# Factors that impact the ripening process and berry composition in wine grapes in NC

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- **How to take a grape sample?**
- **Environmental factors and effects on ripening**
- **Cultural manipulation and effects on repining in North Carolina.**
- **Impact of diseases and potential effects on ripening**

**Or in other words: When is it time to harvest?**

# Ripeness is complex

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**Definitions:**

Physiological maturity: When seeds are able to germinate (usually immediately after veraison)

Ripening: The process between veraison and harvest

Technical maturity ('Grape Maturity'): Set of parameters set by the grower/winemaker

# Ripeness is complex

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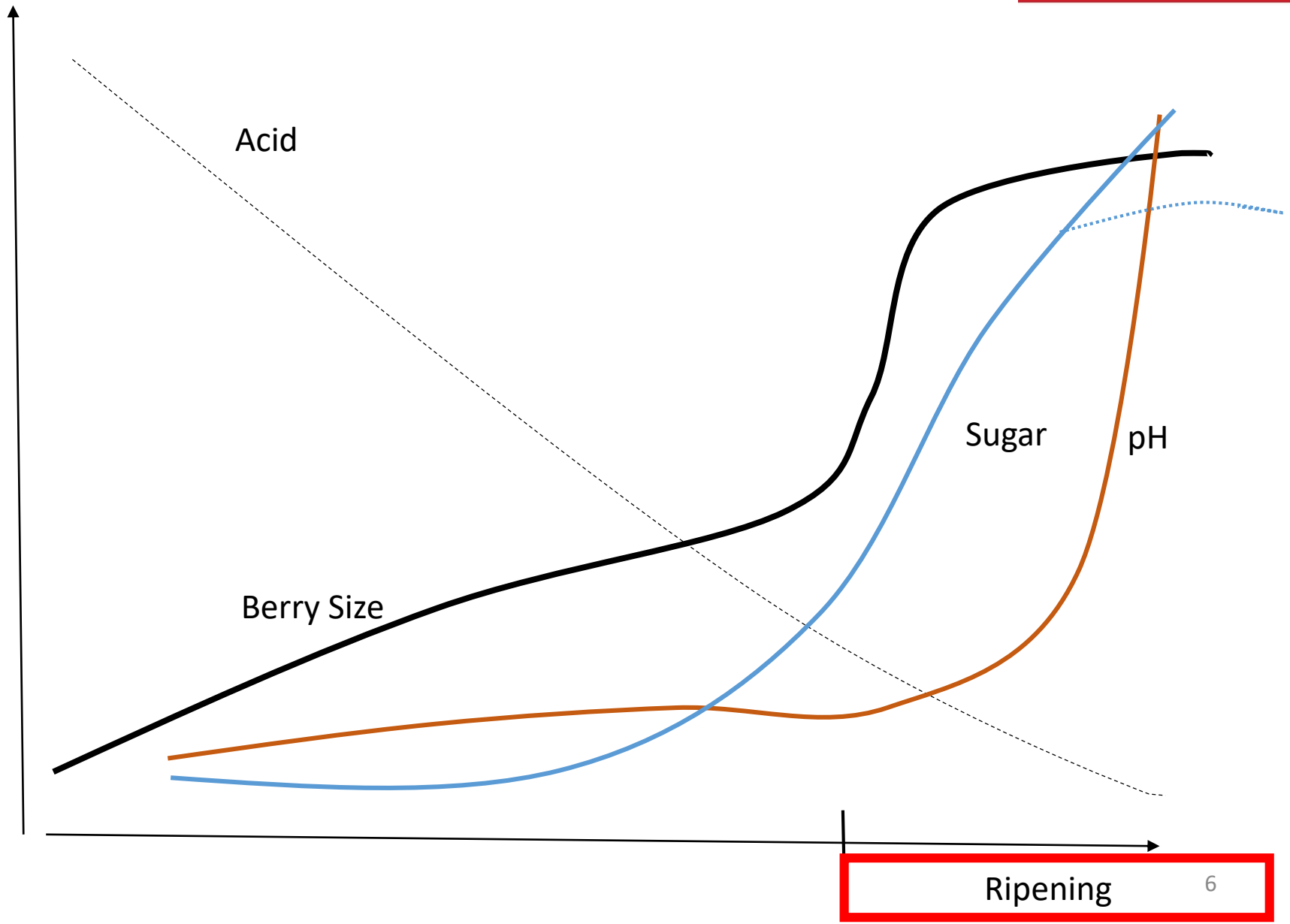
**Sources:**

**Edward (Ed) Hellman (Texas A&T), 2004: How to judge grape ripeness before harvest.**
http://agrilife.org/winegrapes/files/2015/11/ripening.pdf

**Imed Demi (Ohio State), 2014: Determining Grape Maturity and Fruit Sampling**
https://ohioline.osu.edu/factsheet/HYG-1436

# Ripeness is complex



# Ripeness is complex

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No set of numbers alone will be able to tell you when your grapes have reached maturity.

Ripeness is a function of the intended use of the grape (sparkling vs. still wine?) and a man-made definition, which means: variable!

“Varietal character”. Sensory assessment is important!

Sugar, acid, pH, tannins, phenolics, color compounds etc:
**are an AID to decide on maturity**

