Goal: ensure fruit quality and quantity desired for production goals

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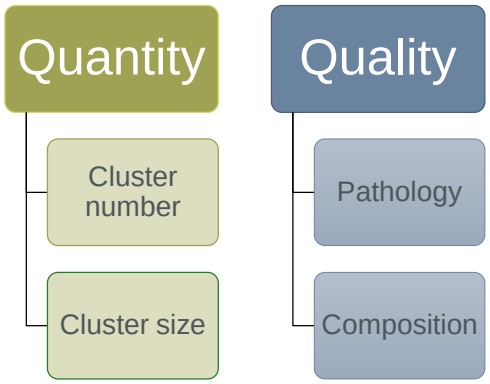
How to manage fruit during the season



Physical Properties

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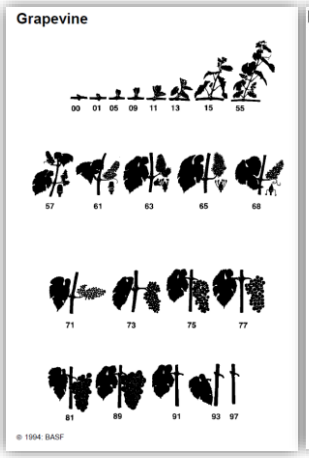
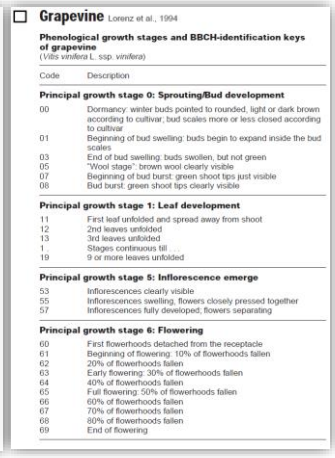
Reading the Vines: Phenology

Operations must adhere to vine growth stages

- Timing and sequence
- Spray programs
- Canopy management
- Fertilization
- Irrigation





Grapevine Lorenz et al., 1994

Phenological growth stages and BBCH-identification keys of grapevine
(*Vitis vinifera* L. ssp. *vinifera*)

Code	Description
Principal growth stage 0: Sprouting/Bud development	
00	Dormancy: winter buds pointed to rounded, light or dark brown according to cultivar; bud scales more or less closed according to cultivar
01	Beginning of bud swelling: buds begin to expand inside the bud scales
03	End of bud swelling: buds swollen, but not green
05	"Wool stage": brown wool clearly visible
07	Beginning of bud burst: green shoot tips just visible
08	Bud burst: green shoot tips clearly visible
Principal growth stage 1: Leaf development	
11	First leaf unfolded and spread away from shoot
12	2nd leaves unfolded
13	3rd leaves unfolded
1.	Stages continuous till ...
19	9 or more leaves unfolded
Principal growth stage 5: Inflorescence emerge	
53	Inflorescences clearly visible
55	Inflorescences swelling, flowers closely pressed together
57	Inflorescences fully developed; flowers separating
Principal growth stage 6: Flowering	
60	First flowerhoods detached from the receptacle
61	Beginning of flowering: 10% of flowerhoods fallen
62	20% of flowerhoods fallen
63	Early flowering: 30% of flowerhoods fallen
64	40% of flowerhoods fallen
65	Full flowering: 50% of flowerhoods fallen
66	60% of flowerhoods fallen
67	70% of flowerhoods fallen
68	80% of flowerhoods fallen
69	End of flowering

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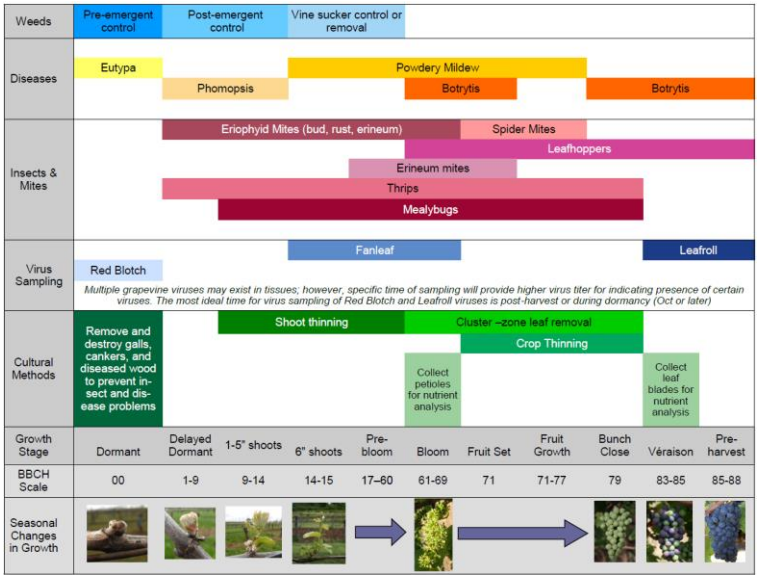
The growing season at a glance



