Department of Horticulture | Oregon Wine Research Institute

Adapting Vineyards for Climate Change

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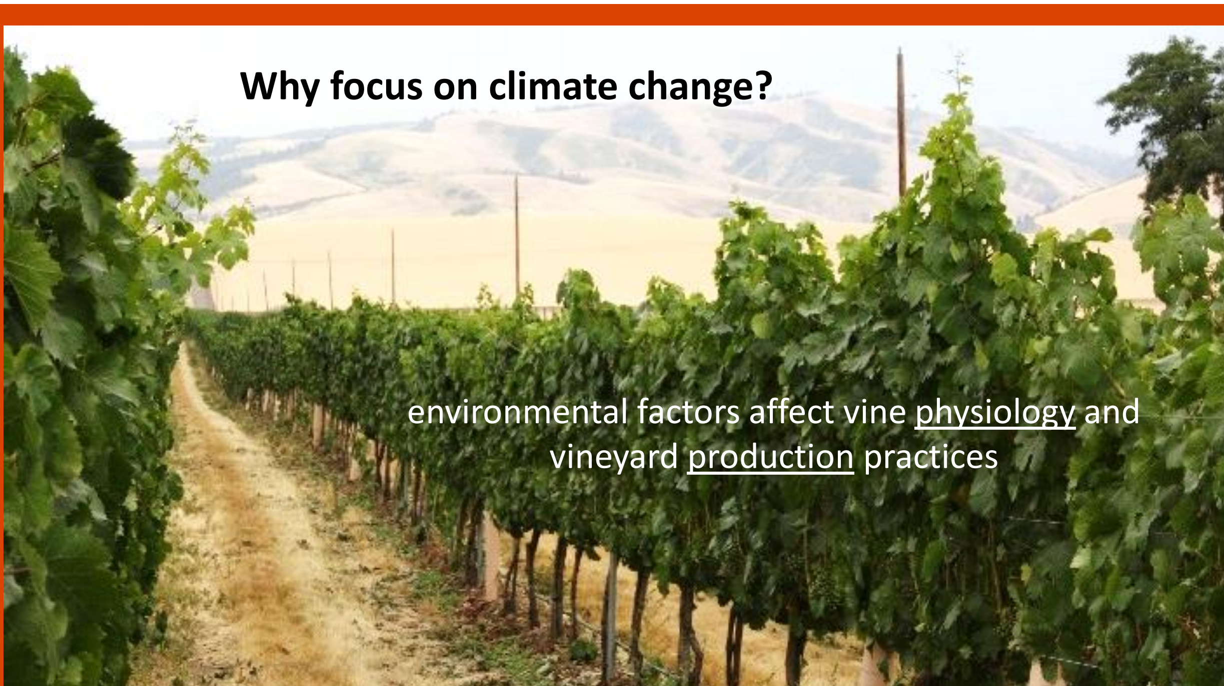
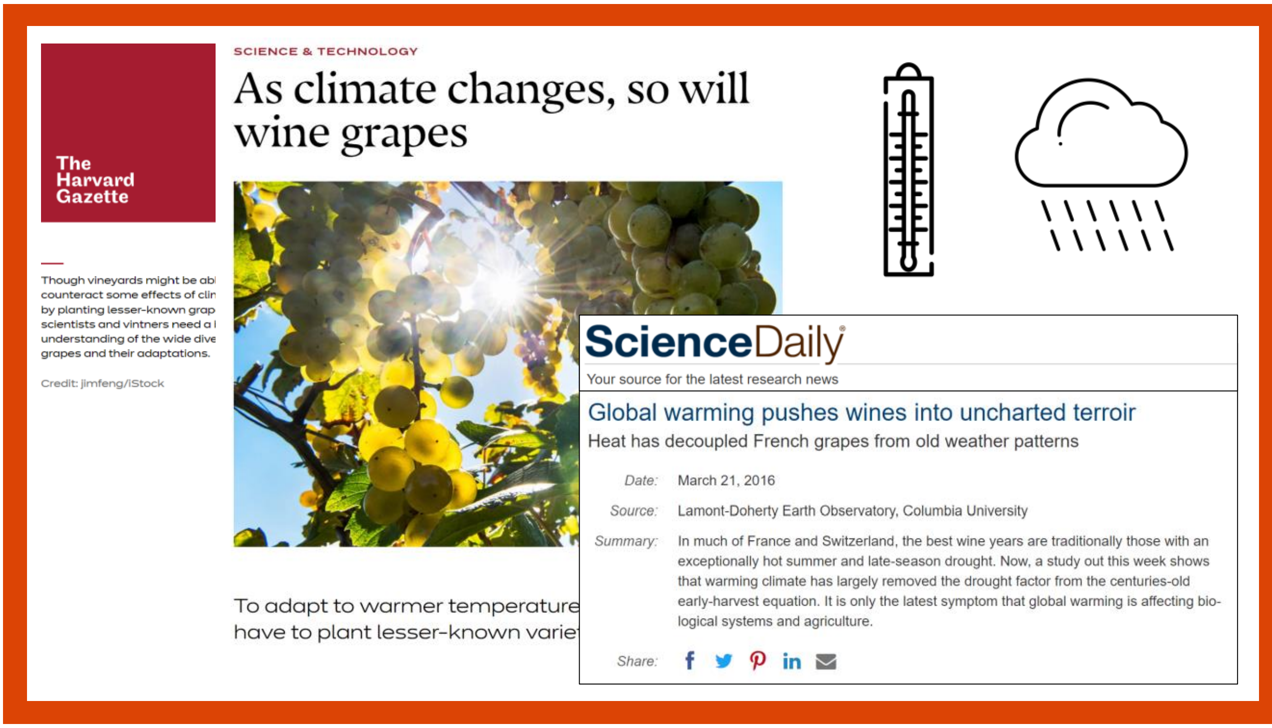
VinCO 2023 – Grand Junction, CO – January 19, 2023