# Ripeness is complex

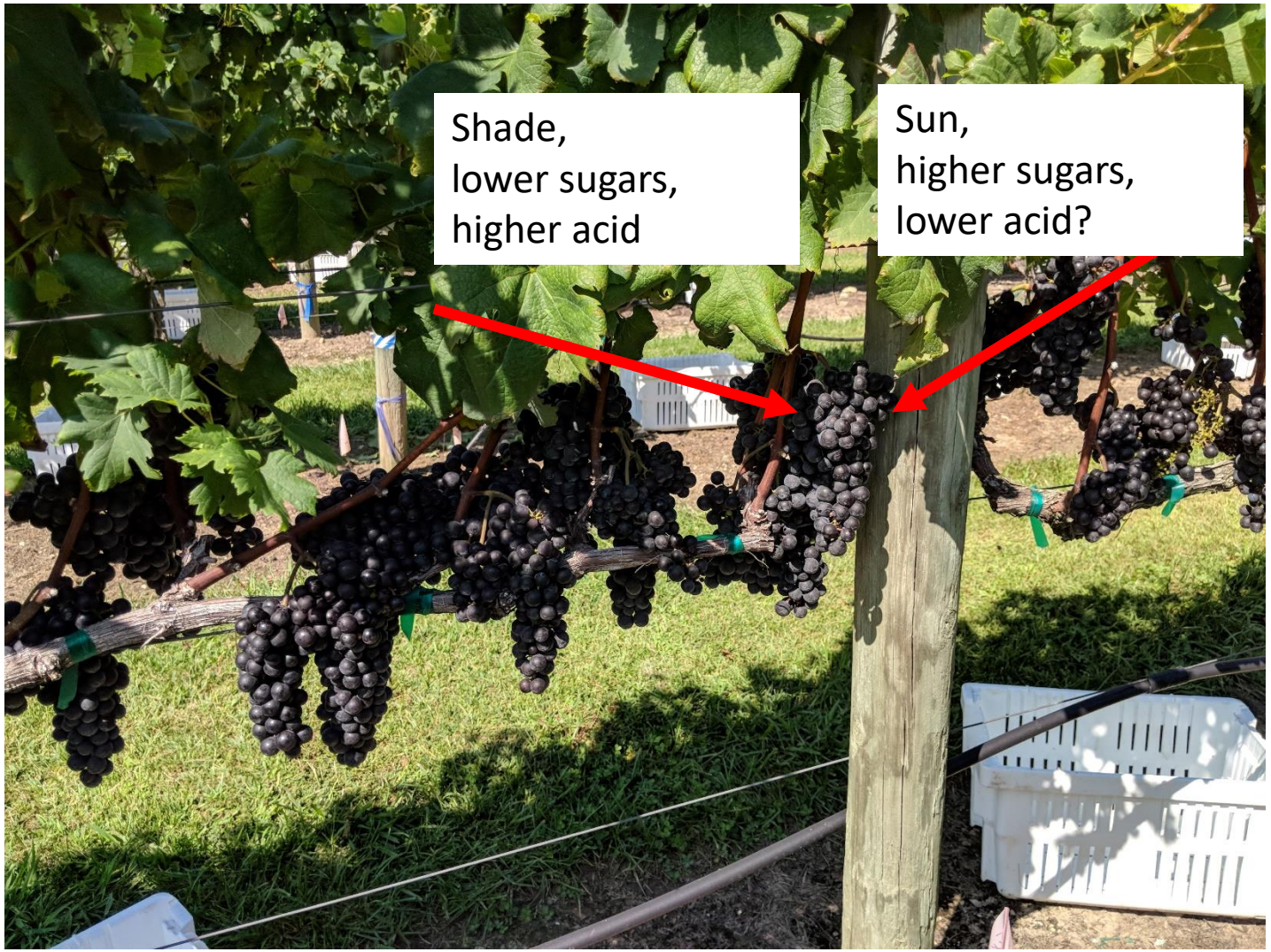
**Keep always in mind:**

The vine has the aim to develop a grape than can spread seed

Monitoring fruit maturity is extremely important

- Collect large enough and random sample that is truly representative to the block intended to harvest.
- Fruit composition can be very different even in one cluster
- Position of cluster on shoot can influence maturity. Basal clusters often develop a little earlier
- Canopy management!!! (later more)

# Ripeness is complex



# Ripeness is complex

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**First step:**

Developing sampling scheme

- Never sample at end of rows. Leave min. of 3 vines between end of row and your first sample.
- Sample in a grid system or in block systems (two rows can be one block)
- 'Representative' means considering your vineyard situation.
- Sample from shaded and exposed location in the canopy!
- Sample from different heights of the vine
- (can be berries or whole clusters)

# Ripeness is complex

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Cluster samples are usually closer to reality than berry samples

Typical cluster sample (for 5 acres or less): 25 clusters

- Samples should be taken weekly, about three weeks before harvest is anticipated.
- Process samples within a few hours
- Crush all berries in a cluster
- Don't use only free run juice! Press thoroughly. **Good measure: 300 ml juice/lbs of fruit**
- **Red varieties: crush, destem and mascerate for 1-2 hours before pressing**

# Ripeness is complex

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- Store juice sample in sealed, full container and allow to settle
- Sulfur dioxide (25mg/L), ascorbic acid helps to delay browing
- Pectolytic enzyme can be added to enhance juice clarity
- Settled and clear juice is ready to be analyzed!

- Analyze samples for Brix, pH and TA. Perform sensory analysis!!!
- Samples can be stored for 1-2 weeks in refrigerator (compare to follow-up samples).
- **Crushing and pressing juice samples is more accurate than tasting berries in the field**
- Juice should be evaluated for aroma and flavor, acidity and taste balance, and color!

# Summary!

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Representative sampling scheme!!!

Fast processing

Crush AND Press

Slow down browning and clarify juice

Parameters AND sensory

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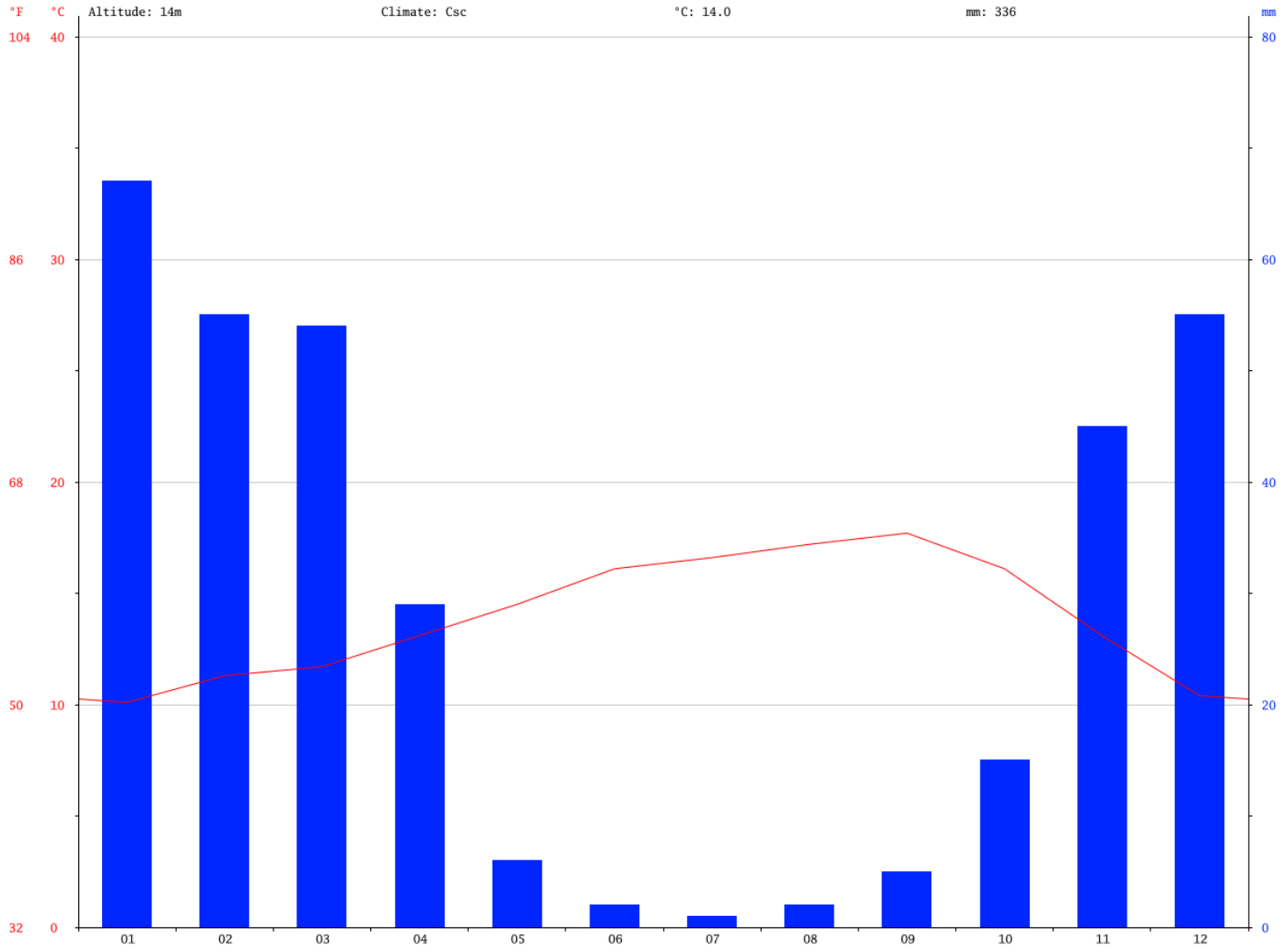
# Factors affecting ripening in North Carolina:

# Weather

Salinas, CA
13.2 Inches/year
Average temperatures between 50-70 F



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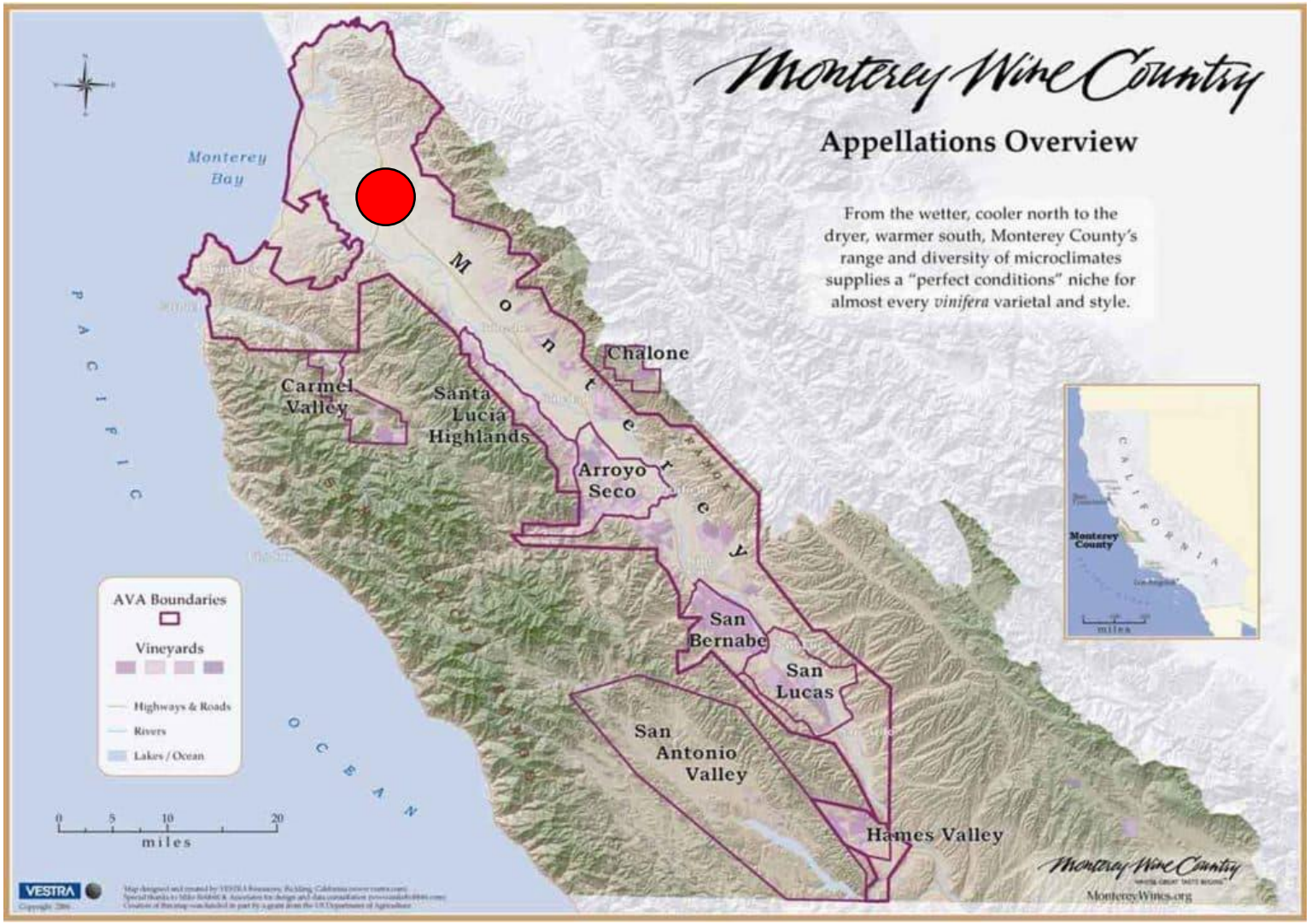
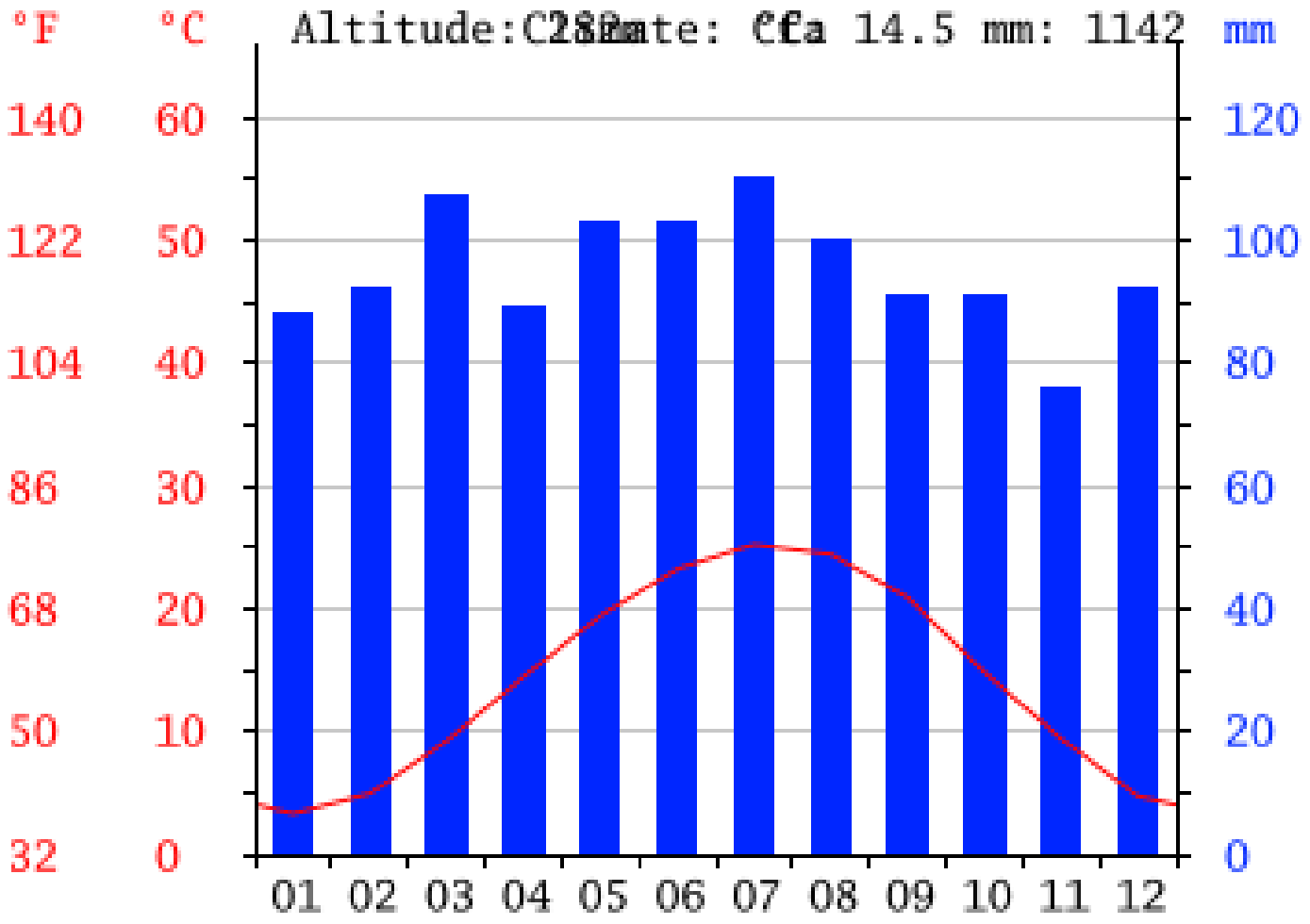