From Skinkis et al. 2021 Pest Management Guide for Wine Grapes in Oregon

Challenge:
Vines are perennials; management is critical from one year to the next

Core Concept: Vine Balance

- What is vine balance?
- How is the concept used?
- How is it measured?
- How is it managed?

Defining Vine Balance = Crop Load

Vine crop load is like vehicle payload

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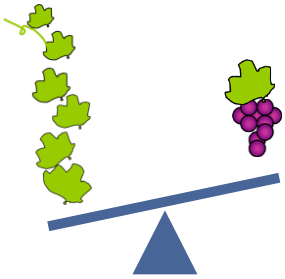
Defining Vine Balance = Crop Load

Vegetative (Canopy) **Reproductive** (Fruit)



Yield ≠ Crop Load

Metric	Optimum
Pruning weight	20 to 40 g canes
Leaf Area : Yield	0.8 to 1.2 m^2/kg
Crop Load Index	5 to 10
Crop Load Index (OR)	3 to 6

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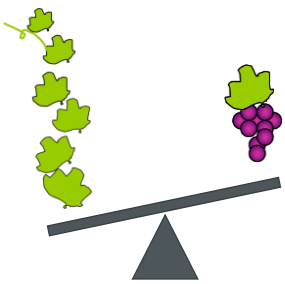
What influences vine balance?

- Vine Spacing
- Training system
- Pruning
- Soil
- Nutrition (fertilizers, soil)
- Water (irrigation, precipitation)
- Pests (weeds, disease, insects)
- Other damage (e.g. cold, herbicides)

Vegetative (Canopy) **Reproductive** (Fruit)



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Optimum metrics for vigor

• Leaf Layer	1 - 1.5 layers
• Internode length	2.4 – 3.1”
• Cane weight (dormant)	20 - 40 g 40 – 60 g Oregon
• Shoot length	14 – 18 nodes
• lateral development	low
• Crop Load Index (yield/pw)	3-10
• Pruning weight (dormant)	0.2 – 0.4 lb/ft
• Shoot density	3-6 shoots/ft

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Measuring Vine Balance: I. Pruning Weights

High Vigor Vines

Low Vigor Vines

Weigh 1 year old wood from reference vines and record

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Measuring Vine Balance: II. Vine Yield

Harvest reference vines individually or in panels and weigh

Record and compare with individual pruning weights and other data

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How to use pruning weight and yield data…

Crop Load: Yield/Pruning Weight	
Vigor Level	Ratio[1]
Low vine vigor or too much fruit	>10
Moderate vigor/fruit level	3-6
High vigor or too little fruit	<3

[1]Kliewer & Casteel 2003

Dormant Cane Weights (g)		
Vigor Level	Arid Region[1]	W. Oregon[2]
Low vigor	<10	<20
Moderate vigor	20-40	40-60
High Vigor	>60	>70

[1]Kliewer & Casteel 2003, [2]Skinkis (unpublished)

Pruning Weights[1]

RULE: **0.2 - 0.4 lb/ft** of canopy is considered optimum. Measure vine pruning weight and divide by length of canopy (vine spacing).

Lower values (<0.2 lb/ft) indicate a **weak or sparse canopy**

Higher values (>0.4 lb/ft) indicate an **overly vigorous vine**

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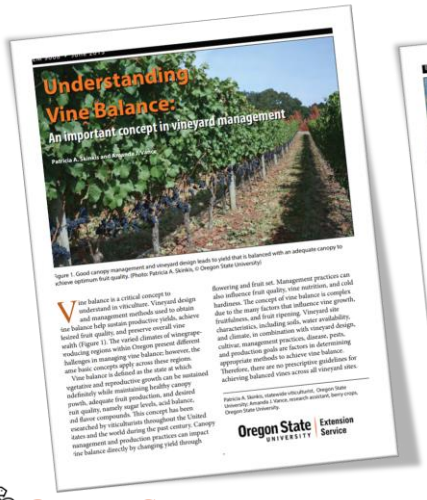
Handouts for session: Understanding Vine Balance, Role of Canopy Management in Vine Balance, and How to Measure Dormant Pruning Weights - from OSU Extension, extension.oregonstate.edu