Oregon State University




The Harvard Gazette

SCIENCE & TECHNOLOGY

As climate changes, so will wine grapes

Though vineyards might be abl
counteract some effects of clir
by planting lesser-known grap
scientists and vintners need a l
understanding of the wide dive
grapes and their adaptations.

Credit: jimfeng/iStock

To adapt to warmer temperature
have to plant lesser-known variet

ScienceDaily
Your source for the latest research news

Global warming pushes wines into uncharted terroir

Heat has decoupled French grapes from old weather patterns

Date: March 21, 2016

Source: Lamont-Doherty Earth Observatory, Columbia University

Summary: In much of France and Switzerland, the best wine years are traditionally those with an exceptionally hot summer and late-season drought. Now, a study out this week shows that warming climate has largely removed the drought factor from the centuries-old early-harvest equation. It is only the latest symptom that global warming is affecting bio-logical systems and agriculture.

Share:

Factors of Change

- Temperature
  - Season length
  - Extreme heat/cold
  - Risk of frost
- Precipitation/humidity
- Solar radiation
- Increasing [CO_2]

Historical Climate Change

- **900-1300 AD** Vineyards in England Baltic Sea region
- **12-13th Century** Europe harvested grapes 1 month later than today
- **14th Century** Little Ice Age – vineyards shift to southern Europe

Estimated 3°F change in temperature since 12th and 13th century!

International Predictions

- **Spain, Portugal, S. Africa, Australia**
  - Problem: Increasing heat inland
  - Resolution: Move to coastal regions and higher elevations
- **Europe**
  - Wine production moves north to cool climate regions
  - 85% reduced acreage in Mediterranean

Will land and water be available?

US Predictions

Acreage Reductions

- Major regions - 81% *(White et al. 2006)*
- Premium wine regions - 20% by 2040 *(Diffenbaugh et al. 2011)*

- **How?**
  - Reduced fruit production (quantity and quality)
  - Lack of water availability
  - Shift in phenology, creating more risk

