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The Effects of Pre-bloom, Fruit Set and Veraison Leaf Removal on Yield, Composition and Wine Quality in the Okanagan Valley

Kevin Usher

P. Bowen, T. Lowery, C. Bogdanoff, J. Urbez-Torres, D. O'Gorman, M. Cliff

Summerland Research and Development Centre

Canada

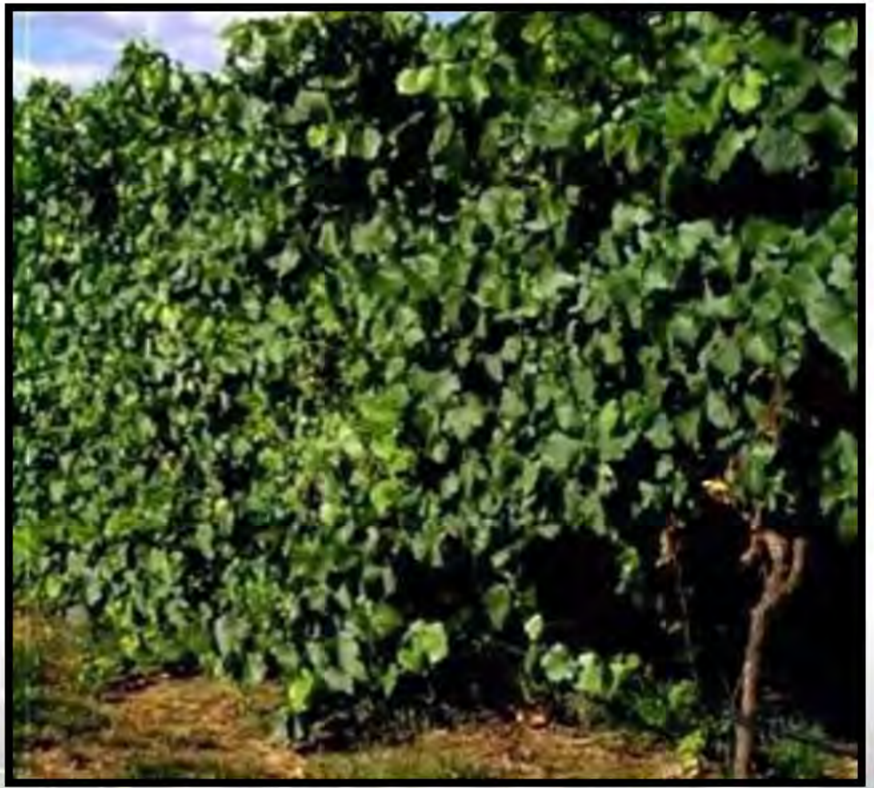
Canopy Management

- Trellis design
- Canopy structure
- Pruning
- Shoot thinning
- Shoot positioning
- Shoot tipping
- Leaf removal
- Fruit removal
- Fruit positioning

Shade Effect On Fruit Quality

Reduced:

- Phenolics (tannins, anthocyanins, etc…)
- Fruity/floral flavour and aroma (eg. monoterpenes)
- Sugar



Increased:

- Malic acid
- Disease incidence
- Herbaceous flavour and aroma

Benefits of Leaf Removal and Open Canopies

- Opens the fruiting zone
- Changes light quality and quantity
- Changes fruit temperature
- Increases air circulation reducing humidity
- Better spray penetration
- Quicker hand harvest
- Useful for leaf hopper control
- Changes fruit composition and quality

How Much Fruit Exposure

- Depends on goals and methods of exposure
- Open canopies provide dappled light
- Dappled light in fruiting zone promotes phenolic and some flavour development
- Optimum exposure levels and timing may be different for white and red grapes