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Using pruning weight data to achieve balance

- Unbalanced vines are not sustainable
  - Increased canopy management costs
  - Decreased yield and fruit quality
- Pruning decisions based on pruning weights

High vigor = leave **more** buds/vine

Low vigor = leave **less** buds/vine

Long-term → adjust vine and row spacing or training system

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Vine Balance: Matching training system to vine capacity

Vineyard Design Decisions

Vine Density → Training System

Annual canopy management steps

- Dormant pruning
- Shoot thinning
- Shoot positioning
- Hedging
- Leaf removal

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High Density VSP in the Willamette Valley

Very low crop load (high PW, low yield)

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First steps…

Cool climates with ample rainfall

Vine Spacing + Training System → Canopy Management

corrective measures

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Vine Canopy Management – *Arid climates*

Less canopy management needed

Vine Spacing + Training System → Water and nutrient management

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Can we fix overly vigorous vines?

Short Term: Canopy Management
- Shoot thinning/suckering
- Hedging
- Leaf removal

Long Term: Multiple approaches
- Fertility
- Moisture
- Vineyard floor practices
- Training system

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Pinot noir (VSP)
Willamette Valley

Moderate vigor due to years of competitive grass alleys, dry-farmed

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Shoot thinning – a necessity

- **When:** Shoots < 6”
- **Why:** decrease density to 3-6 shoots/ft
- Benefits of shoot ↓ density
  - Increase air flow
  - Increased sunlight exposure
    - Improved bud development (fruitfulness)
    - Increased bud hardiness
    - Sun and air flow = disease management
- Influences yield

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Hedging – a necessity in vigorous vines, high density

Hedging of VSP systems = top and sides

Hedge height must not exceed row width to avoid adjacent row shading

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Myth: Hedging causes lateral growth

Laterals will grow without hedging in high vigor vines.

Symptom of high vine vegetative vigor

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Leaf Removal BMPs

- **What:** leaves in fruit zone
  - Morning-sun side of canopy (E of N-S rows)
  - May remove 50-100% of cluster zone leaves
  - Best in high vigor, high density canopies
- **When:**
  - Bloom to fruit set (optimum)
  - Pea-size to bunch close (latest)
  - Do not start at véraison or later

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Oregon Leaf Removal Research Results (Pinot noir)

- **Timing:** the earlier, the better
- 100% leaf removal early = higher anthocyanin and wine color intensity, no sunburn
- Increased aroma compounds with more leaf removal
- Minimal impact on fruit set/yields
- Important tool for disease prevention

Fruit at harvest from 100% cluster zone leaf removal at bloom, 2018

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Yield Management

Crop Estimation and Cluster Thinning

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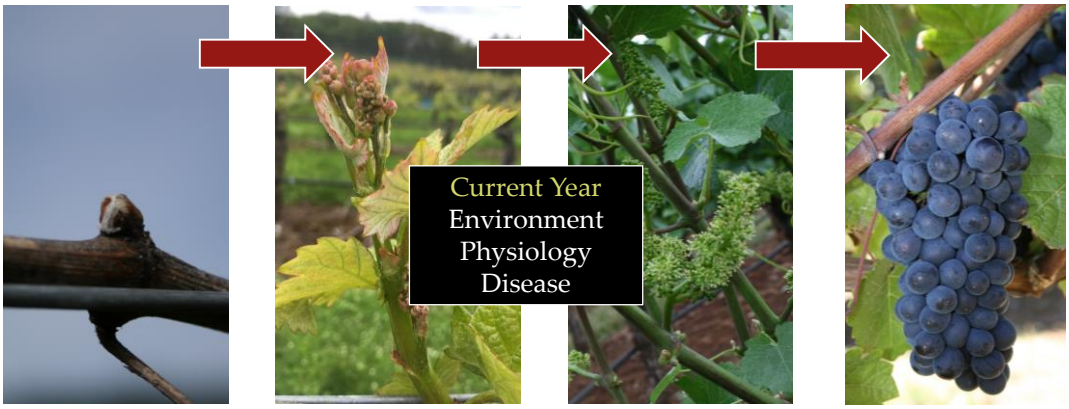
Factors Influencing Yield