Temperature extremes = More days >95°F

https://vineyards.com/photos/maps/USA%20Wine%20Map.png

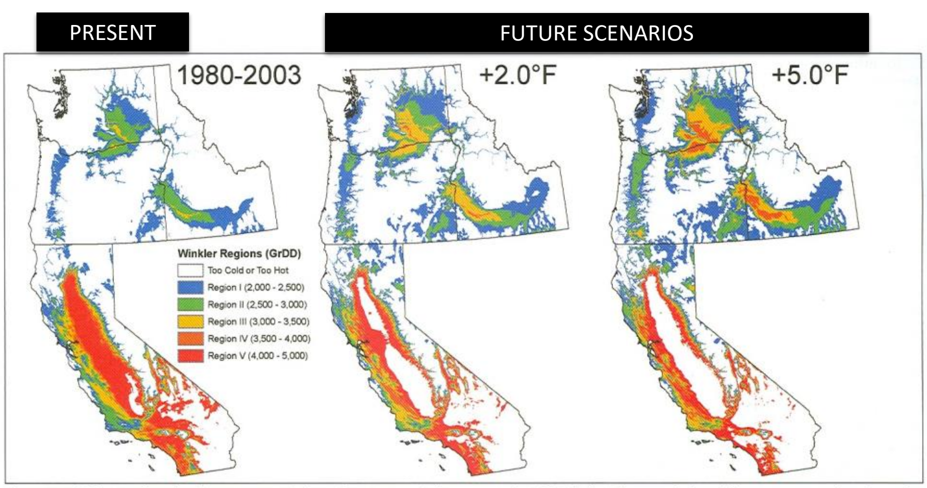
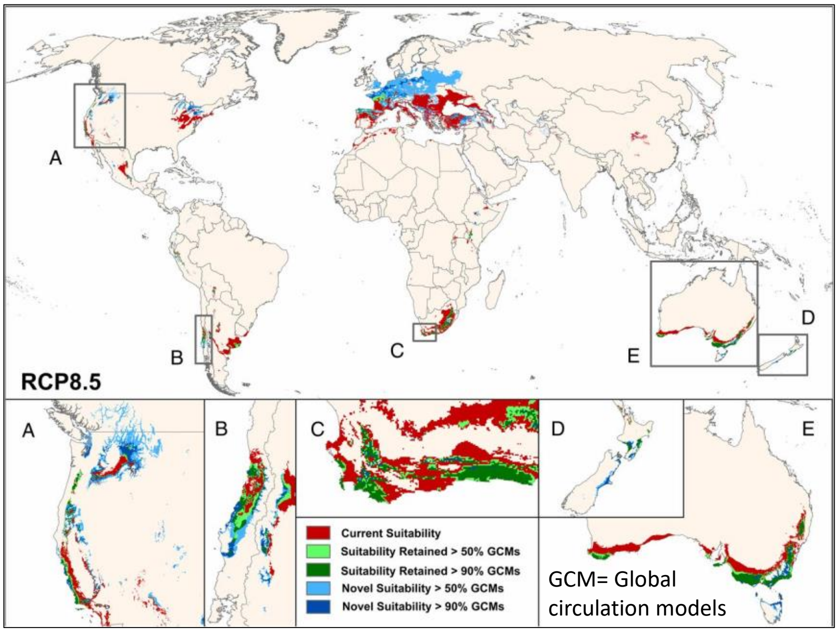


Figure V. Winkler Regions for the western U.S. based on Daymet (Thornton et al., 1997) daily 1 km resolution daily temperature data (growing degree-days, base 50°F over Apr–Oct). The left panel is the average over the 1980–2003 time period. The middle panel is a projection of a +2.0°F increase over 1980–2003 (low range of projected climate change by 2049). The right panel is a projection of a +5.0°F increase over 1980–2003 (high range of projected climate change by 2049).

Jones 2007



Hannah et al. PNAS 2013

A warming climate shifts grape phenology

- **1.8°F increase = ~1 week earlier harvest**
- France 2.7°F in 20th Century and harvest 2 weeks earlier

How changing climate impacts the wine industry…

Vineyard
yield, growth, fruit composition

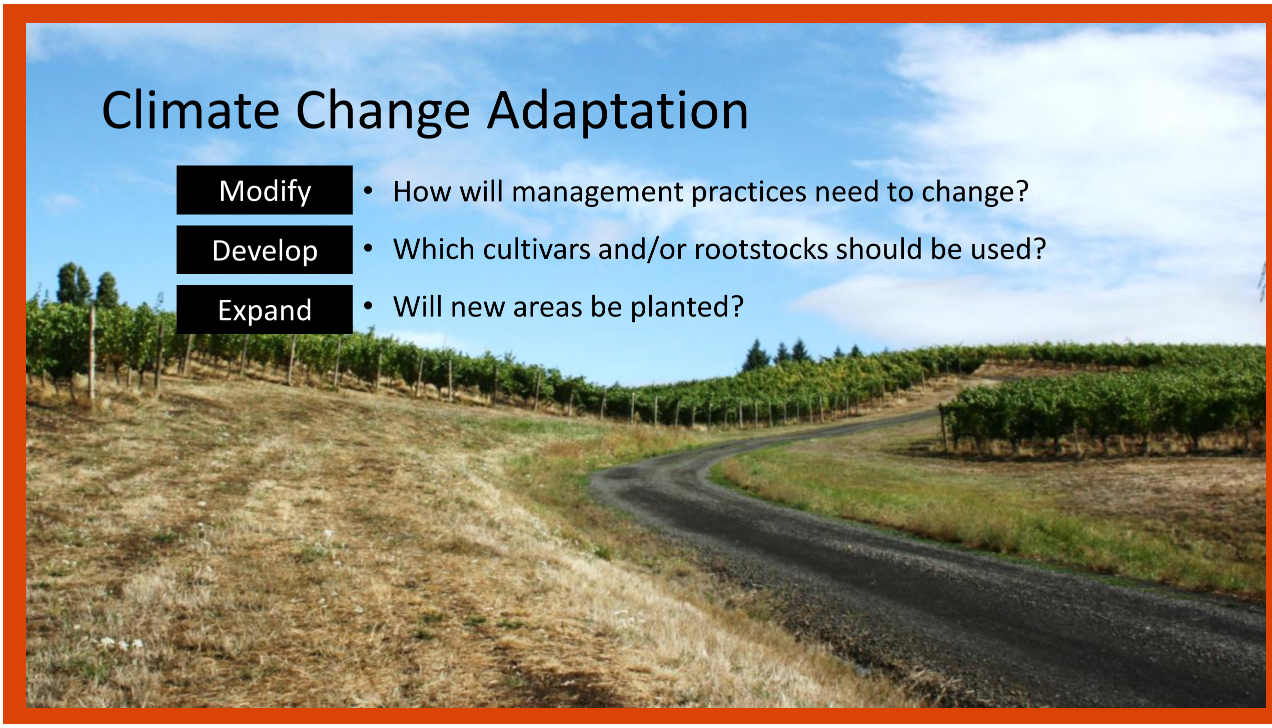
- Drought
- Excessive heat
- Freeze/Frost
- Erratic rainfall