1. Compositional Evaluation of Okanagan Pinot Noir and Chardonnay Grapes

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1) Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland, B.C., Canada
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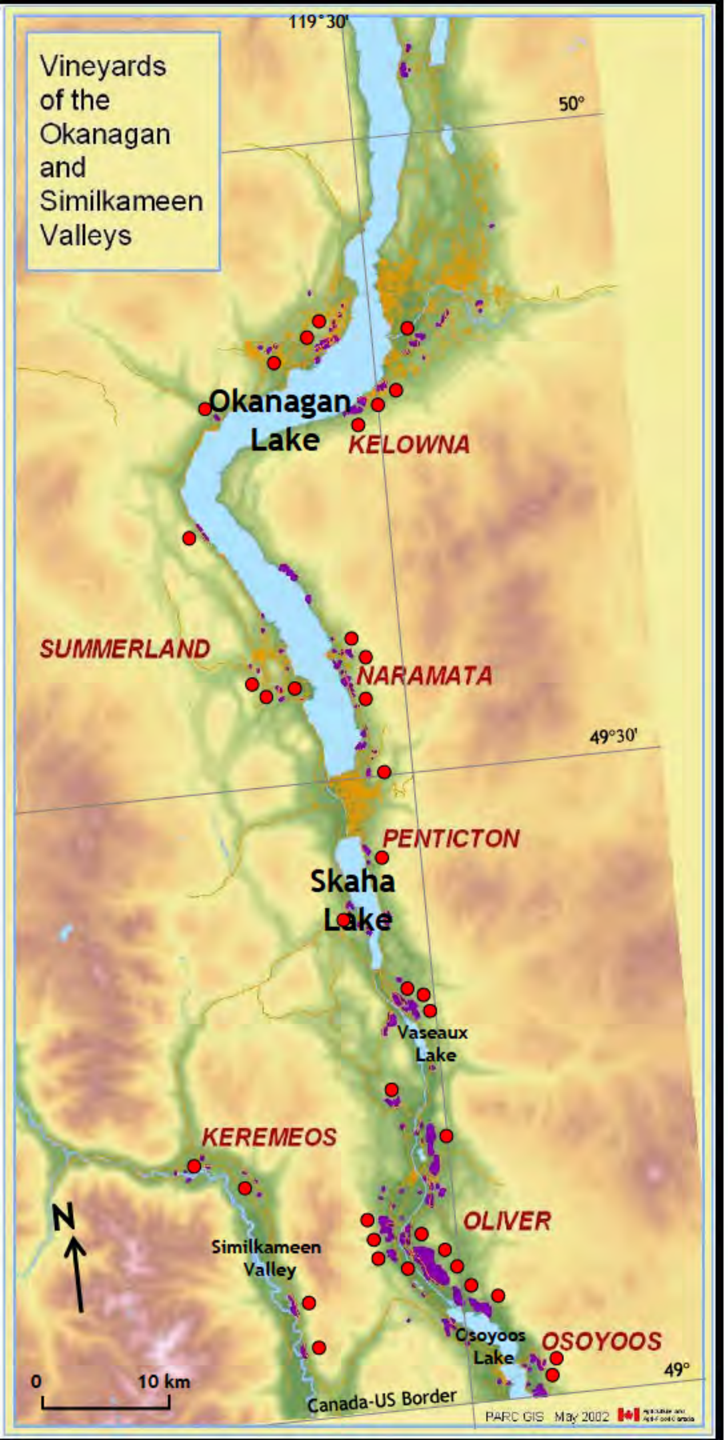


Study Design

- Chardonnay clone 76 - 40 vineyards
- Pinot noir clone 115 - 40 vineyards
- Two plots within each vineyard
- 5 vines (one panel) per plot
- Three consecutive years

Vine, Canopy and Fruit Environment

Vine size, canopy density and fruit environment

- cane / cordon
- circumference
- trunk circumference
- canopy height and width
- canopy volume
- hedging
- leaf removal
- cluster exposure
- canopy openness
- canopy surface area

Leaf quality

- leaf area
- leaf dry weight
- petiole dry weight
- leaf greenness
- leaf nitrogen content

Fruit and yield components

- crop load
- yield per vine
- clusters per vine
- average cluster weight
- berry fresh weight
- skin fresh weight
- skin dry:fresh ratio

Fruit Composition

Basic composition
- Soluble solids
- Titratable acidity
- pH

Aroma

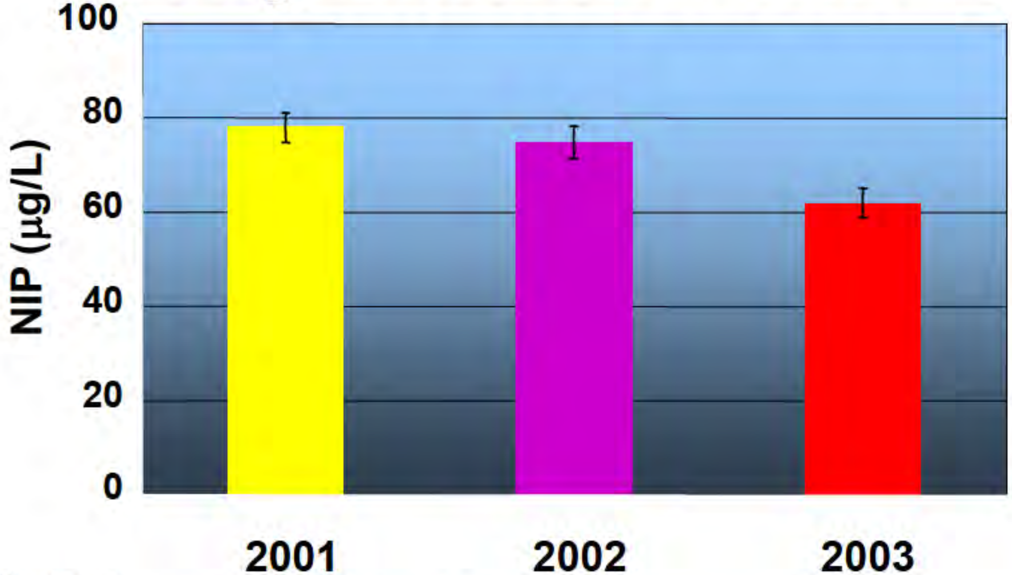
Aroma Volatiles (norisoprenoids (NIP))
Glycosyl glucose (flavour potential)