Yield formation is a two season cycle

Crop Estimation & Cluster Thinning

- **Crop Estimation:** *Estimate* yield pre-harvest
  - **Purpose:** Adjust crop level for harvest, prepare for wine production

- **Cluster Thinning:** Adjusting crop level to achieve target yields

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Lag Phase Yield Estimation

Yield/Block =
(# bearing vines) (# clusters/vine) (lag cluster wt.) (increase factor)

LAG

HARVEST

Increase Factor

Harvest cluster wt ÷ Lag cluster wt

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Lag Phase Yield Estimation Method

Oregon Pinot noir (Price)

- Mid-lag at 55 days post bloom
  - Correlated to 75% hard seed tips
  - Timing of bloom not specified
- Increase Factor = 1.8 to 2.0
- **Sampling**
  - 4% of vineyard (variable blocks as much as 30%)
  - 200-400 clusters


Predicting Yield in Oregon Vineyards

Steve Price
Dept. of Horticulture
Oregon State University

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Crop Estimation Pitfalls

Timing

- Difficulty determining lag timing
- Unknown duration of lag period
- Using optimum increase factor

Sampling

- Insufficient sample size
- Lack of random sampling
- Accounting for non-bearing/weak vines
- Representative cluster size

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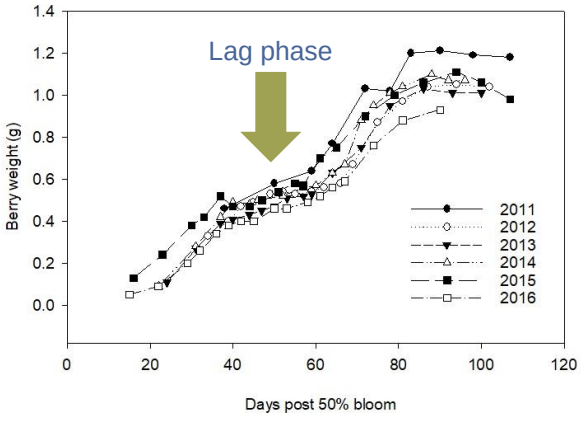
Pinot noir Berry Development Curve



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Skinkis & McLaughlin in progress

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Timing of Lag Phase

- Start: 49 days post-50% bloom
- Middle: 55 days post-50% bloom
- Finish: 61 days post-50% bloom*
- Duration: 12 days (6-24 day range)
- GDD_{50} at mid-lag: 1000 (after 50% bloom)

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Skinkis & McLaughlin in progress

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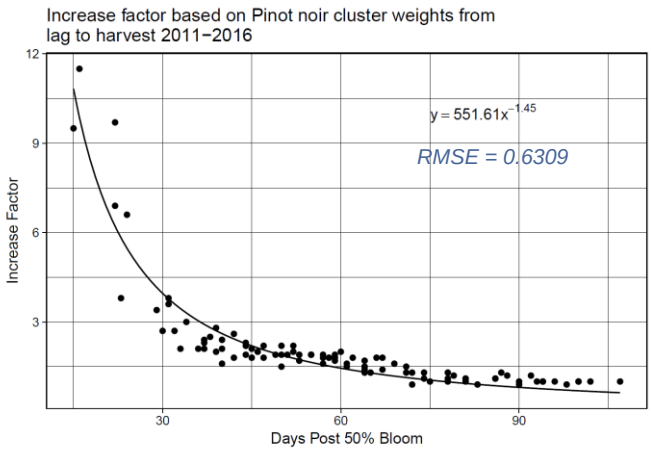
Increase Factors – *Days post-bloom*



Determine increase factors based on
- Day count
- Thermal time

From
- Bud break
- Bloom

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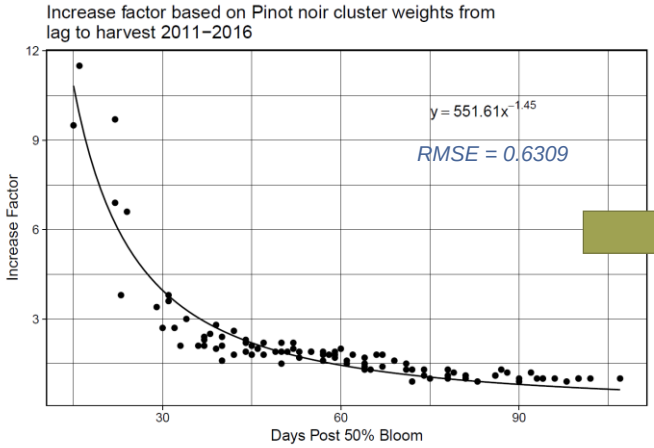
Increase Factors – *Days post-bloom*