Winery
amendments, processes, style

- Atypical ripeness
- High alcohol
- Erratic fermentation

Sales
Price and market

- New cultivar identity
- New wine styles
- Changing consumer preference


Climate Change Adaptation
Modify
• How will management practices need to change?
Develop
• Which cultivars and/or rootstocks should be used?
Expand
• Will new areas be planted?


Modifying Current Vineyards
Short Term Options
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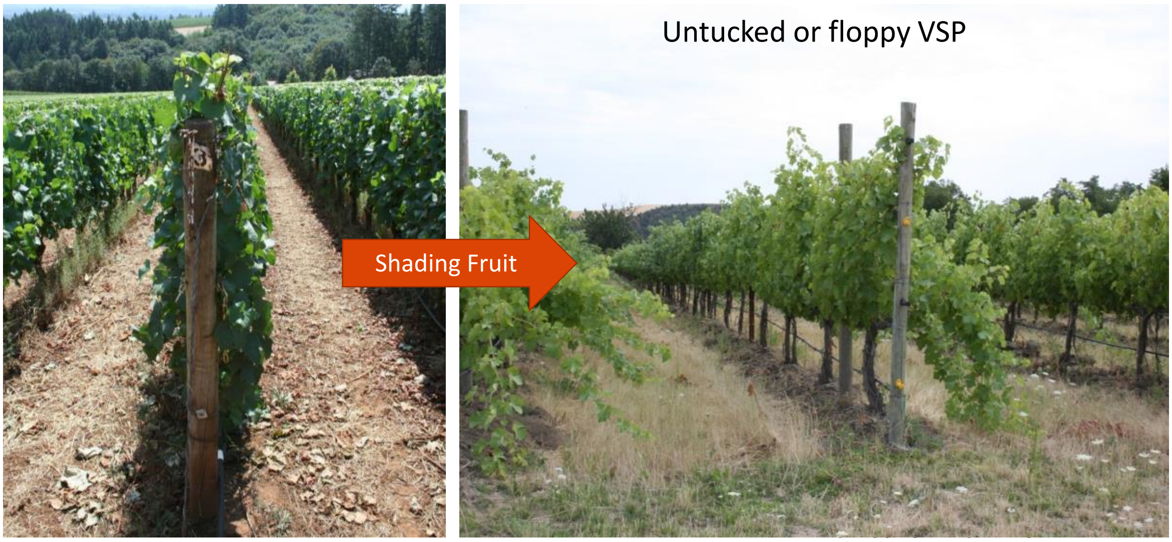
Modifying Training Systems



Modifying Training Systems

Hanging Systems for Shading

- lower density plantings to conserve water
- hanging systems with higher shoot density or double canopy

Temperature modifications

- **Retrain to higher head height/fruit zone**
  - Frost protection
  - Heat reduction from soil surface
- **Vegetation on vineyard floor**
  - Reduced heat near soil
  - Increased humidity
  - Soil moisture to mediate temperature
  - Water penetration (California 2023!)

Antonio Perez Ortiz

Cover crop improves water infiltration

Central Valley California
January 2023

Vine Stressors and Disease Severity

Greater vine water, nutrient, and heat stress lead to more disease expression

- **Viruses**
  - Red Blotch
  - Leafroll
- **Grapevine Trunk Diseases**
  - Botryosphaeria Die back (Bot canker)
  - Esca
  - Eutypa