Winston-Salem, NC
45 Inches/year
Average temperatures between 45-77 F



Winston-Salem, NC
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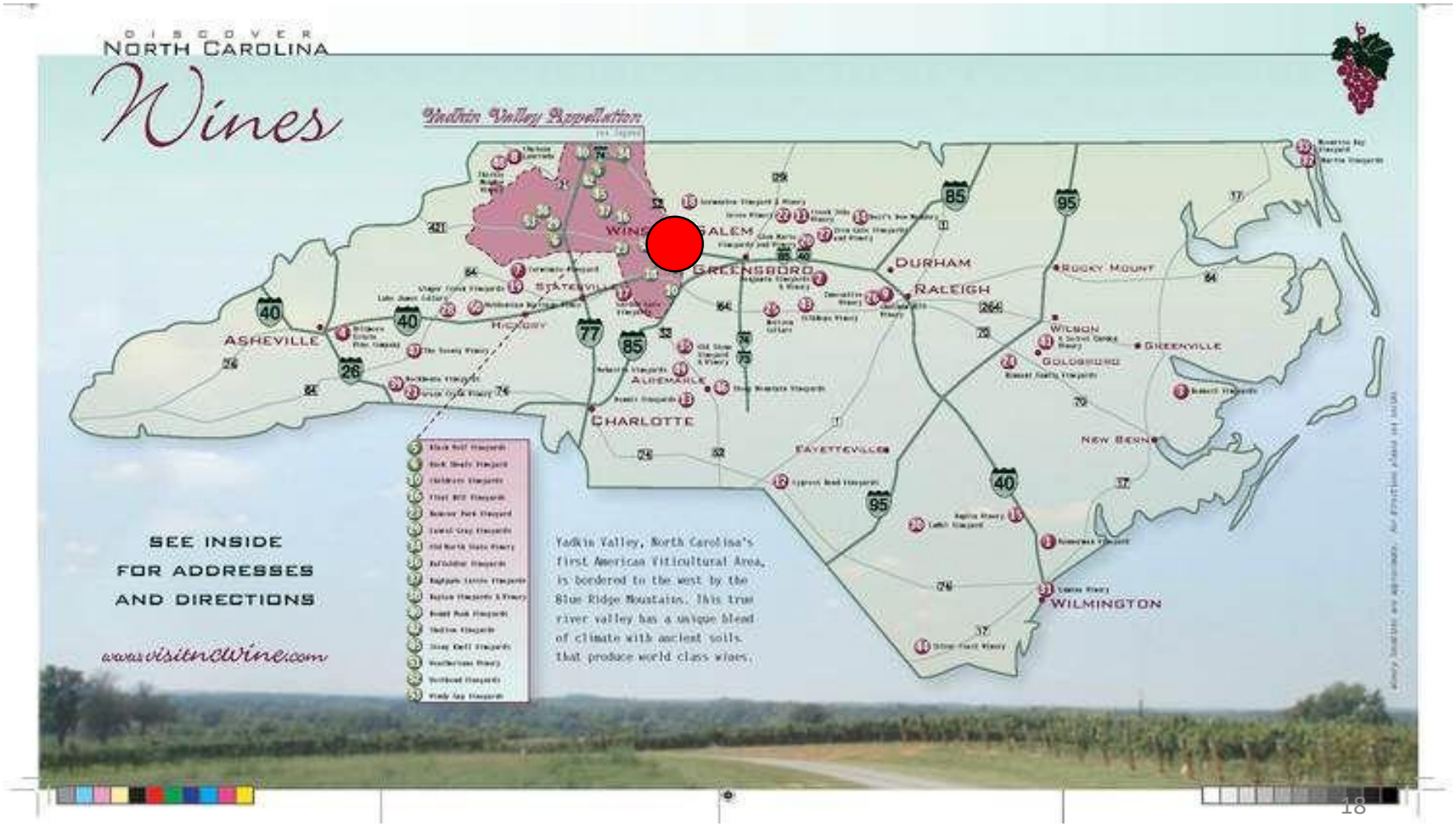
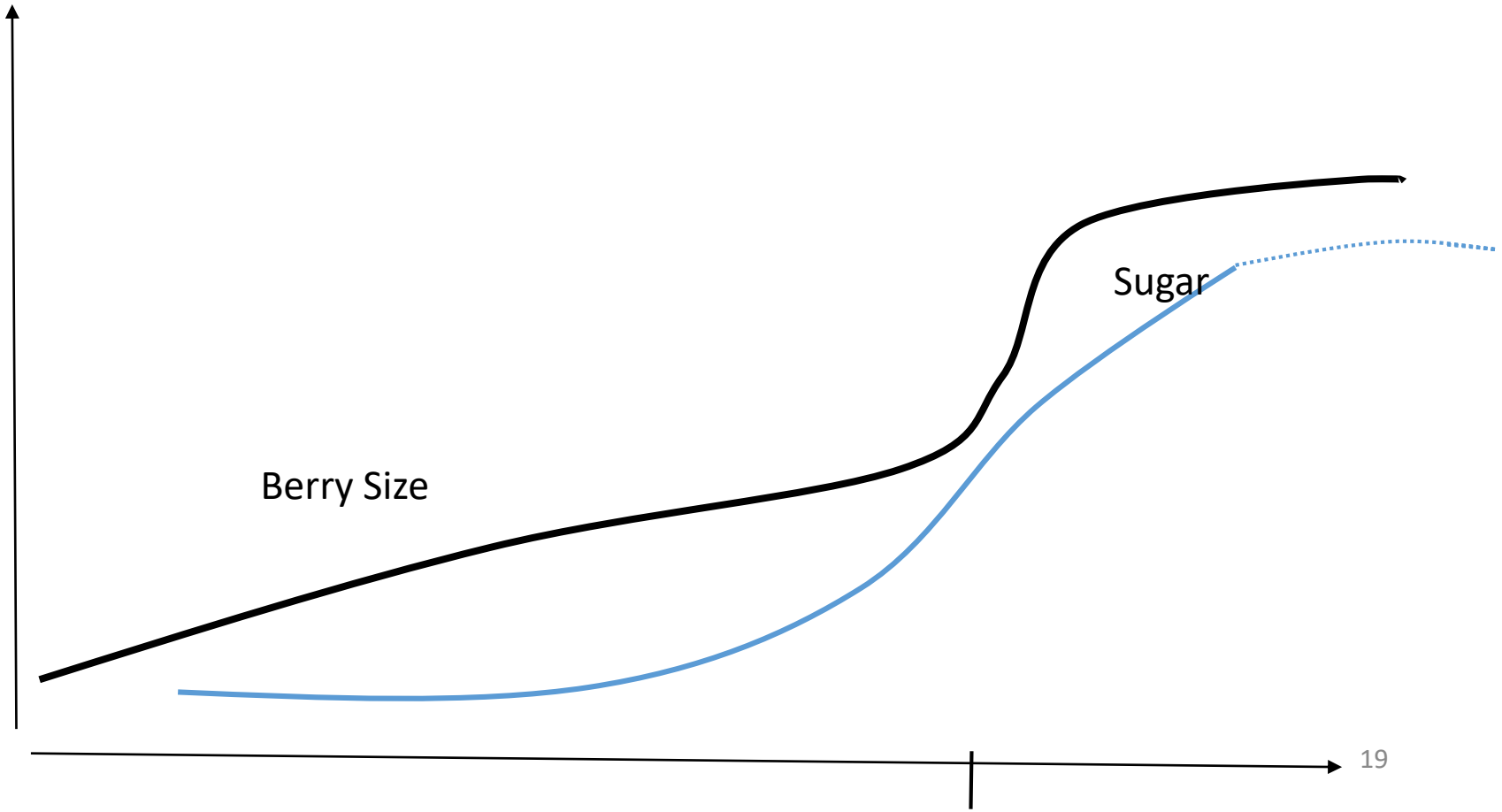


