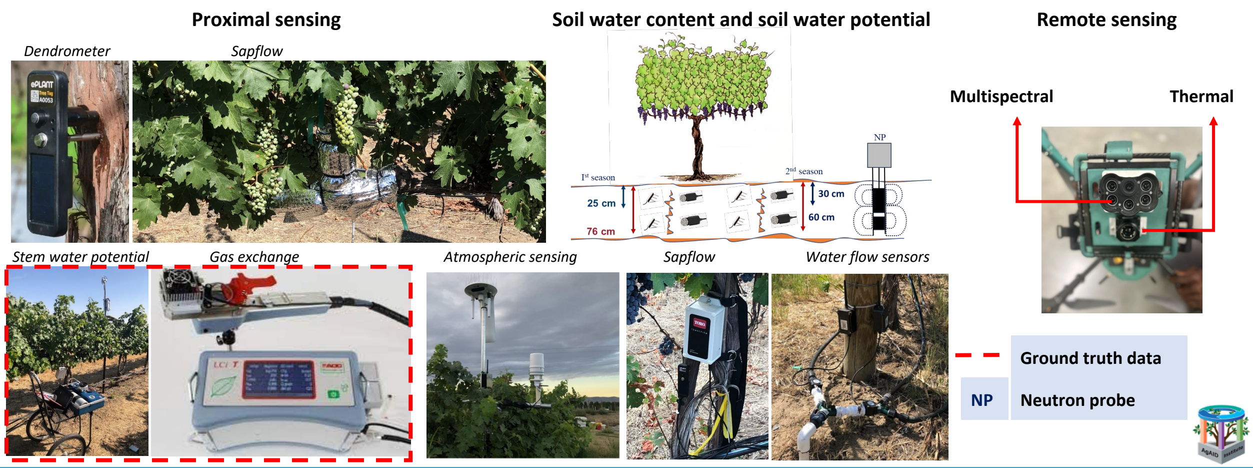
Grapes Cold Hardiness Prediction from Weather Data



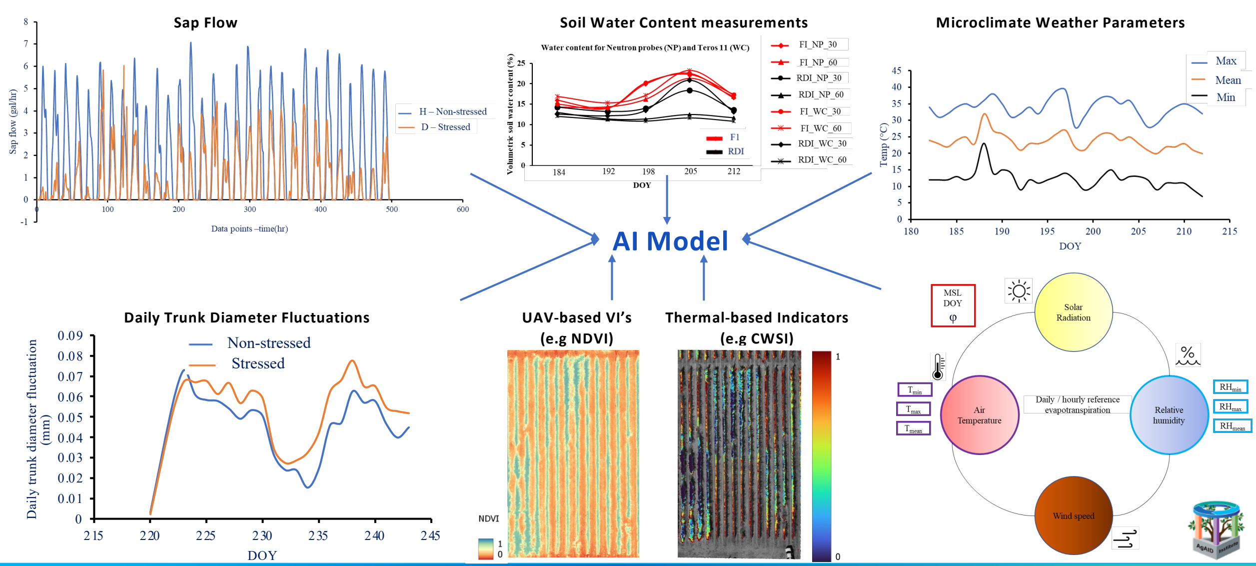
- Uses machine learning methods
- Allow for inclusion of additional weather features such as solar rad, relative humidity, dew point, etc.
- Combines data from different cultivars, so the ones with less data learn from the ones more data
- Can be used to predict budbreak and other phenological states
- Easily adaptable to other crops given crop data
- **Is in beta state (still not public)**