Nitrogen
- Total nitrogen
- Yeast assimilable nitrogen content (YANC)
- Free Amino Nitrogen (FAN)
- Ammonium

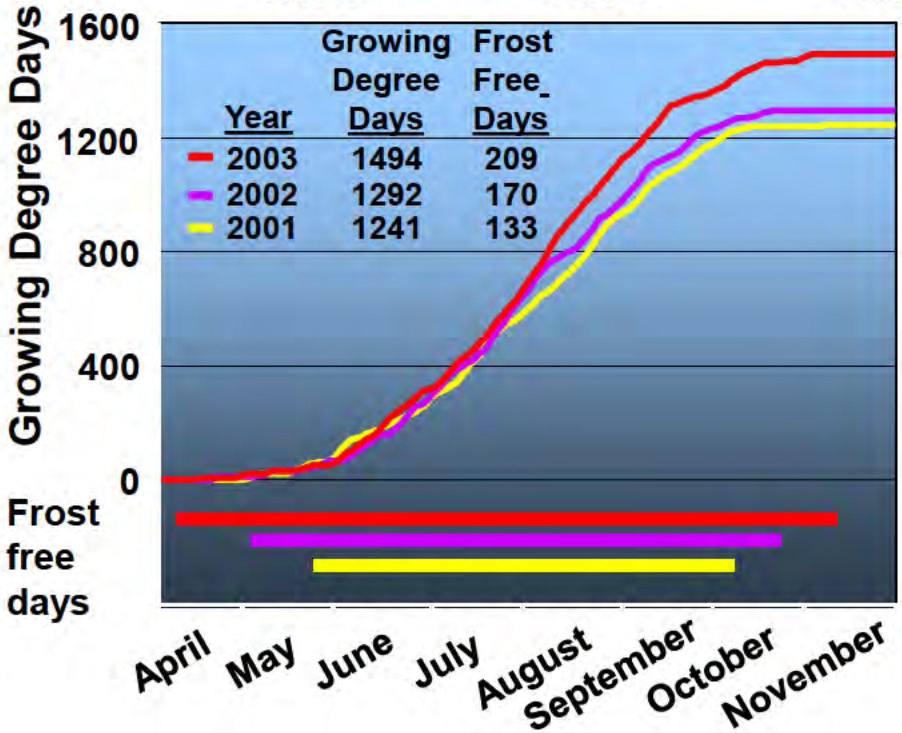
Ions

Inorganic ions (Potassium, Phosphate, Sodium, Calcium, etc…)
- Organic acids (tartrate, malate, citrate, isocitrate)

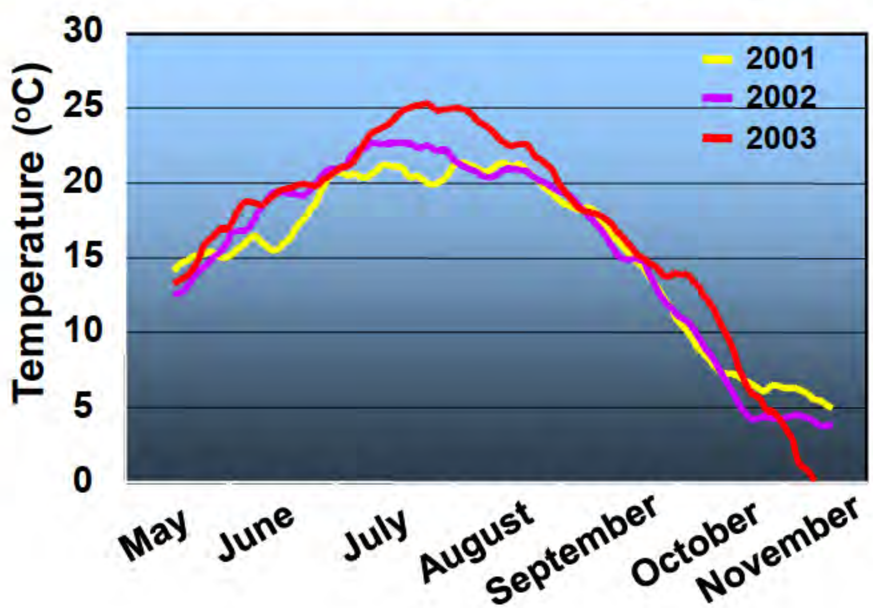
Yearly Differences in Total Norisoprenoid