# of days post 50% bloom	increase factor
15	10.9
20	7.2
25	5.2
30	4.0
35	3.2
40	2.6
45	2.2
50	1.9
55	1.7
60	1.5
65	1.3
70	1.2
75	1.1
80	1.0

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Skinkis & McLaughlin in progress

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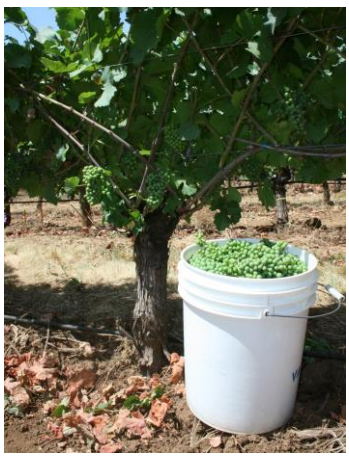
How to reach the most accurate estimate?

- Follow good sampling procedures
- Maintain records of both lag and harvest cluster weights
- Develop vineyard specific increase factors
- Recognize: greatest variability in cluster size
  - Tricky estimates in poor set years (hens & chicks)
  - Cluster weight change can be highly variable from lag to harvest
- Crop estimates are ESTIMATES not actuals



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Is yield or vine balance more important for fruit and wine quality?

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Yield & Quality: Central focus for Oregon Pinot Noir

- Reasons for cluster thinning
  - Hasten ripening
  - Increase fruit quality
  - Decrease *Botrytis*
  - Sustain vine health/balance
  - Winery capacity
- Yield reduction: 25 to 50%
- Cost: $700-800/A

Reasons	% of Responses
Achieve Quality	73
Vine balance	11

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Uzes & Skinkis, J. of Extension 2016

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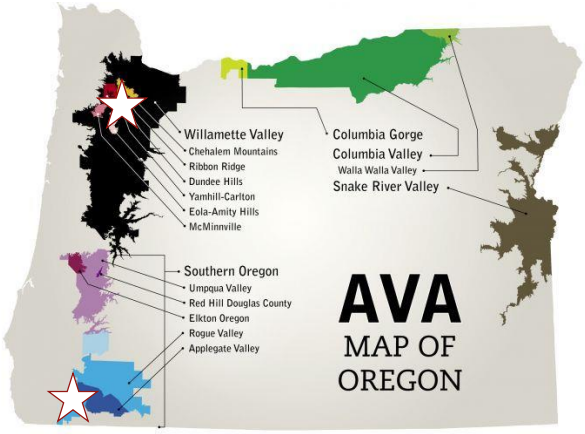
Phase I Crop Load Trials 2010-2013



Timing	Intensity of crop thinning
Pre-bloom	Moderate (1 cluster/shoot)
Fruit set	Severe (0.5 cluster/shoot)
Lag phase	Full crop (2 clusters/shoot)
Véraison	+ wing - wing

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Impacts on Vine Growth

Increasing Yields

Concerns	Benefits
Over-cropping stress	Hold back vigor (later thinning)
Severely delayed ripening	More yield (economic)
Poor fruit quality	Few differences in fruit quality

Increasing yield did not change…

- Spring shoot growth
- Canopy leaf area
- Pruning weight
- Vine nutrient status

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Decreasing yield by 40% ↑ Brix, no further increase with more severe thinning, not required to reach ~2.5 T/A

Importance of canopy/vine size or the fruit weight on fruit composition?

Summary: 3 Years x 2 vineyards

	Vine Size	Fruit wt.
Response	Pruning Weight	Yield
TSS (Brix)	X	X
pH		
TA	X	
Total anthocyanins	X	X
Total phenolics	X	
Total tannins		
YAN (fermentable N)	X	
Alpha amino acids	X	
Ammonia	X	

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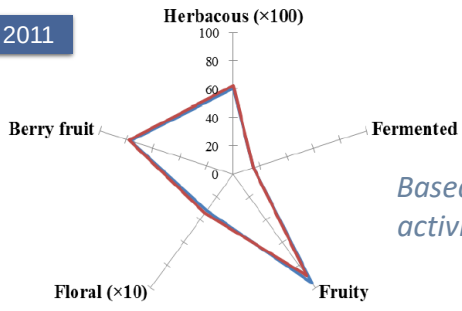
Yield had little impact on wine aroma compounds