Automated Deficit Irrigation in Grapevines (I)

Recent Progress: Sensing and ground truthing to understand water stress in Cabs (2022 and 2023 season)



Automated Deficit Irrigation in Grapevines (II)



Intelligent Dormant Tree Pruning

Human (expert) pruner

Robotic pruner on the WSU Prosser farm

*Ongoing work by Joseph Davidson (OSU), Cindy Grimm (OSU), Manoj Karkee (WSU)

Intelligent Blossom Thinning and Spraying

Flower thinning to control crop load

Robotic thinning at the WSU Prosser farm

Reuse of robotic platform for intelligent spraying

*Ongoing work by Manoj Karkee (WSU), Joseph Davidson (OSU), Cindy Grimm (OSU)

Heat Stress Mitigation - Apples, Grapes

- **Apple/Grape**

Heat stress on leaves | necrosis | browning | photooxidation | splitting and necrosis | Source: George Zhuang | Gambetta et al., 2021

- **Mitigation**

Conventional evaporative cooling (25 min ON/OFF) | Fogging (> 80°F continuous) | Netting | Fog-net | Evaporative cooling

- **Approach**
  - Weather data driven AI based fruit/berry surface temp. models to drive the mitigation

> - Heat stress cause of largest losses in WA tree fruits
> - Fruit surface 16-22F more than air temp (varies by cultivar)

Demo Farm – Smart Vineyard

AgAID Institute – K12 Education

AgAID Institute – Field Days & Bilingual Programs

AgAID Institute – Undergraduate Research Internships

Artificial Intelligence is here to stay

August 21, 2023, Seattle, WA

Senate Agriculture Chairwoman Debbie Stabenow says she expects provisions dealing with artificial intelligence in the next farm bill.

For more information on AgAID, visit https://agaid.org/

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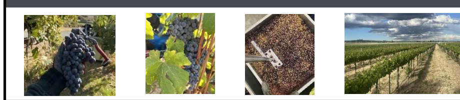
WSGS

17 November 2023

Screening Rootstocks Against the Northern Root-Knot Nematode (*Meloidogyne hapla*)

Bernadette Gagnier
PhD Candidate
WSU-IAREC
Prosser, WA

wine.wsu.edu



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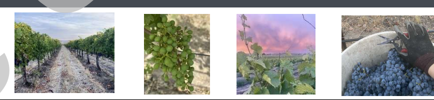
Viticulture and Enology



1

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Background

Northern Root-Knot Nematode (*Meloidogyne hapla*)

- Soil-borne microscopic roundworm
- Adult *M. hapla* are sedentary endoparasites
- Second-stage juveniles are mobile in the soil

Second-Stage Juvenile *M. hapla*; root galls on *V. vinifera;* Adult *M. hapla*, stained red

UC Davis Nemaplex

2

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Why this Experiment?

Rootstock experiments dominated by other species or horticultural outcomes

- Primarily conducted on other *Meloidogyne* spp.
  - *M. hapla* is prevalent in Washington vineyards
- Increased interest in rootstock use (phylloxera)
- Support of Washington-based field trial


J Nematol. 1989 Jan;21(1):92-8.

Overwintering Stages of Meloidogyne incognita in Vitis vinifera

H Melakeberhan, H Ferris, M V McKenry, J T Gaspard

PMID: 19287581 PMCID: PMC2618909

Free PMC article

Abstract

The overwintering of Meloidogyne incognita in and arou... was studied in a naturally infested vineyard at the Kearn...