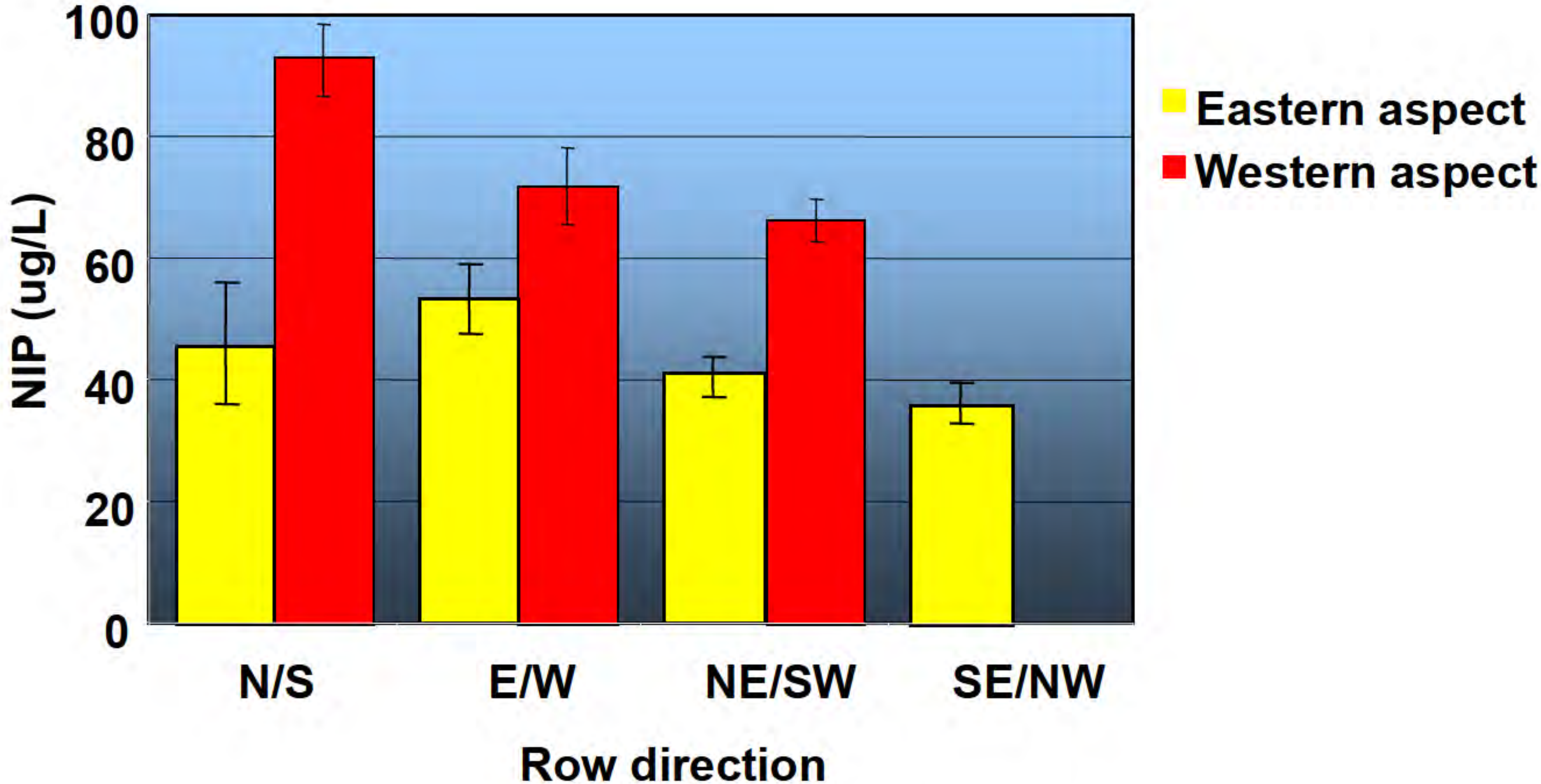
Optimal temperature for NIP biosynthesis is 10 – 20 ^{O}C