Modified irrigation, nutrition, floor management will be required

Wine Grape Cultivar Diversity Needed





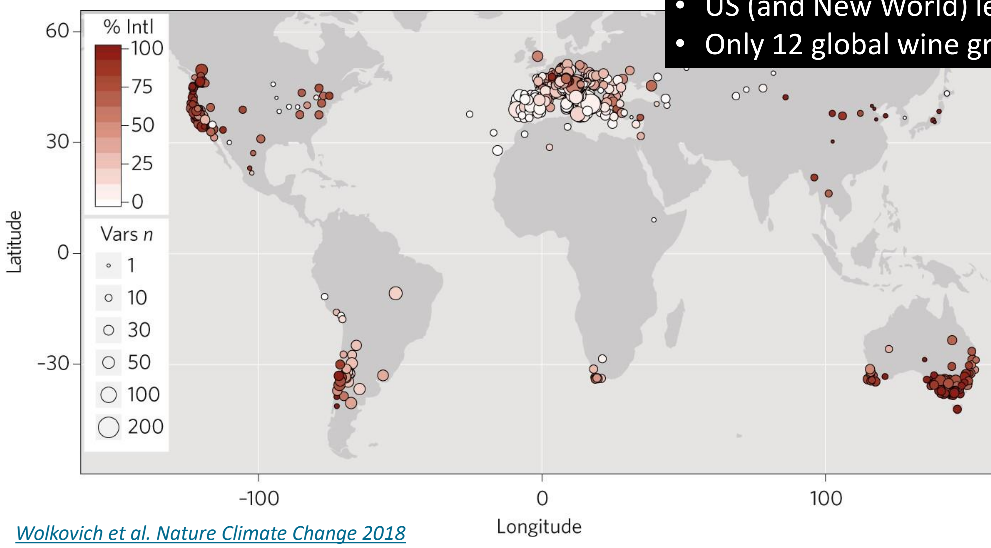
Pinot noir | Pinot gris | Chardonnay | Merlot | Tempranillo

Q. How many different **wine grape** cultivars exist in the world?

Q. How many different cultivars make up the majority of **wine grapes** worldwide?

Grape Cultivar Diversity

- Greatest diversity in Europe
- US (and New World) least diversity
- Only 12 global wine grape cultivars



Wolkovich et al. Nature Climate Change 2018

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Welcome New Cultivars

Explore existing diversity or develop new?

- **Existing:**
  - *Vitis vinifera* wine grapes = 1,100 varieties
  - Evolved from selection pressures over centuries
- **Developing**
  - Takes 20-30 years or more!
  - Unknown suitability to new environments, production

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Rootstocks for the Future

- Rootstocks allow flexibility
  - Poor soils
  - Drought
  - Pest pressures
- Suitability needs further testing
  - Trials in progress throughout US, World
  - CO, CA, OR, WA, TX, MO, etc.

Table 1. Grapevine rootstock ratings.

Rootstock	Riparia Gloire	3309C	101-14 Mgt	Schwarzmann	420A Mgt	5BB	SO4	8B	5C	125AA	161-49C	99R	110R	1103P	140Ru	1616C	44-53 Malègue	Gravesac
Characteristic																		
Adaptability to shallow, dry, clay soil	1	3	2	1	3	2	1	—	3	3	1	2	4	3	3	1	2	2
Adaptability to deep silt or loam	1	1	1	2	1	1	1	—	3	2	1	3	3	3	3	2	3	3
Adaptability to deep, dry, sandy soil	2	2	2	3	2	1	1	—	1	1	2	2	3	3	4	2	2	3
Tolerance of water-logged soil	3	3	3	—	2	2	3	—	—	—	2	1	3	3	2	3	3	3
Tolerance of lime	1	1	1	—	3	3	2	2	2	4	3	2	2	2	2	1	1	3
Tolerance of acid soil	1	1	1	1	2	2	3	—	1	3	—	4	3	2	1	1	3	4
Nitrogen uptake	2	2	3	2	4	4	4	1	2	4	3	3	2	2	3	3	2	2
Vigor conveyed to vine	1	2	3	1	3	3	3	2	3	4	3	3	2	4	3	3	1	2
Drought tolerance	1	3	1	1	2	3	2	3	2	4	2	2	3	4	4	2	2	1
Resistance to ring nematode	2	1	4	2	4	2	2	2	2	—	—	2	3	1	2	—	2	1
Tendency to overbear	4	3	1	4	1	2	1	3	2	2	2	2	1	2	2	2	4	1
Vegetative cycle (time to ripening)	1	2	1	1	2	2	2	3	3	4	2	4	1	4	2	4	2	2

From Grapevine Rootstocks for Oregon Vineyards, OSU Extension

Vegetative cycle:
1=shortest, 4=longest

Nematode data:
1=highly susceptible
2=susceptible
3=moderately resistant
4=resistant