Vitis 51 (1), 19–26 (2012)

Susceptibility of *Vitis vinifera* 'Semillon' and 'Chardonnay' to the root-knot nematode *Meloidogyne javanica*

Field Performance of Winegrape Rootstocks and Fumigation during Establishment of a Chardonnay Vineyard in Washington

Katherine E. East, Inga A. Zasada, Julie Tarara, and Michelle M. Moyer

Rootstock Effects on Deficit-Irrigated Winegrapes in a Dry Climate: Vigor, Yield Formation, and Fruit Ripening

Markus Keller, Lynn J. Mills, and James F. Harbertson

Irrigation and Rootstocks to Manage Northern Root-Knot Nematode During Wine Grape Vineyard Establishment

Melakeberhan et al. 1989, Keller et al. 2012, Rahman et al. 2012, East et al. 2021, East et al 2021

3

Viticulture & Enology
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Greenhouse Screens vs Field Trials

Greenhouse Screens

- Quick turnover

- Space
- Many rootstocks

- Reproduction factor value

Field Trials

- Long-term performance

- Vineyard variables
- Labor intensive

- Vine performance

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Rootstock Material

Rootstock	Attributes	Why
Chardonnay	Commonly planted white cultivar	White cultivar response to *M. hapla*
Cab Sauv	Commonly planted red cultivar	Red cultivar response to *M. hapla*
1103P	Drought and salt tolerant	Further support of success in field trial
SO4	Cool region rootstock, performs well in a range of soils	Not explored in WA long term field trial
5BB	High vigor, cooler sites on well drained clay/loam soils	Related to 101-14 and T-5C, in field trial
Minotaur	RKN resistance, easy rooting and bench grafting	Relatively new, *M. hapla* not explored
1616C	Low vigor rootstock, delayed ripening	Explored in short term WA field trial
140RU	Drought and salt tolerant, high vigor	Not explored in WA long term field trial
44-53 M	Low-moderate vigor, drought tolerant	Phylloxera tolerance, *M. hapla* not explored
99R	Moderate vigor, moderate drought and salt tolerance	Phylloxera tolerance, not explored in WA
SW	Moderate-low vigor, low drought tolerance	Similar to 101-14 Mgt, adapts to many soils

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Rootstock Material - *V. vinifera*

Rootstock	Attributes	Why
Chardonnay	**Commonly planted white cultivar**	**White cultivar response to *M. hapla***
Cab Sauv	**Commonly planted red cultivar**	**Red cultivar response to *M. hapla***
1103P	Drought and salt tolerant	Further support of success in field trial
SO4	Cool region rootstock, performs well in a range of soils	Not explored in WA long term field trial
5BB	High vigor, cooler sites on well drained clay/loam soils	Related to 101-14 and T-5C, in field trial
Minotaur	RKN resistance, easy rooting and bench grafting	Relatively new, *M. hapla* not explored.
1616C	Low vigor rootstock, delayed ripening	Explored in short term WA field trial
140RU	Drought and salt tolerant, high vigor	Not explored in WA long term field trial
M4453	Low-moderate vigor, drought tolerant	Phylloxera tolerance, *M. hapla* not explored
99R	Moderate vigor, moderate drought and salt tolerance	Phylloxera tolerance, not explored in WA
SW	Moderate-low vigor, low drought tolerance	Similar to 101-14 Mgt, adapts to many soils

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Rootstock Material - Drought Tolerance

Rootstock	Attributes	Why
Chardonnay	Commonly planted white cultivar	White cultivar response to *M. hapla*
Cab Sauv	Commonly planted red cultivar	Red cultivar response to *M. hapla*
1103P	**Drought and salt tolerant**	**Further support of success in field trial**
SO4	Cool region rootstock, performs well in a range of soils	Not explored in WA long term field trial
5BB	High vigor, cooler sites on well drained clay/loam soils	Related to 101-14 and T-5C, in field trial
Minotaur	RKN resistance, easy rooting and bench grafting	Relatively new, *M. hapla* not explored.
1616C	Low vigor rootstock, delayed ripening	Explored in short term WA field trial
140RU	**Drought and salt tolerant, high vigor**	**Not explored in WA long term field trial**
99R	**Moderate drought and salt tolerance, moderate vigor**	**Phylloxera tolerance, not explored in WA**
SW	Moderate-low vigor, low drought tolerance	Similar to 101-14 Mgt, adapts to many soils

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Rootstock Material - Low Vigor