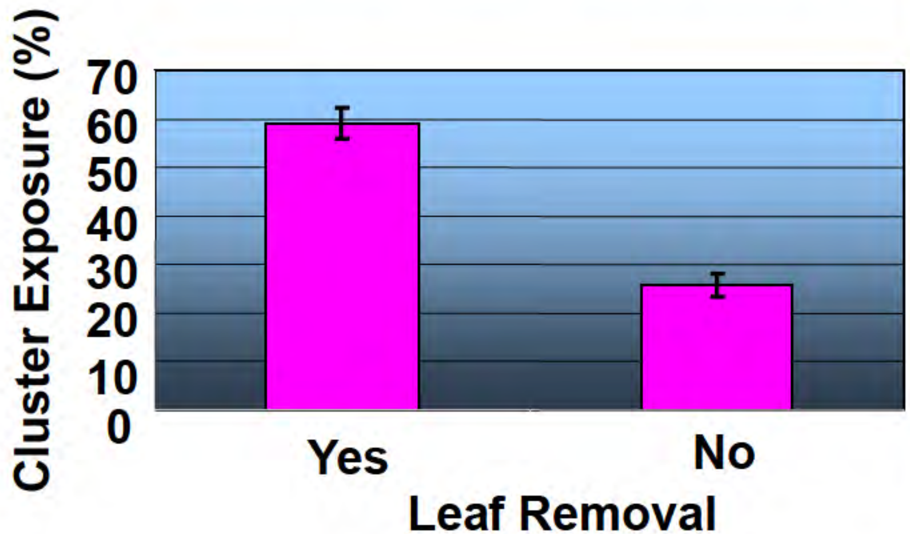
Average Daily Temperature

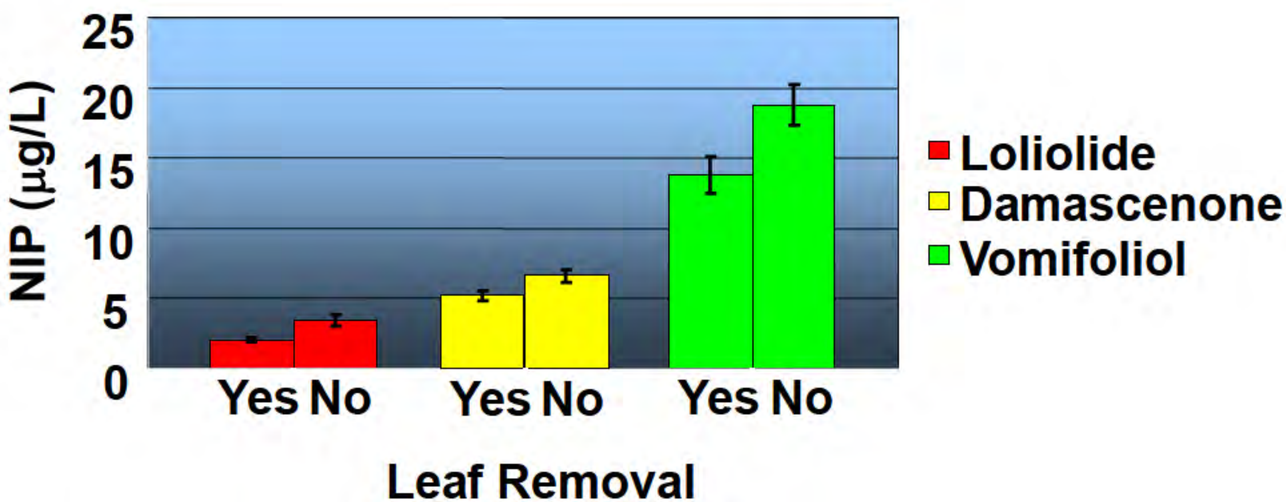