# Weather and ripening:

**Too wet!**

- Berry quality benefits from mild to moderate water deficit!!!!
- **Let's look at Brix!**



# Weather and ripening:

**Too wet!**

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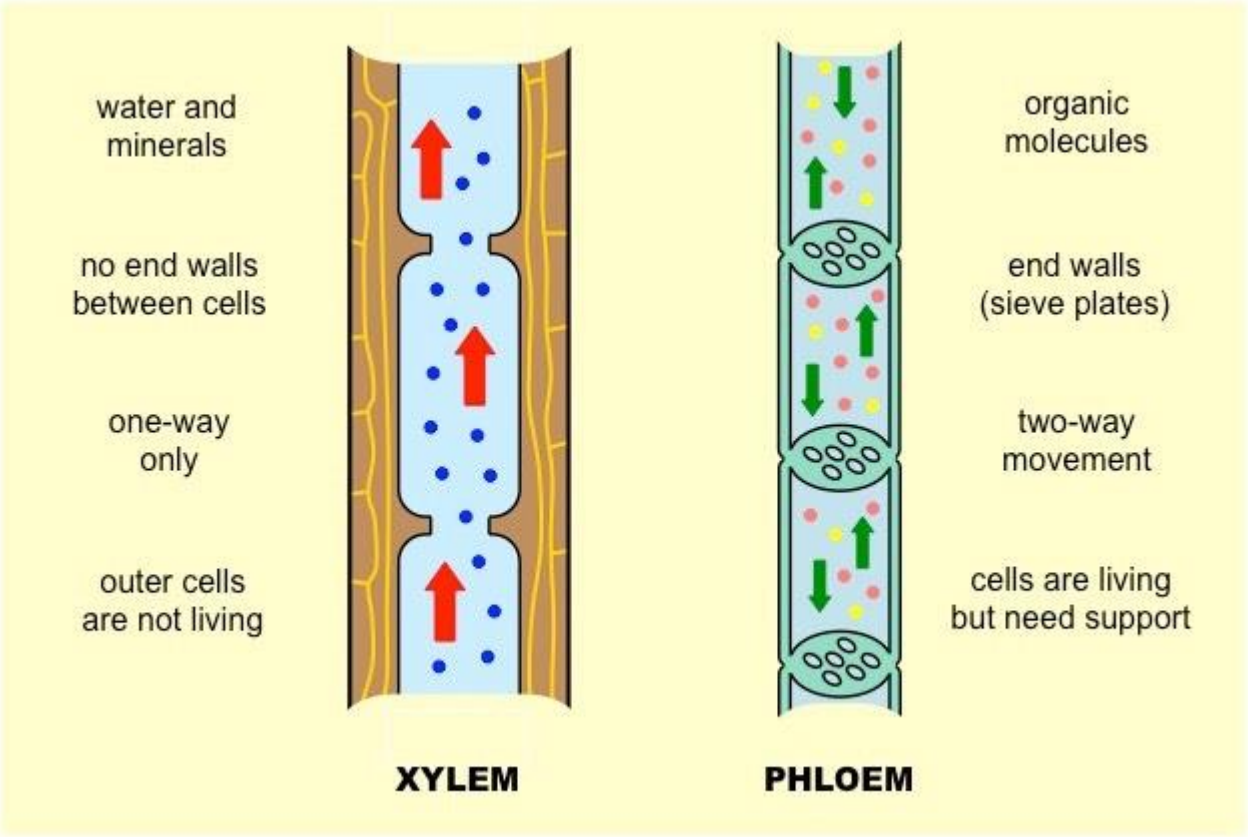
- Why is this happening? (Research from Washington State)

## IMPLICATIONS OF GRAPE BERRY WATER RELATIONS FOR VINEYARD MANAGEMENT

| Growth stage | Physiological function | Berry response |
|---|---|---|
| Before ripening | Xylem supplies most of the water to berries. | Berry size is sensitive to soil water availability. |
| During ripening | Phloem supplies most of the water to berries. This is a time of rapid sugar accumulation. | Berry size is insensitive to soil water availability. |
| After maturation | No more phloem inflow and sugar accumulation. | Weight loss in berries can occur due to dehydration. |

# Weather and ripening:

**Too wet!**




Contributes to berry growth before veraison

Contributes to berry growth after veraison

# Weather and ripening:

**Too wet!**

- Early rainfall affects berry size more than thought
- **After reaching maximum Brix, berries can lose about 5% weight for each degree increase in Brix**

**Problem: Weather in North Carolina very variable!**

Dehydration techniques and short-term ozone-treatments might be suitable techniques for our climate to develop a more consistent wine quality every year.

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# Factors affecting ripening in North Carolina:

# Leaf removal?

# Leaf Removal

**Actual research data**

UNIVERSITY OF GEORGIA EXTENSION

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Cain Hickey

Rachael White

**Question:** Will too much exposure lead to reduced anthocyanins here in the Southeast?

**Or:** Can we use leaf-removal as an additional management tool for rots?

# Hypotheses

- Leaf removal will increase total phenolics and anthocyanins
- Pre-bloom removal will reduce crop yield
- Leaf removal will reduce acidity

# Leaf Removal

**Actual research data**

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## Thurmond, NC → Cabernet franc clone 214

| Leaf removal effect on phenolics and anthocyanins in Cabernet franc. | | |
|---|---|---|
| | Total estimated phenolics (a.u. / g berry) | Total estimated anthocyanins (mg / g berry) |
| NO | 84.60 b | 0.58 |
| PB-6 | 100.00 a | 0.63 |
| PFS-6 | 97.97 a | 0.62 |
| Canopy side | | |
| East | 94.10 | 0.58 b |
| West | 94.26 | 0.63 a |

- NO = No leaf removal
- PB-6 = Removal of 6 leafs **Pre Bloom**
- PFS-6 = Removal of 6 leafs **Post Fruit Set**

# Leaf Removal

**Actual research data**

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## Thurmond, NC → Cabernet franc clone 214

| Leaf removal effect on primary juice chemistry in Cabernet franc. | | | |
|---|---|---|---|
| | **Soluble solids (°Brix)** | **pH** | **Titratable acidity (g/L)** |
| NO | 22.9 | 3.66 | 3.77 a |
| PB-6 | 23.1 | 3.70 | 3.71 ab |
| PFS-6 | 22.5 | 3.61 | 3.50 b |