Rootstock	Attributes	Why
Chardonnay	Commonly planted white cultivar	White cultivar response to *M. hapla*
Cab Sauv	Commonly planted red cultivar	Red cultivar response to *M. hapla*
1103P	Drought and salt tolerant	Further support of success in field trial
SO4	Cool region rootstock, performs well in a range of soils	Not explored in WA long term field trial
5BB	High vigor, cooler sites on well drained clay/loam soils	Related to 101-14 and T-5C, in field trial
Minotaur	RKN resistance, easy rooting and bench grafting	Relatively new, *M. hapla* not explored.
1616C	**Low vigor rootstock, delayed ripening**	**Explored in short term WA field trial**
140RU	Drought and salt tolerant, high vigor	Not explored in WA long term field trial
44-53 M	**Low-moderate vigor, drought tolerant**	**Phylloxera tolerance, *M. hapla* not explored**
99R	Moderate vigor, moderate drought and salt tolerance	Phylloxera tolerance, not explored in WA
SW	**Moderate-low vigor, low drought tolerance**	**Similar to 101-14 Mgt, adapts to many soils**

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Rootstock Material - Cooler Climates

Rootstock	Attributes	Why
Chardonnay	Commonly planted white cultivar	White cultivar response to *M. hapla*
Cab Sauv	Commonly planted red cultivar	Red cultivar response to *M. hapla*
1103P	Drought and salt tolerant	Further support of success in field trial
SO4	**Cool region rootstock, performs well in a range of soils**	**Not explored in WA long term field trial**
5BB	**High vigor, cooler sites on well drained clay/loam soils**	**Related to 101-14 Mgt and Teleki-5C, in field trial**
140RU	Drought and salt tolerant, high vigor	Not explored in WA long term field trial
M4453	Low-moderate vigor, drought tolerant	Phylloxera tolerance, *M. hapla* not explored
99R	Moderate vigor, moderate drought and salt tolerance	Phylloxera tolerance, not explored in WA
SW	Moderate-low vigor, low drought tolerance	Similar to 101-14 Mgt, adapts to many soils

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Rootstock Material - RKN resistance

Rootstock	Attributes	Why
Chardonnay	Commonly planted white cultivar	White cultivar response to *M. hapla*
Cab Sauv	Commonly planted red cultivar	Red cultivar response to *M. hapla*
1103P	Drought and salt tolerant	Further support of success in field trial
SO4	Cool region rootstock, performs well in a range of soils	Not explored in WA long term field trial
5BB	High vigor, cooler sites on well drained clay/loam soils	Related to 101-14 and T-5C, in field trial
Minotaur	**RKN resistance, easy rooting and bench grafting**	**Relatively new, *M. hapla* not explored**
140RU	Drought and salt tolerant, high vigor	Not explored in WA long term field trial
M4453	Low-moderate vigor, drought tolerant	Phylloxera tolerance, *M. hapla* not explored
99R	Moderate vigor, moderate drought and salt tolerance	Phylloxera tolerance, not explored in WA
SW	Moderate-low vigor, low drought tolerance	Similar to 101-14 Mgt, adapts to many soils