All others:
1=lowest, 4=highest

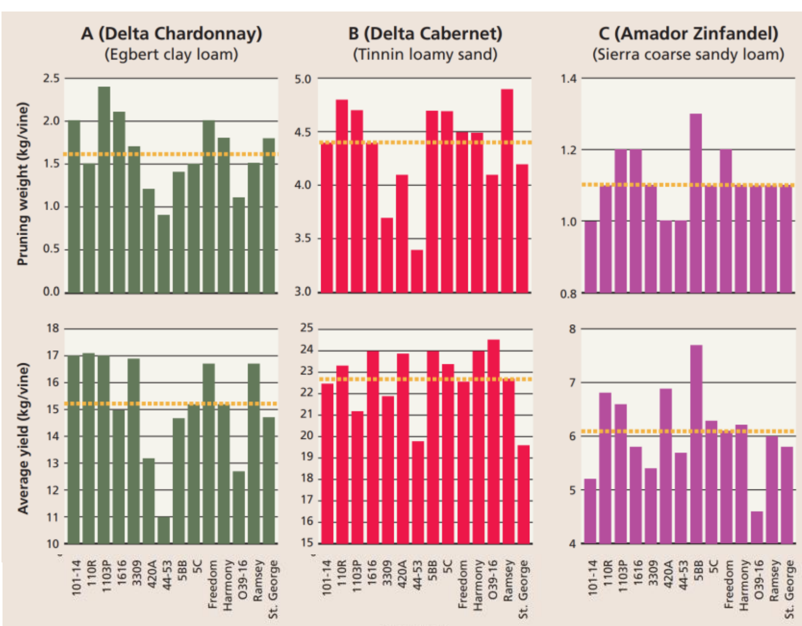
101-14 not ring nematode resistant

TABLE 1. Rootstock characteristics

Rootstock	Parentage	Vigor*	Drought resistance	Lime tolerance†	Salt resistance	Wet feet‡	Soil preference§
				%			
St. George	*V. rupestris*	H	Var	14	M/H	L/M	Deep, uniform, loam
1616C	*V. solonis* × *V. riparia*	L	L	L/M	M/H	H	Deep/fertile
3309C	*V. riparia* × *V. rupestris*	L/M	L/M	11	L/M	L/M	Deep, well-drained
44-53	*V. riparia* × 144M	M	M/H	10	na	H	Loam/good fertility, high Mg
101-14	*V. riparia* × *V. rupestris*	L/M	L/M	9	L/M	M/H	Heavy, moist clay
420A	*V. berlandieri* × *V. riparia*	L	L/M	20	L	L/M	Fine texture, deep/fertile
5BB	*V. berlandieri* × *V. riparia*	M	L/M	20	L/M	Var	Moist clay
5C	*V. berlandieri* × *V. riparia*	L/M	L	20	M	Var	Moist clay
1103P	*V. berlandieri* × *V. rupestris*	H	H	17	M	H	Adapted to drought, saline soils
110R	*V. berlandieri* × *V. rupestris*	M/H	H	17	M	Var	Hillside soils, acid soils, moderate fertility
Freedom	1613 C × *V. champinii*	H	M/H	M	L/M	L	Sandy to sandy loams
Harmony	1613 C × *V. champinii*	M/H	Var	M	L/M	L	Sandy loams, loamy sands
Ramsey	*V. champinii*	VH	H	M	H	L/M	Light sand, infertile soils
O39-16	*V. vinifera* × *V. rotundifolia*	H	L	L	L	na	Poor on coarse, sandy soils

* L = low; M = medium; H = high; VH = very high; Var = variable; na = not available.
† Tolerance to lime-induced chlorosis (percent by weight of finely divided calcium carbonate in soil that can be tolerated by the rootstock).
‡ Wet feet = tolerance to excessive moisture caused by poor soil drainage.
§ Actual performance characteristics of these rootstocks on specific soils and scions may vary.
Source: Christensen (2003) and Pongracz (1983).

Christensen et al. 2003



14 rootstocks
3 cultivars
3 soils (vineyards)