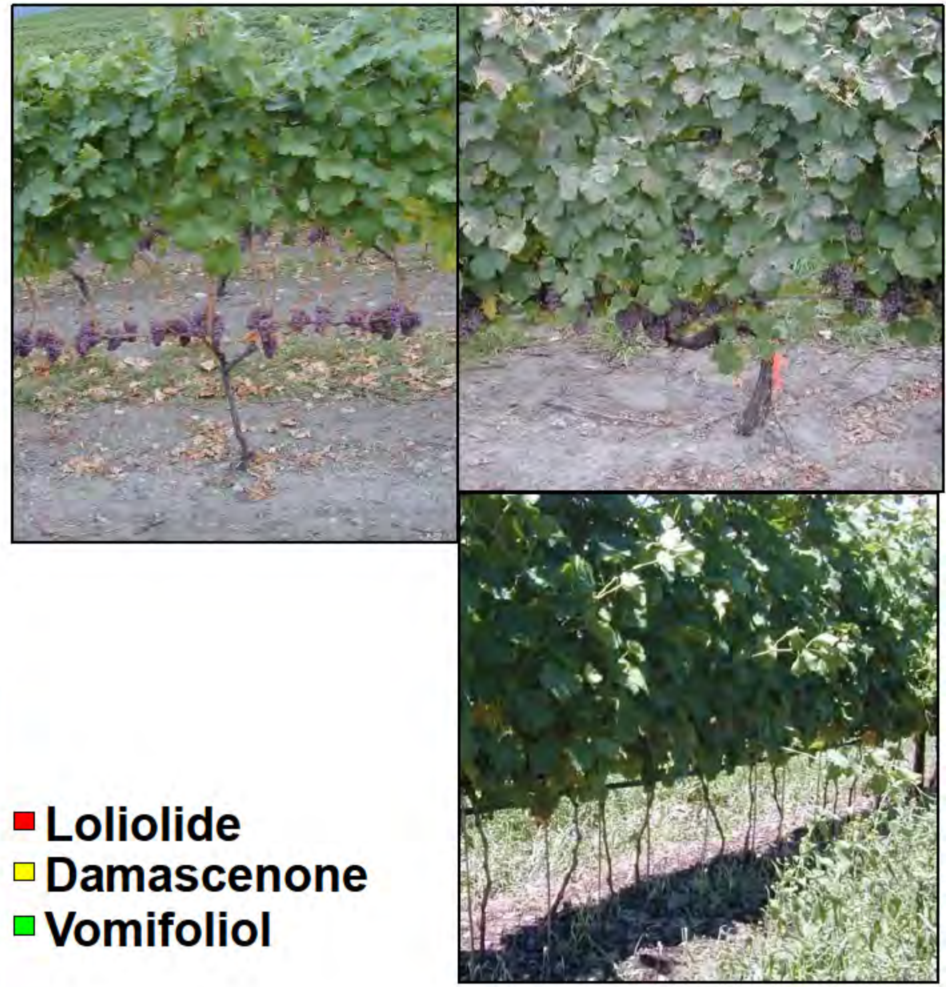
Total Norisoprenoids vs Row Direction and Slope Aspect