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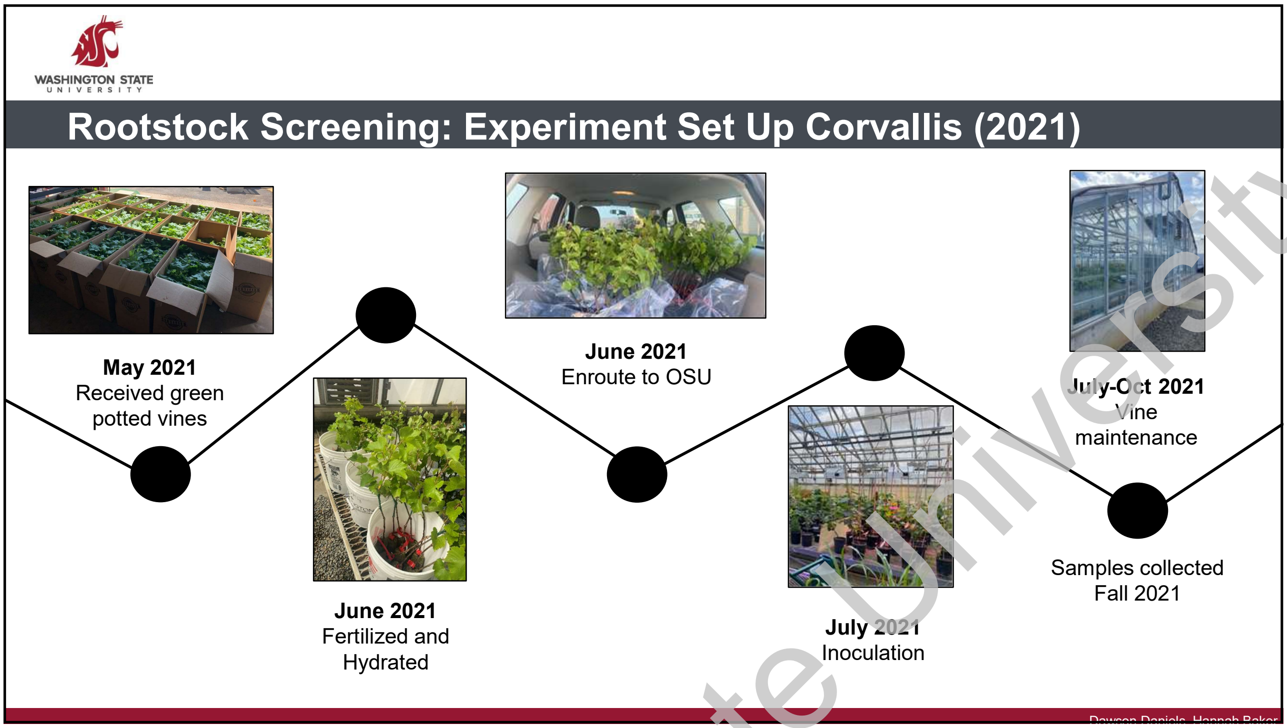
WASHINGTON STATE UNIVERSITY
Rootstock Screening: Experiment Set Up Corvallis (2021)
May 2021
Received green potted vines
June 2021
Fertilized and Hydrated
June 2021
Enroute to OSU
July 2021
Inoculation
July-Oct 2021
Vine maintenance
Samples collected Fall 2021

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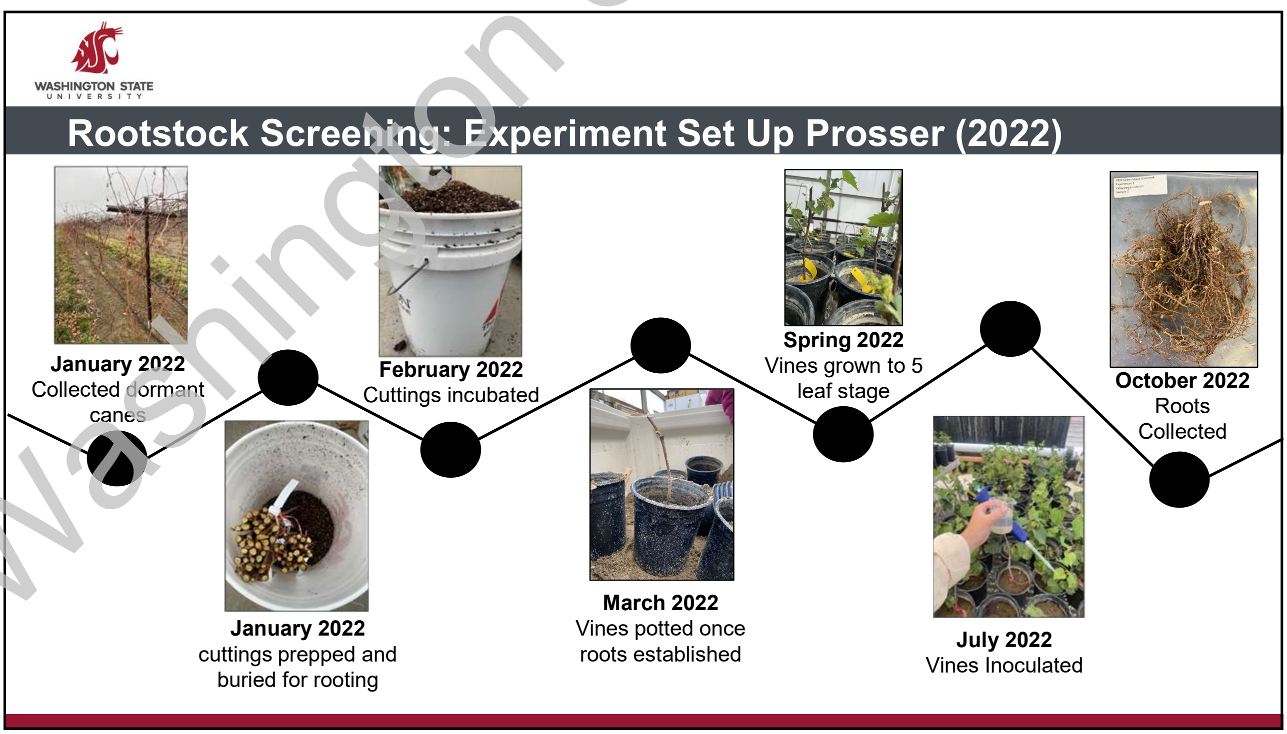
WASHINGTON STATE UNIVERSITY
Rootstock Screening: Experiment Set Up Prosser (2022)
January 2022
Collected dormant canes
January 2022
cuttings prepped and buried for rooting
February 2022
Cuttings incubated
March 2022
Vines potted once roots established
Spring 2022
Vines grown to 5 leaf stage
July 2022
Vines Inoculated
October 2022
Roots Collected