Vine Size

3-year averages
Dotted line = average across all rootstocks

Yield

Lambert et al. 2008, California Agriculture

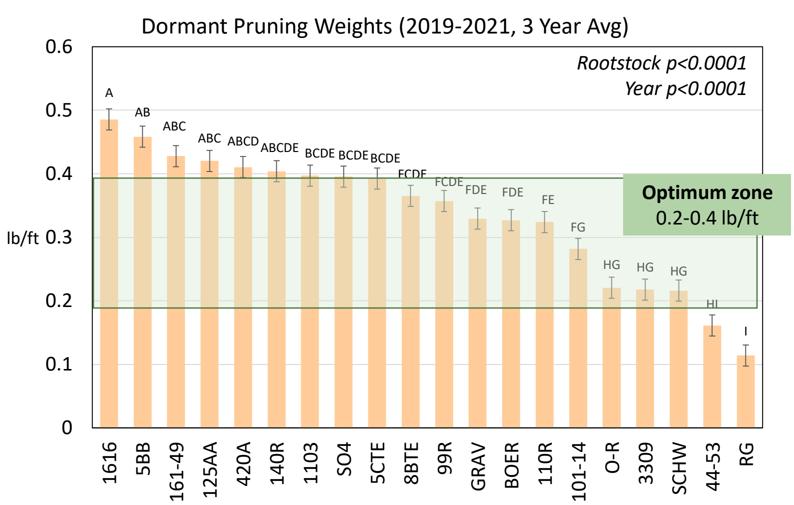
OSU Rootstock Research

101-14
1103P
110R
125AA
140R
161-49
1616
3309C
420A
44-53
5BB
5CTE
8BTE
99R
BOER
GRAV
own-rooted
Riparia Gloire
Schwarzmann
SO4

Most drought-tolerant
- 125 AA
- 1103 P
- 140 Ru
- 110 R
- 5 BB
- 8 B

Least drought-tolerant
- Riparia Gloire
- 101-14
- Schwarzmann
- Gravesac

Impacts on Vine Growth – *Pruning Weight (OR)*

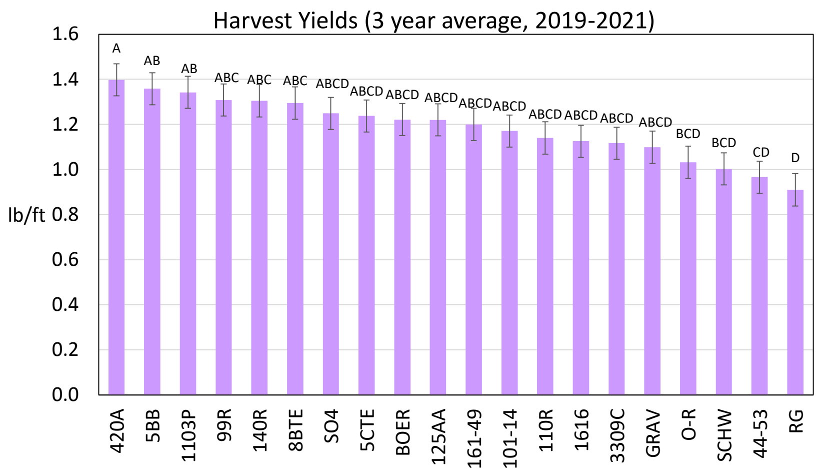


Above optimum PW (High Vigor)
1616
5 BB
161-49
125AA

Below optimum PW (Weak Vines)
44-53
Riparia Gloire

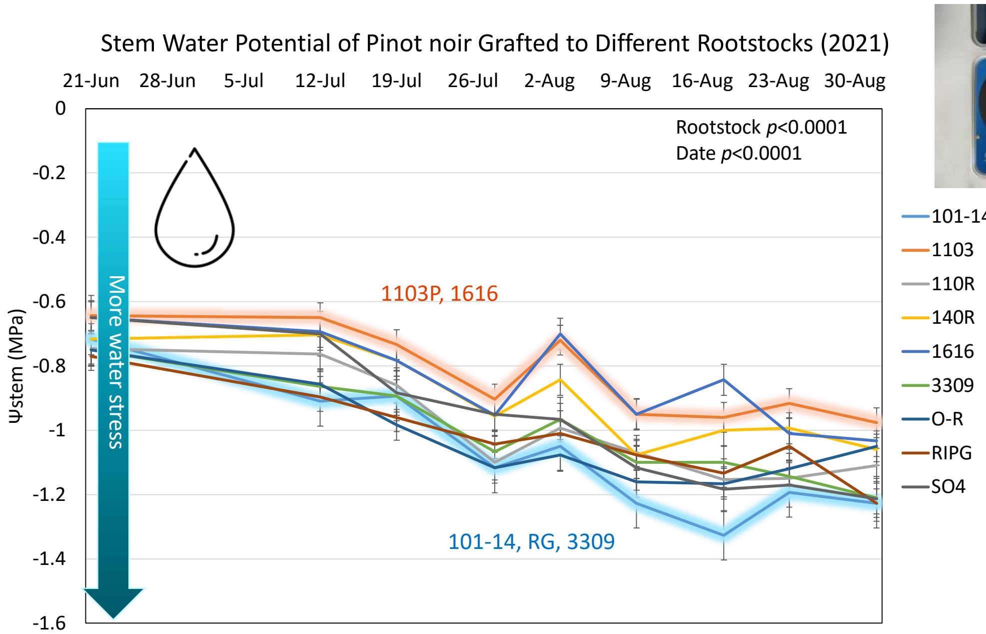
Means (±SE),

Results – *Harvest Yields*



Means (±SE)