2011

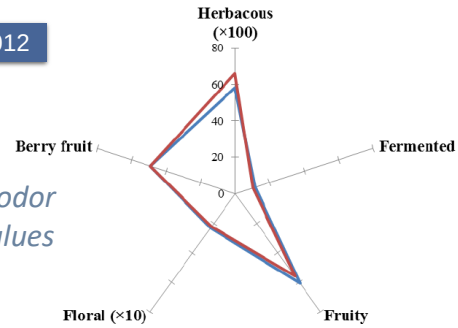


Control 7.3 T/A

Thinned 2.66-4.33 T/A

Based on odor activity values

2012



Control 3.99 T/A

Thinned 1.22-2.13 T/A

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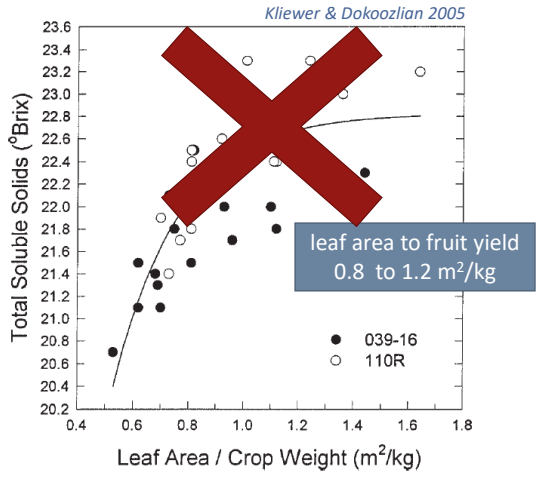
Phase I Crop Load Studies: Summary

- Yield = secondary quality impact
  - Year and vine vigor most important
  - Timing of crop thinning did not impact quality
- Vines are not over-cropped



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AMERICAN VINEYARD FOUNDATION

Statewide Crop Load Project

Nine years of progress…

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Industry Participation (2012-2020)

Participation
25 companies
5 counties
6 AVAs

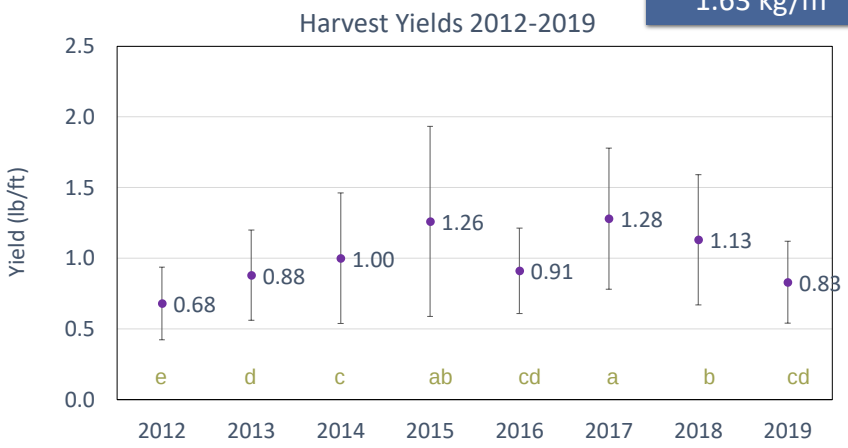
Annually:
10-15 vineyards

3+ years (n=14)
9 years (n=5)

A to Z Wineworks | Adelsheim | Airlie Winery | Archery Summit | Alas Vineyard Management
Bethel Heights | Björnson Vineyard | Chehalem Wines | Cristom | Dion Vineyard | Domaine Drouhin
Domaine Serene | Duck Pond | Forest Hills Farms | Jackson Family Wines | Johan Vineyards
Ken Wright Cellars | Lemelson Vineyards | Results Partners | Stoller | Van Duzer Vineyards
Willakenzie Estate | Winemakers Investment Properties/Precept Wine | Winter's Hill Winery

Harvest Yields by Year

8-year mean:
1.0 lb/ft
1.63 kg/m



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Mean ± SD, all vineyards and treatments