# Leaf Removal

**Actual research data**

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## Thurmond, NC → Cabernet franc clone 214

| Leaf removal effect on *Botrytis* in Cabernet franc. | | | |
|---|---|---|---|
| | Incidence (%) | Severity (%) | Estimated crop loss (%) |
| NO | 54.0 a | 4.6 | 2.4 |
| PB-6 | 30.0 b | 1.6 | 0.5 |
| PFS-6 | 10.0 c | 0.1 | 0.0 |

# Hypotheses, revisited

- Leaf removal will increase total phenolics and anthocyanins
  - ***Generally so***
  - ***Unremarkable canopy side effect***
- Pre-bloom removal will reduce crop yield
  - ***Trends suggest yes, statistics = no.***
- Leaf removal will reduce acidity
  - ***Yes, by a range of 0.2 to 0.9 g/L***

# Thank you

- Jones von Drehle Vineyard and Winery
- ***Eric Steinbicker (Vineyard Manager)***
- ***Rachael White (UGA)***
- ***Annie Vogel (UGA)***
- ***Abby Whitacker (NC Coop. Ext)***

# Leaf Removal

**Actual research data**

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- Karen Blaedow
- Cain Hickey

**Question:** How efficient is the use of automated leaf removal vs. hand leafremoval?

**Or:** Can we use leaf-removal as an additional management tool for rots?

# Leaf Removal

**Actual research data**

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## Hypothesis

**Automated leaf removal will result in similar berry composition, disease incidence and yield as hand leaf removal**

# Leaf Removal

**Actual research data**

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Treatments (post-bloom fruit zone leaf removal):

(1) Removal of 2 leafs opposite of clusters
(2) Removal of 4 leafs
(3) Removal of 6 leafs
(4) Crew
(5) Mechanical Leaf Removal
(6) No Leaf removal (Control)

5 replicates, 4 vines per replicate. 2018 and 2019.

**Merlot + Chardonnay**

# Leaf Removal

**Actual research data**

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Chardonnay 2018

| Treatment | Berry weight (g) | Cluster # | Tons per acre |
|---|---|---|---|
| 2 Leaf removal | 1.5 | 28.9 | 3.2 |
| 4 Leaf removal | 1.48 | 28.15 | 3.2 |
| 6 Leaf removal | 1.47 | 29.65 | 3.3 |
| Crew | 1.45 | 32.9 | 3.8 |
| Mechanical | 1.51 | 29.45 | 3.2 |
| Control | 1.54 | 28.95 | 3.2 |

Merlot 2018

| Treatment | Berry weight (g) | Cluster # | Tons per acre |
|---|---|---|---|
| 2 Leaf removal | 1.39 | 29.68 | 2.94 |
| 4 Leaf removal | 1.31 | 25.8 | 2.46 |
| 6 Leaf removal | 1.29 | 25.5 | 2.16 |
| Crew | 1.41 | 25.83 | 2.64 |
| Mechanical | 1.32 | 27.1 | 2.52 |
| Control | 1.42 | 27.6 | 2.70 |

# Leaf Removal

**Actual research data**

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Chardonnay 2018

| Treatment | Brix | pH | TA (g/L) |
|---|---|---|---|
| 2 Leaf removal | 18.66 | 3.676 | 4.608 |
| 4 Leaf removal | 18.8 | 3.694 | 4.562 |
| 6 Leaf removal | 18.84 | 3.682 | 4.476 |
| Crew leaf removal | 19.16 | 3.712 | 4.414 |
| Mechanical | 18.58 | 3.71 | 4.486 |
| Control | 18.78 | 3.662 | 4.826 |

Merlot 2018

| Treatment | Brix | pH | TA (g/L) |
|---|---|---|---|
| 2 Leaf removal | 17.46 | 3.622 | **4.138** |
| 4 Leaf removal | 18.56 | 3.722 | 3.788 |
| 6 Leaf removal | 18.62 | 3.766 | 3.634 |
| Crew leaf removal | 18.2 | 3.734 | 3.722 |
| Mechanical | 18.02 | 3.736 | 3.824 |
| Control | 18.02 | 3.586 | **4.154** |

# Leaf Removal

**Actual research data**

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| Treatment | Disease Severity (%) | Disease Incidence (%) |
|---|---|---|
| Mechanical | 0.688 | 21.2 |
| **Control** | **2.94** | **36** |
| 4 leaf removal | 0.538 | 18.8 |
| 6 leaf removal | 1.108 | 21.6 |

# Leaf Removal

**Actual research data**

# Leaf Removal

**Actual research data**

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## Hypothesis, revisited

Automated leaf removal will result in similar berry composition, disease incidence and yield as hand leaf removal

- **Berry composition: yes**
- **Disease incidence: yes**
- **Yield? 2019 results**

# Thank you

- Burnshirt Vineyards
- ***Eric Case (Vineyard Manager)***
- ***Karen Blaedow (NC Coop. Ext.)***
- ***Xiaonan Shi (NC State)***
- ***Tekan Rana (NC State)***
- ***Emma Volk (NC State)***
- ***Cain Hickey (UGA)***

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# Factors affecting ripening in North Carolina:

# Diseases

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# Grape Viruses

**Actual research data**

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Ca. 70 different Grape Viruses are identified
Ca. 25 associated diseases

| Virus | Name |
|---|---|
| GLRaV 1-10 | Grapevine leafroll associated virus 1-10 |
| GRBaV | Grapevine red blotch associated virus |
| GVA-F | Grapevine virus A-F |
| GFkV | Grapevine fleck virus |
| GFLV | Grapevine fanleaf virus |
| GRSPaV | Grapevine ringspot associated virus |
| Many many more | Besides viruses, we test for the presence of Xf (Pierces Disease) and plasmodium. |

# Grape Viruses

**Actual research data**

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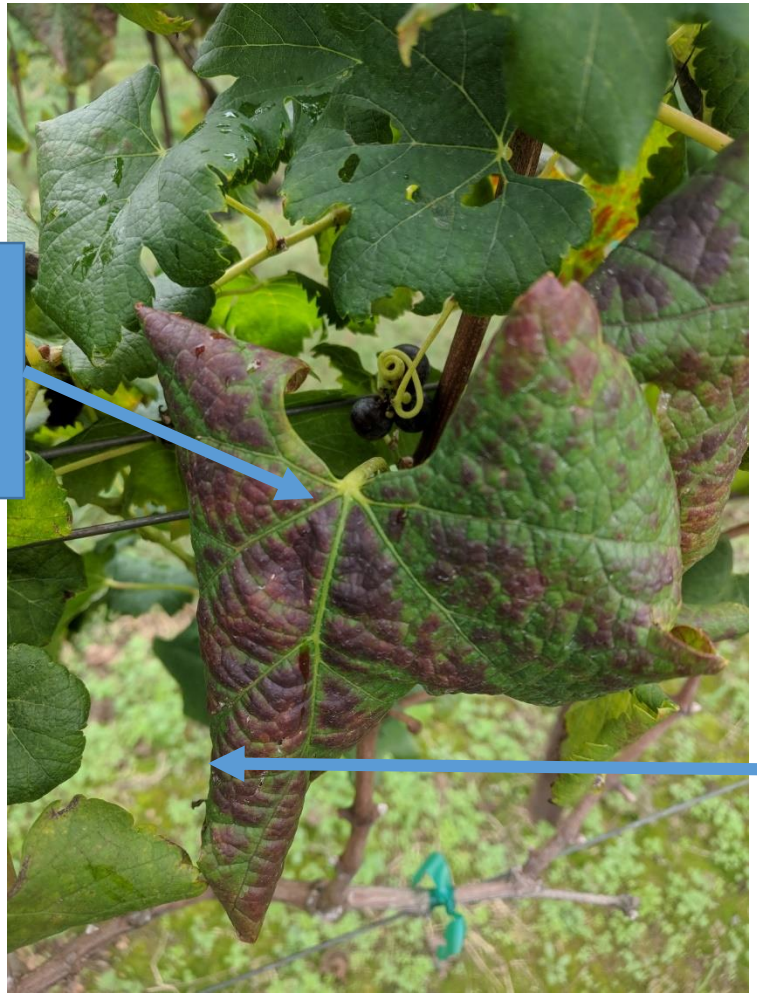
Most grapevine viruses are single stranded RNA viruses