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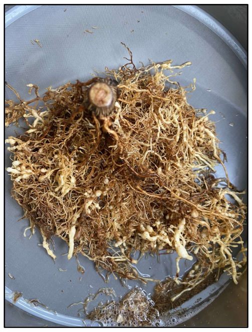
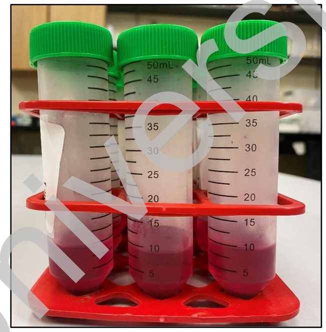
Processing the Samples



Roots bleached, shaken and eggs collected

Roots wrapped and ready to dry

Samples dyed with acid fuchsin



Samples ready for quantification under inverted microscope

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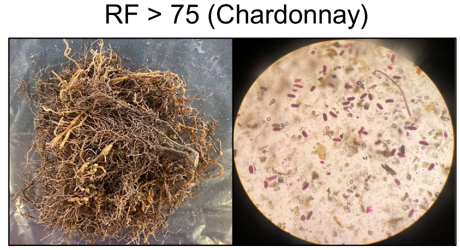
What is Reproduction Factor?

Reproduction Factor *M. hapla* Eggs

- RF = final nematode egg population/initial nematode population
- RF value > 1 indicates that the plant is a good host
- RF value < 1 indicates a poor host

RF = 0 (1103P)

RF > 75 (Chardonnay)



RF calculated from initial nematode population of 5000 *M. hapla* eggs/pot

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Results - Corvallis Trial

2021 Experiment 1

Rootstock	Average *M. hapla* eggs/g of root	R_f
Chardonnay	69773.9a	134.7a
44-53 M	21910.9b	34.7b
SO4	1181.3b	2.5b
5BB	79.6b	0.1b
SW	0b	0b
1103P	0b	0b
140 RU	0b	0b
1616C	0b	0b
p values	*<0.0001*	*<0.0001*

2021 Experiment 2

Rootstock	Average *M. hapla* eggs/g of root	R_f
Cabernet Sauvignon	518.3a	1.34a
99R	28.6b	0.1b
Minotaur	0b	0b
p values	*<0.0001*	*<0.0001*

Rf value > 1 indicates that the plant is a susceptible host

Statistics: JMP ANOVA and Tukeys HSD

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Results - Corvallis Trial

2021 Experiment 1

Rootstock	Average *M. hapla* eggs/g of root	R_f
Chardonnay	69773.9a	134.7a
44-53 M	21910.9b	34.7b
SO4	1181.3b	2.5b
5BB	79.6b	0.1b
SW	0b	0b
1103P	0b	0b
140 RU	0b	0b
1616C	0b	0b
p values	*<0.0001*	*<0.0001*

2021 Experiment 2

Rootstock	Average *M. hapla* eggs/g of root	R_f
Cabernet Sauvignon	518.3a	1.34a
99R	28.6b	0.1b
Minotaur	0b	0b
p values	*<0.0001*	*<0.0001*

Rf value > 1 indicates that the plant is a susceptible host

Statistics: JMP ANOVA and Tukeys HSD

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Results – Prosser Trial

2022 Experiment 1		
Rootstock	**Average *M. hapla* eggs/g of root**	**R_f**
Chardonnay	14069.9a	17.5a
44-53 M	1073b	1.6b
SO4	98.7b	0.1b
5BB	0b	0b
SW	11b	0.01b
1103P	0b	0b
140RU	203.6b	0.3b
1616C	5.1b	0.01b
p values	*<0.0001*	*<0.0001*