Rootstock p<0.0001
Year p<0.0001



Vineyard Design

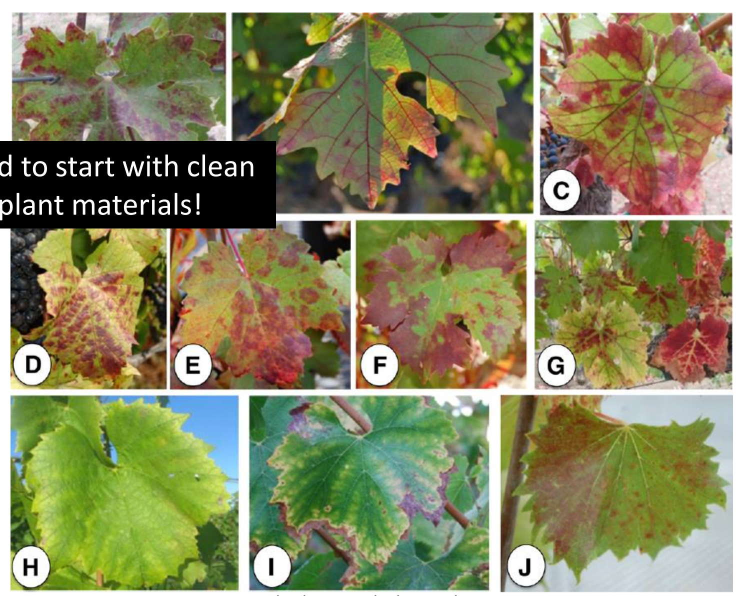
- Row Orientation
- Row and vine spacing
- Training system
- Head height
- Irrigation methods
- Permaculture techniques

Grapevine Viruses

More than 80 viruses of grapevines!

- Red Blotch
- Leaf Roll
- Fan Leaf
  Pinot gris Virus
- Grapevine virus A
- Grapevine virus B
- Rupestris stem pitting
- Tomato Ring Spot Virus
- Many more…

Need to start with clean plant materials!



Source: Sudarshana et al. Phytopath. 2015

Plant Materials - *Certified or not?*

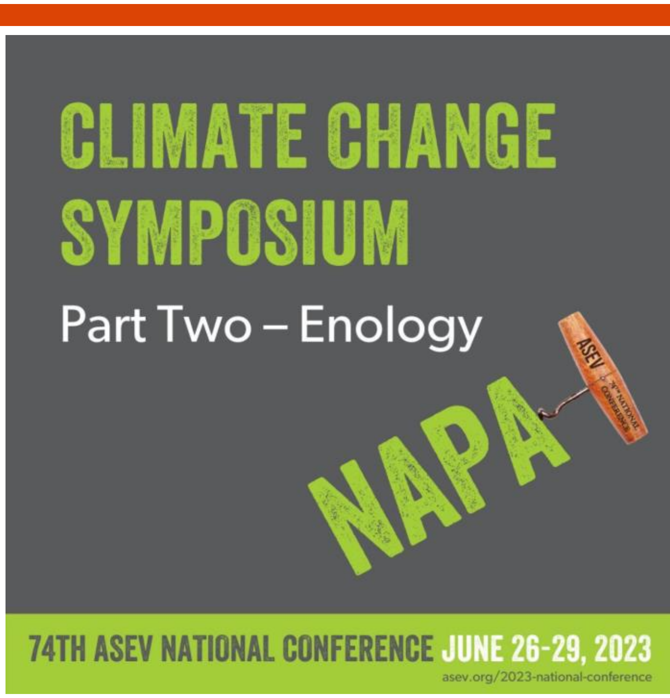
- **Certified plant materials**
  - Propagated from mother vines that are part of a state certification program.
  - Certification program has protocols to evaluate and test vines for **viruses and other diseases of importance.**
  - Tested only for <u>known</u> viruses <u>listed</u> in state certification program.
  - Not all are free of crown gall.
- **Non-certified materials**
  - Not guaranteed to be free of viruses or diseases of concern.
  - Not propagated from vines under strict evaluation of a certification program.
  - Buy at your own risk.
  - **Often "new" cultivars or those that lack wide commercial significance are not certified.**

Learn more at:

[National Clean Plant Network for Grapes]

Summary

- **Develop for changes**
  - Increased temperatures
  - Drought
  - Erratic rainfall/storms
  - Frost/freeze
  - Shifting grapevine phenology
- **Methods to adopt**
  - New varieties
  - Rootstocks
  - Training Systems
  - Vineyard design



Interested in learning more?

www.asev.org

ASEV membership:
Access to recorded sessions from Viticulture Climate Change Session in 2022!


Oregon State University
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