| Common | Name |
|---|---|
| GLRaV-2 | Grapevine leafroll associated virus 2 |
| GLRaV-3 | Grapevine leafroll associated virus 3 |
| GLRaV-4 | Grapevine leafroll associated virus 4 |
| GLRaV-7 | Grapevine leafroll associated virus 7 |
| GRBaV | Grape Red Blotch associated virus |
| GV A | Grapevine Virus A |
| GV B | Grapevine Virus B |

# Grape Viruses

Grape Leafroll associated Virus (GLRaV)



# Grape Viruses

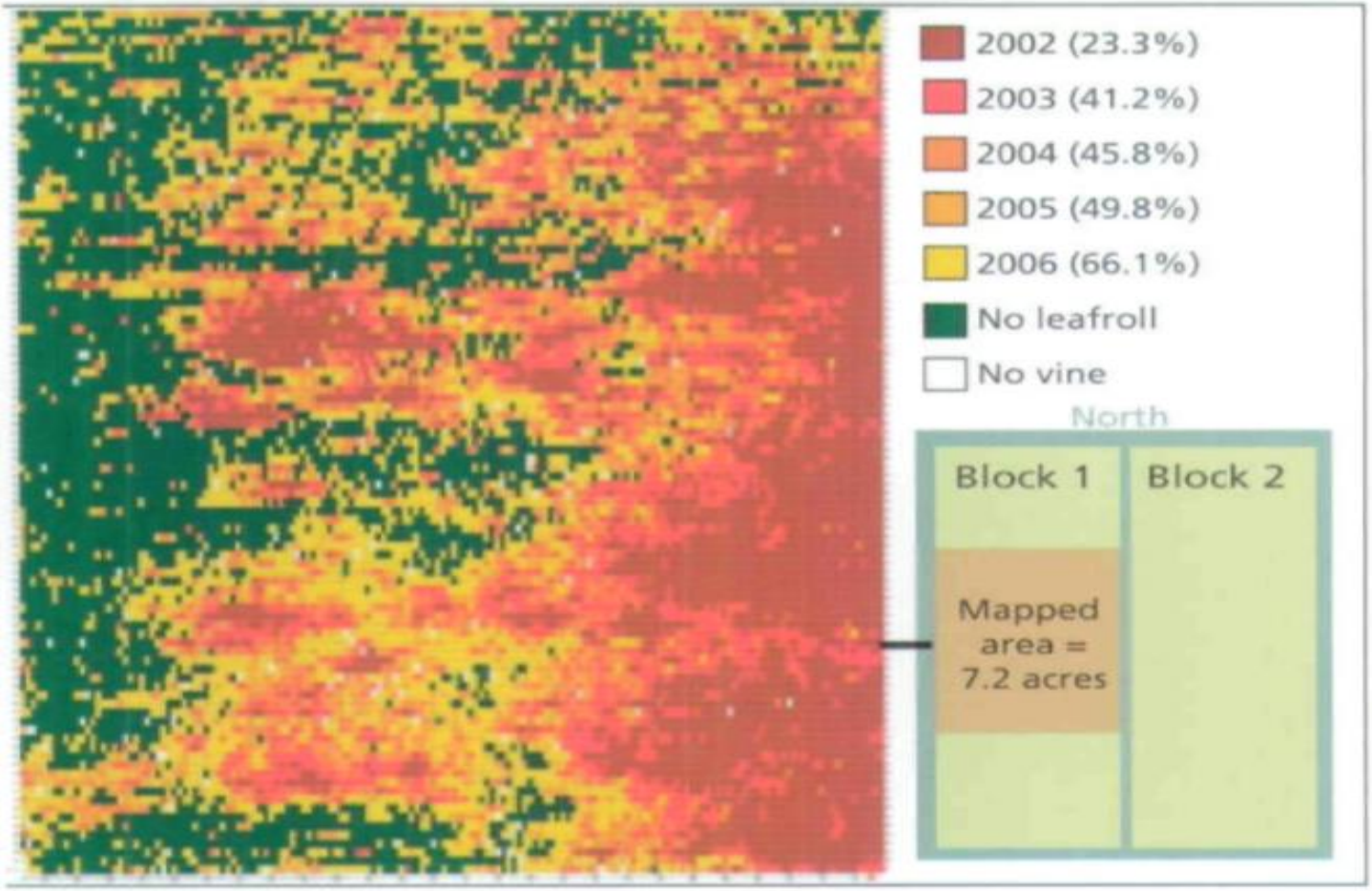
Grape Leafroll associated Virus (GLRaV)

- Transmitted via Mealybugs
- Please contact Hannah Burrack

hannah_burrack@ncsu.edu

# Grape Viruses

Grape Leafroll associated Virus (GLRaV)




Gorino et al. 2008, California Agriculture 62(4): 156-160

# Grape Viruses

**Actual research data**

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VIRGINIA TECH

***Vinifera* vineyard survey:**

Nine symptomatic blocks in vineyards in the **Upper Hiwassee Highlands AVA**, **Yadkin Valley AVA** and **Henderson Co.** were surveyed in October 2018 (10 random plants per block). Given is the percentage of plants positively tested for the presence of virus.

| GLRaV-2 | GLRaV-3 | GLRaV-4 | GLRaV-7 | GRBV | GVA | GVB | GRSPaV | TMSV | X.f. |
|---|---|---|---|---|---|---|---|---|---|
| 1 %* | 22 % | 0 % | 0 % | 23 % | 0 % | 0 % | 72 % | 0 % | 7 % |