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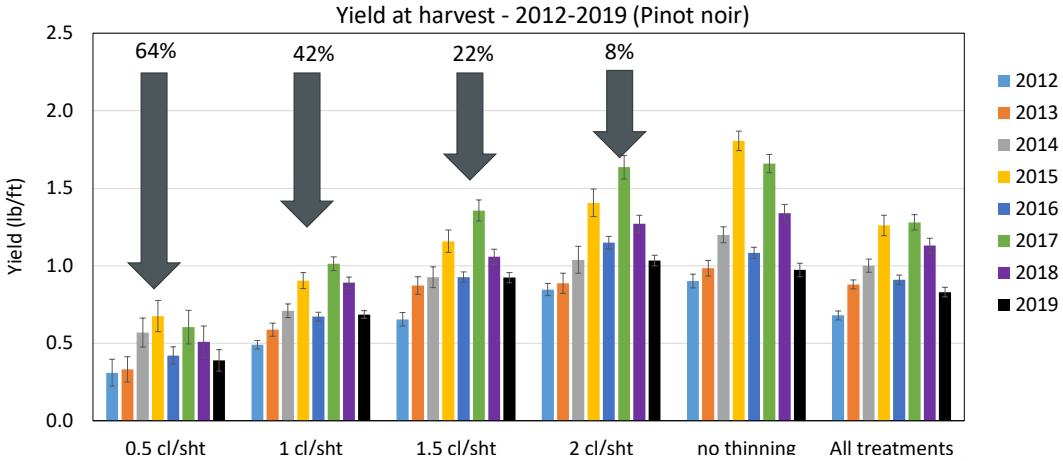
Harvest Yield – *Treatment x Year*



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Cluster thinning on per-shoot basis

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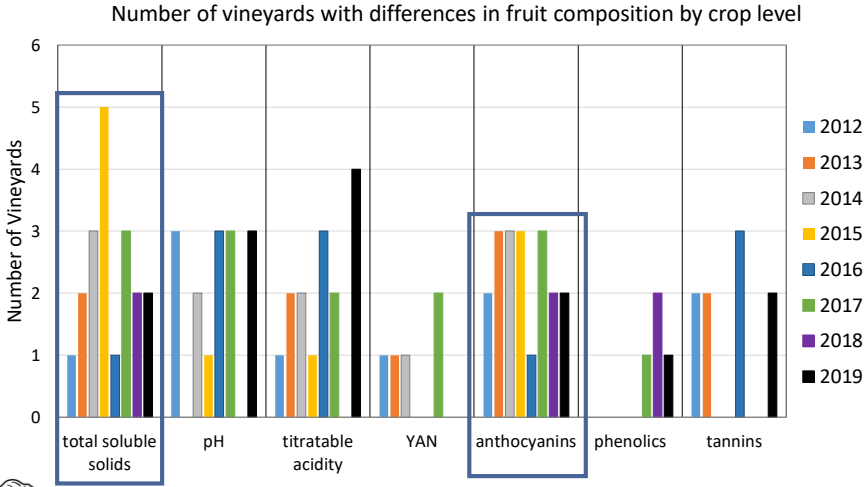
Results: Fruit Compositions All Years



10-14 vineyards/year
55-85% had at least 1 thing different
15-45% no fruit differences
No consistent differences by crop level

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Fruit Composition – *All Sites & Years (2012-2016)*

With increasing yield or pruning wt.

Yield	Pruning Weight
pH (↓)	TA (↑)
TA (↑)	Tannin (↓)
Anthocaynin (↓)	YAN (↑)
Tannin (↓)	

But, no big changes!

Comparing Yield and Brix (2012-2016)

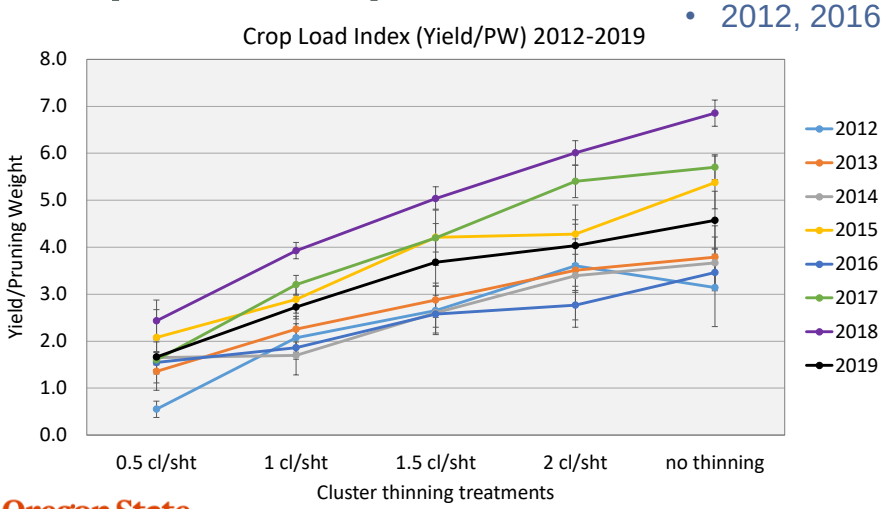
Analysis all sites, all years:
For each 1 lb/ft ↓ = ↑ 0.6 °Brix