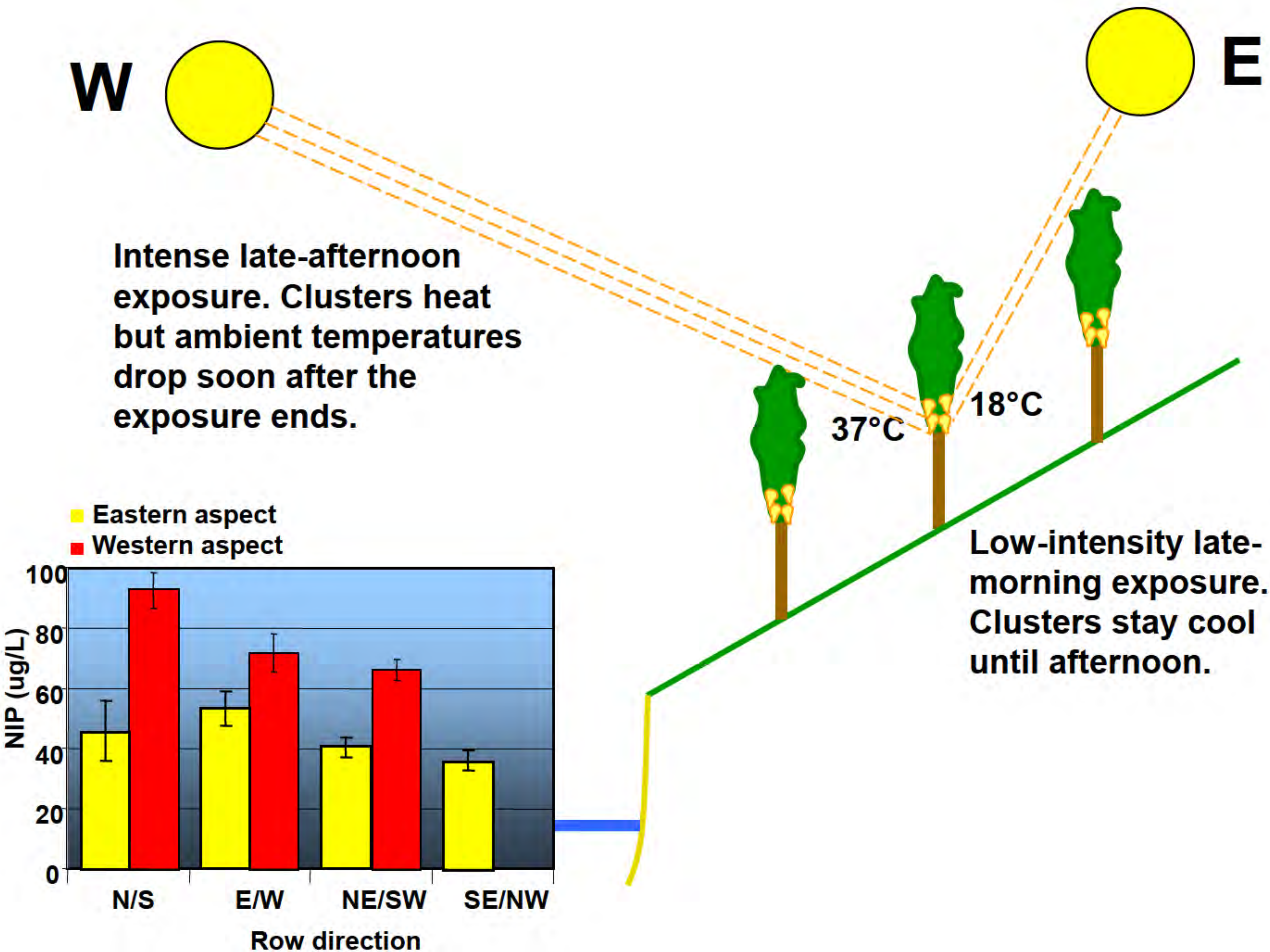


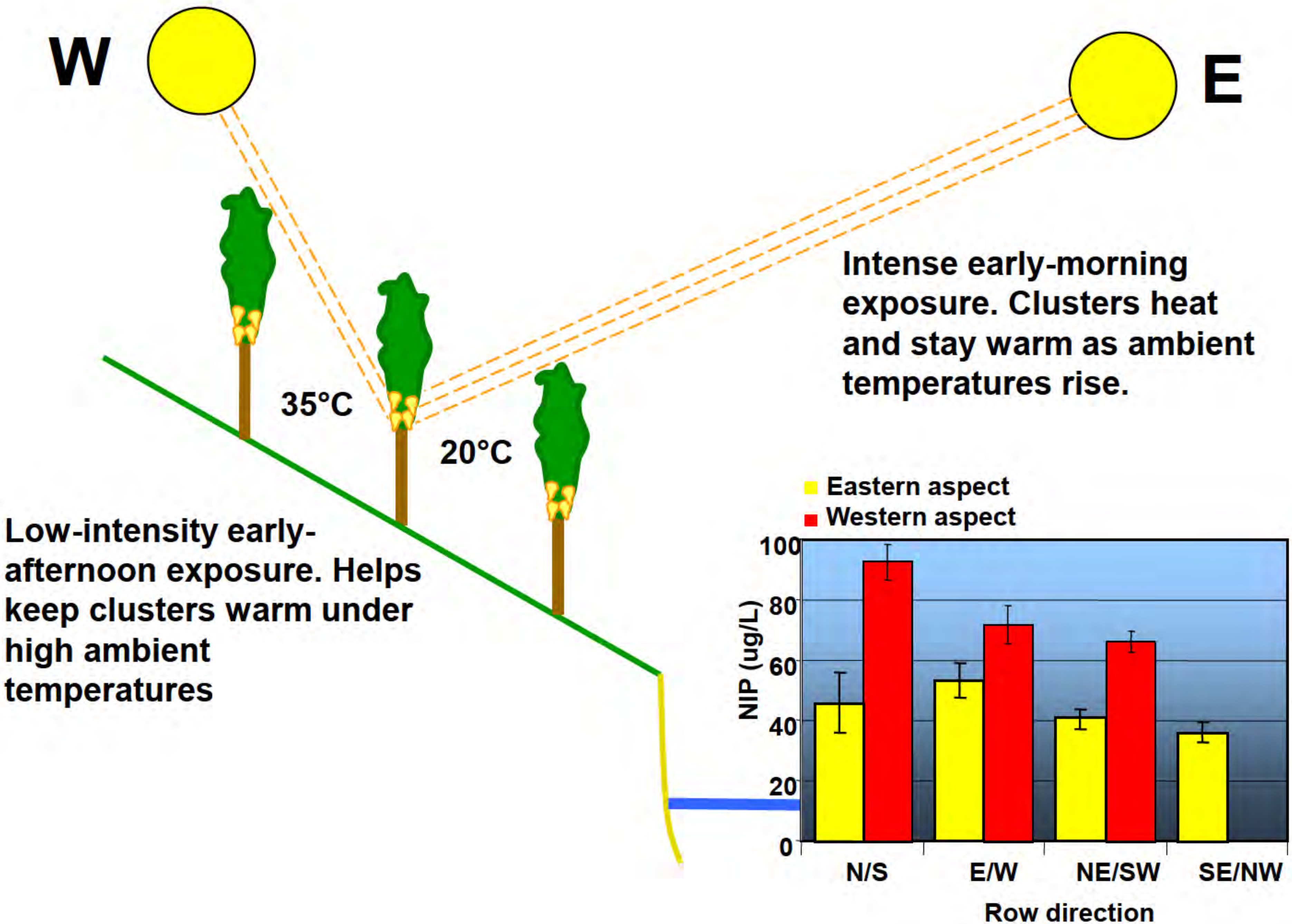
Cluster Exposure Affects Norisoprenes








W
E
Intense late-afternoon exposure. Clusters heat but ambient temperatures drop soon after the exposure ends.
37°C
18°C
Low-intensity late-morning exposure. Clusters stay cool until afternoon.
Eastern aspect
Western aspect
NIP (ug/L)
0
20
40
60
80
100
N/S
E/W
NE/SW
SE/NW
Row direction


W
E
Intense early-morning exposure. Clusters heat and stay warm as ambient temperatures rise.
35°C
20°C
Low-intensity early-afternoon exposure. Helps keep clusters warm under high ambient temperatures
Eastern aspect
Western aspect
100
80
60
40
20
0
NIP (ug/L)
N/S
E/W
NE/SW
SE/NW
Row direction