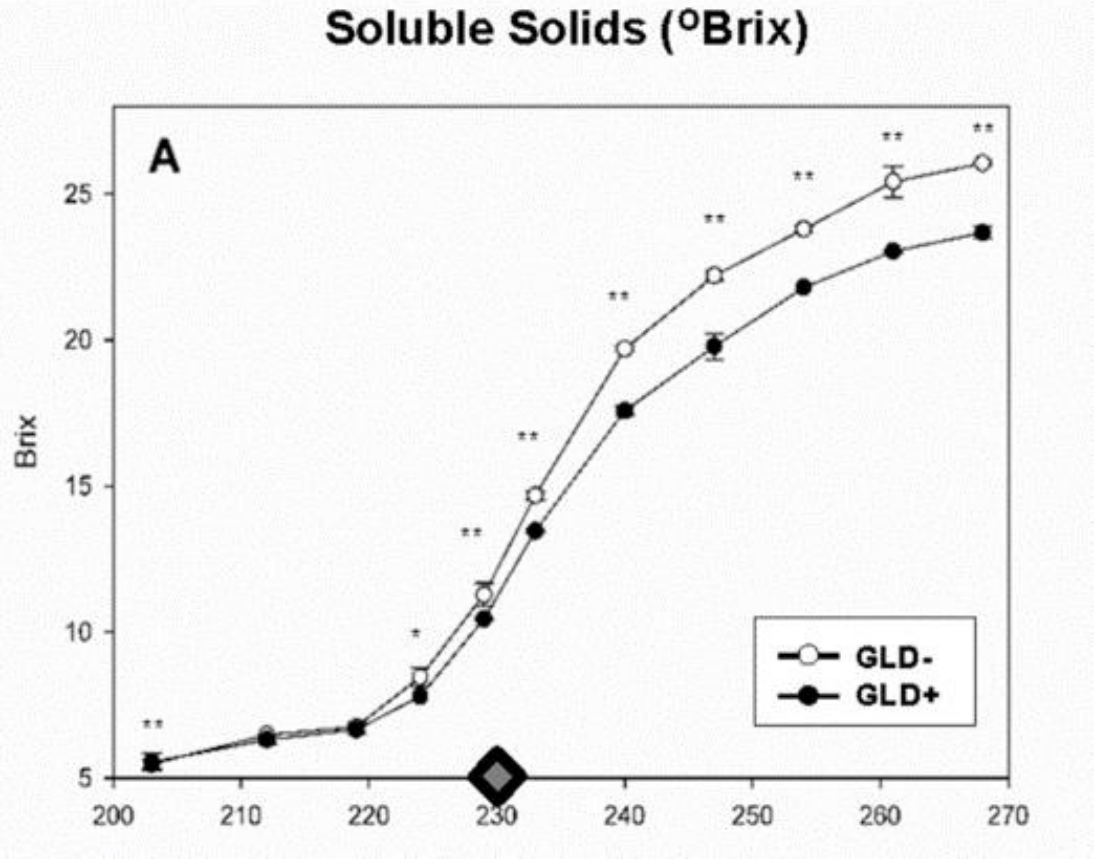
**Grapevine Leafroll associated Virus – 3: 22%**

**Grape Red Blotch Virus: 23%**

# Grape Viruses

Grape Leafroll associated Virus (GLRaV)

GLRaV-3




Alabi et al. 2016, PLOS-One: DOI:10.1371.journal.pone.0149666

# Grape Viruses

## Grape Leafroll associated Virus (GLRaV)

### GLRaV-3

| Variable | Treatment means by season[Y] | | | | | |
|---|---|---|---|---|---|---|
| | 2009 | | 2010 | | 2011 | |
| | Non-symptomatic | Symptomatic | Non-symptomatic | Symptomatic | Non-symptomatic | Symptomatic |
| Yield (kg/vine)[α] | 4.70 | 3.39 | 4.19 | 3.52 | 5.68 | 4.51 |
| Bunch/vine (n) [α] | 90*,a | 76*,b | 86*,a | 70*,b | 116*,a | 99*,b |
| Pruning weight (g/vine) [α] | NA | NA | 315.0 | 279.6 | 359.3 | 272.0 |
| TSS (Brix)[β] | 24.8*,a | 23.3*,b | 25.0*,a | 23.1*,b | 23.5*,a | 22.5*,b |
| Titratable acidity (g/L) [β] | 5.47*,b | 6.10*,a | 6.40*,b | 6.76*,a | 4.35*,b | 4.69*,a |
| pH [β] | 3.65*,a | 3.58*,b | 3.34*,a | 3.33*,b | 3.65*,a | 3.55*,b |

[α]Data represents means of raw data from 12 pairs of non-symptomatic (uninfected) and symptomatic (GLD-affected) vines for 2009 and 2010 seasons and eight pairs of vines for the 2011 season due to new infections of four non-symptomatic vines as determined by RT-PCR.

[β]Data represents means of raw data from fruit triplicates taken from fruit lots from non-symptomatic and symptomatic vines at commercial harvest.

[Y]Means followed by an asterisk (*) differ statistically ($p \leq 0.05$) and alphabetical letters were used to separate means for each significant treatment effect comparison. Significant season effects ($p \leq 0.05$) were obtained for all variables except yield and pruning wood weight but no significant 'Treatment × Season' effects were found in all cases. NA, data not taken.

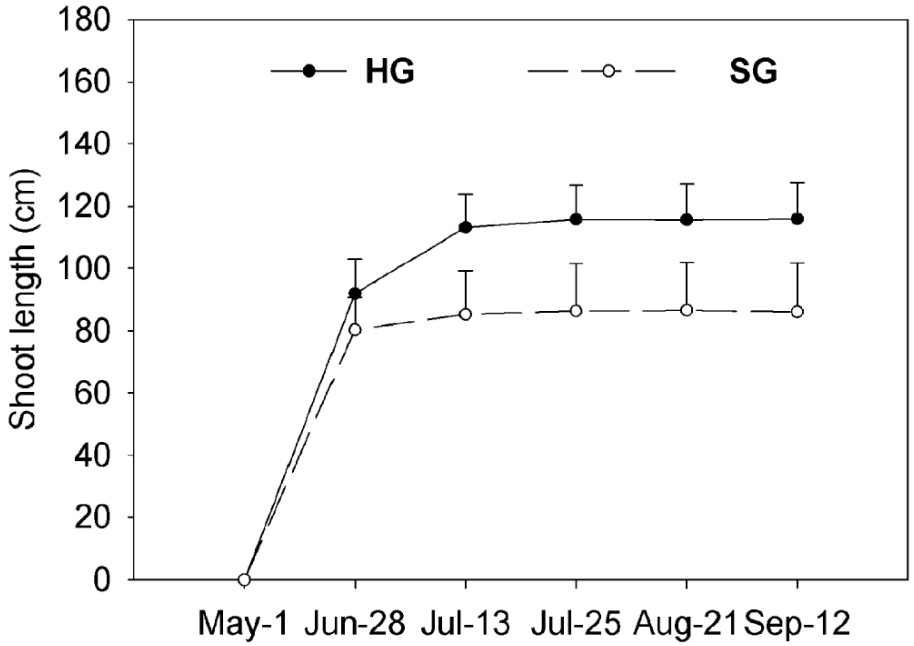
doi:10.1371/journal.pone.0149666.t001

Alabi et al. 2016, PLOS-One: DOI:10.1371.journal.pone.0149666

# Grape Viruses

Grape Leafroll associated Virus (GLRaV)

GLRaV-3




Endeshaw et al. 2014, Scienta Horticulutrae 170: 228-236.

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# Factors that impact the ripening process and berry composition in wine grapes in NC

## TAKE HOME

# Take home one

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**Management tactics and diseases affect fruit composition**

**→ Staying on top of canopy management and disease control wins half the battle in North Carolina!**

# Take home two

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**Harvest decisions in the Southeast are complex: Diseases (especially bunch rots) may still get in your way**

**→ You can't change the weather! Watch closely and harvest before it's too late.**

# Take home three

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**A well thought through fruit sampling scheme will help you to identify harvest windows.**

**→ Also here: You can't change the weather! Sometimes in NC everything is on top of each other.**

# Take home four

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# Thank you!

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## Thank you for your attention

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