2022 Experiment 2		
Rootstock	**Average *M. hapla* eggs/g of root**	**R_f**
Cabernet Sauvignon	8144.8a	14.8a
99R	5.6b	0.01b
Minotaur	5.7b	0.01b
p values	*0.0006*	*0.0033*

Rf value > 1 indicates that the plant is a susceptible host

Statistics: JMP ANOVA and Tukeys HSD

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Results – Prosser Trial

2022 Experiment 1		
Rootstock	**Average *M. hapla* eggs/g of root**	**R_f**
Chardonnay	14069.9a	17.5a
44-53 M	1073b	1.6b
SO4	98.7b	0.1b
5BB	0b	0b
SW	11b	0.01b
1103P	0b	0b
140RU	203.6b	0.3b
1616C	5.1b	0.01b
p values	*<0.0001*	*<0.0001*

2022 Experiment 2		
Rootstock	**Average *M. hapla* eggs/g of root**	**R_f**
Cabernet Sauvignon	8144.8a	14.8a
99R	5.6b	0.01b
Minotaur	5.7b	0.01b
p values	*0.0006*	*0.0033*

Rf value > 1 indicates that the plant is a susceptible host

Statistics: JMP ANOVA and Tukeys HSD

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Big Picture

2022 Experiment 1		
Rootstock	Average *M. hapla*	R_f
140RU	203.6b	0.3b
1616C	5.1b	0.01b
p values	<0.0001	<0.0001

2022 Experiment 2		
Rootstock	Average *M. hapla*	R_f

Rootstocks can host *M. hapla* but they do so at lower rates than own-rooted *Vitis vinifera*.

plant is a susceptible host

Statistics: JMP ANOVA and Tukeys HSD

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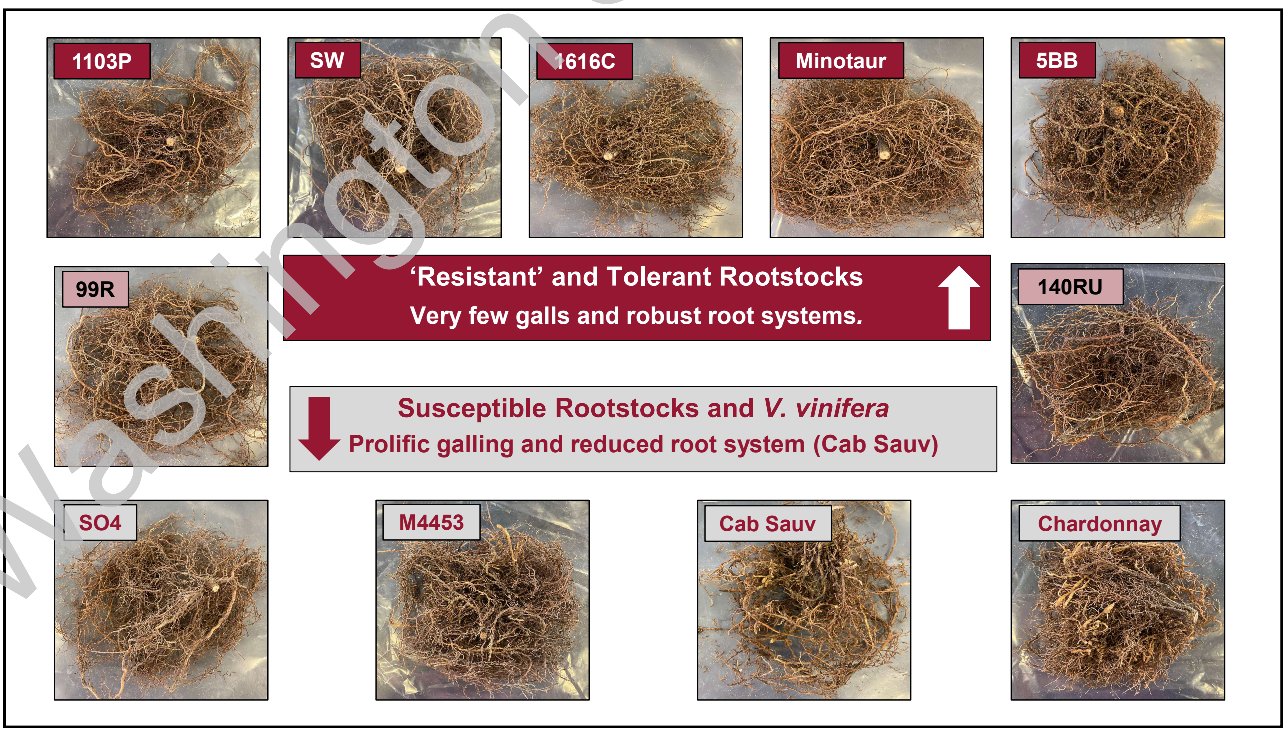