Convert to acres based on example vineyard spacing

For each **2.7 ton/acre ↓** (vineyard with 8' rows), there is a **↑ 0.6 °Brix**

Crop Load Impact

- 2018 - highest crop load
- 2012, 2016 - lowest crop load



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Cluster thinning on per-shoot basis

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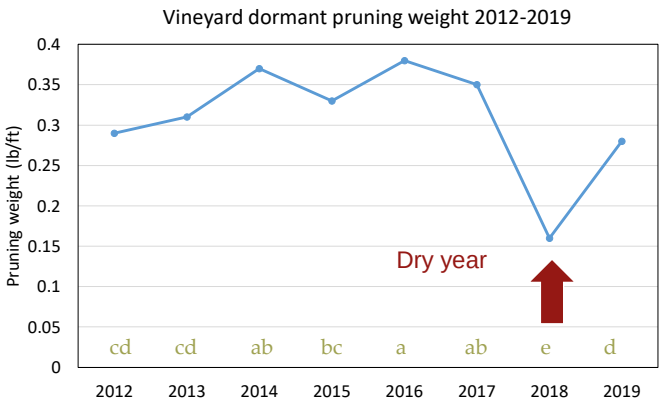
Seasonal impacts – *pruning weight*



Lower dormant pruning weight in all sites 2018, rebound in 2019

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Crop Level Effect - *Wine Sensory*

- **Expert panel** – 2012-2016
  - No differences by crop level
  - No preferred crop level
  - Differences by site and vintage
- **In-house sensory**
  - Blind tasting: no clear preferences
  - Revealed: identified preference

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Crop Load Research Summary

- Site and year have greater impact on fruit and wine quality than crop thinning
- Most often Brix and anthocyanin affected, but not improved with most severe thinning treatments (did not have to get to 2 T/A)
- Crop level had no effect on wine sensory perception
- No clear link between yields and preference
- Vine balance has greater impact than yield (tons/acre)

Standard target yields will NOT ensure quality across all vineyards in a region!

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Take Home Message

- Managing quality and quantity in the vineyard is not straight-forward
- Achieving vine balance will ensure optimum quality, quantity, and economics
- Pathway to optimum vine balance varies by vineyard (soils, climate, etc).
- Need in-depth knowledge of…
  - Vineyard conditions (soil, elevation, etc)
  - Climate
  - Plant materials
  - Vineyard design
  - Management steps

Feeling Overwhelmed?
Work together and build trust with your vineyard management team!

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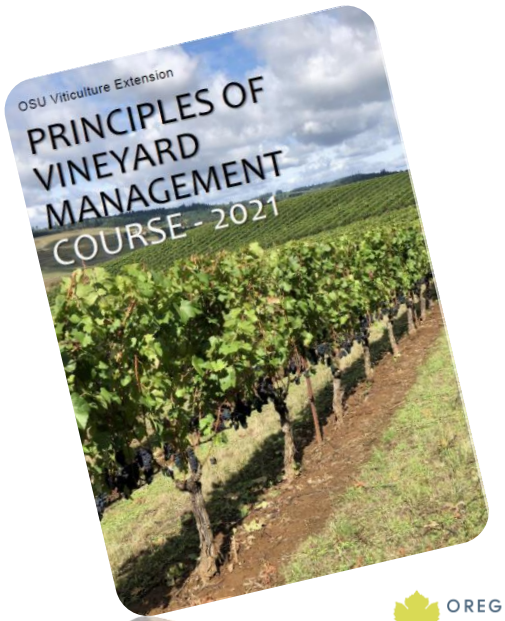
Want to learn more?

- Topics: establishment through management
- Completely online
- 10 weeks of content
- Live or recorded lectures available
- Begins March 30, 2021



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THANK YOU!

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