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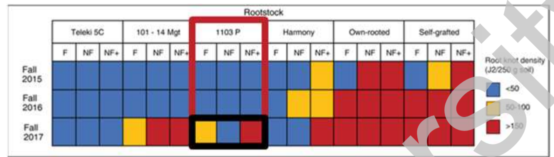
Take Home

- Greenhouse screens are fast
- Reproduction value is a useful tool
- Not all rootstocks are resistant
- Not a replacement for field trials
- Rootstocks perform better than own-rooted
- Own-rooted:

  White Cultivars **(Chardonnay Rf > 75)**

  vs

  Red Cultivars **(Cabernet Rf > 7)**
- Integrated Pest Management



Field Trial Results

Howland et al. 2015. Photo: Michelle Moyer

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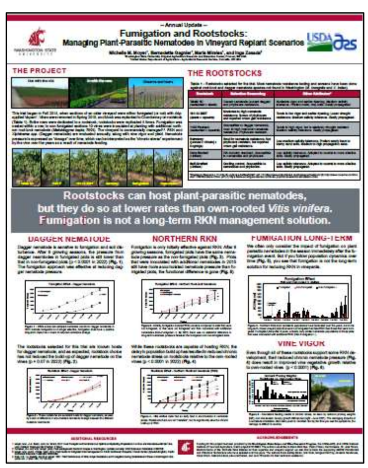
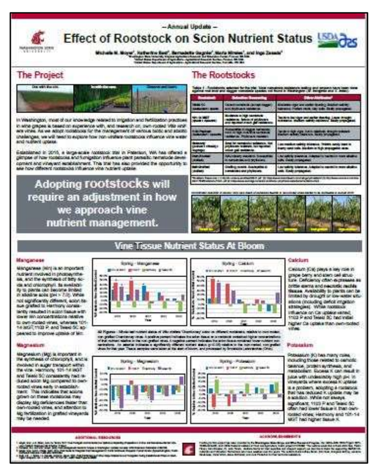
ROOTSTOCK POSTERS

'Team Nema'

rootstock posters and susceptible root examples





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Acknowledgments

Advisor and Committee Members

- **Dr. Michelle Moyer – WSU**
- Dr. Inga Zasada – USDA
- Dr. Tom Collins – WSU
- Dr. Deirdre Griffin-Lahue – WSU
- Dr. Lisa Wasko DeVetter – WSU

Washington State COMMISSION ON PESTICIDE REGISTRATION

Project #21SN005

WA 46°N WINE

This research was funded by Washington State University, Auction of Washington Wines and all Washington State wine grape growers and wineries through the Washington State Wine Commission.

Moyer Lab (WSU)
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- Maria Mireles
- Jesse Stevens

Zasada Lab (USDA)
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- Hannah Baker
- Lester Nunez Rodriguez
- Mckenna Platt

Previous WSU/USDA
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- Dr. Margaret McCoy
- Dr. Catie Wram
- Dr. Katherine East
- Polet Torres

INLAND DESERT NURSERY
Dawson Daniels

Clean Plant Center Northwest
START CLEAN, STAY CLEAN

USDA Agricultural Research Service

Oregon State University

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QUESTIONS

***M. hapla* and rootstocks articles**

bernadette.gagnier@wsu.edu

2019 Rootstock Greenhouse Screen

Field-Based Fumigation and Rootstock Paper

Rootstock Effects: Grape and Wine Composition

M. hapla Reproduction On Red Or White Cultivars

Field-Based Irrigation and Rootstock Article

Rootstock Effects: Vigor, Yield Formation, and Fruit Ripening

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