2. Manipulating Grape and Wine Vegetative Aromas through Vineyard Management Practices.

K. Usher, P. Bowen, C. Bogdanoff, D. Gregory, J. Drover

Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland, B.C.

VSP

Sprawl

Experimental Design

2 Varieties

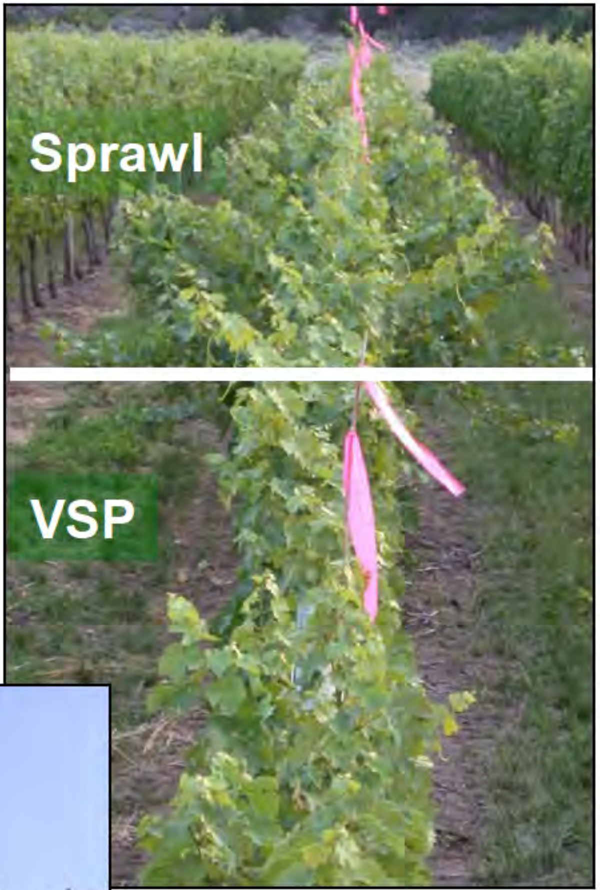
1) Cabernet Sauvignon
2) Merlot

4 Treatments X 4 Blocks

1) Sprawl and early tipping (early July)
2) Sprawl and late tipping (late July)
3) VSP and early tipping
4) VSP and late tipping

4 Sampling dates

1) Pre-veraison
2) Post-veraison
3) Commercial maturity
4) Extended maturation



Vine Measurements

- **Canopy dimensions:**
  Height
  Width
  Shoot length
  Shoot number
  Lateral number
  Lateral length

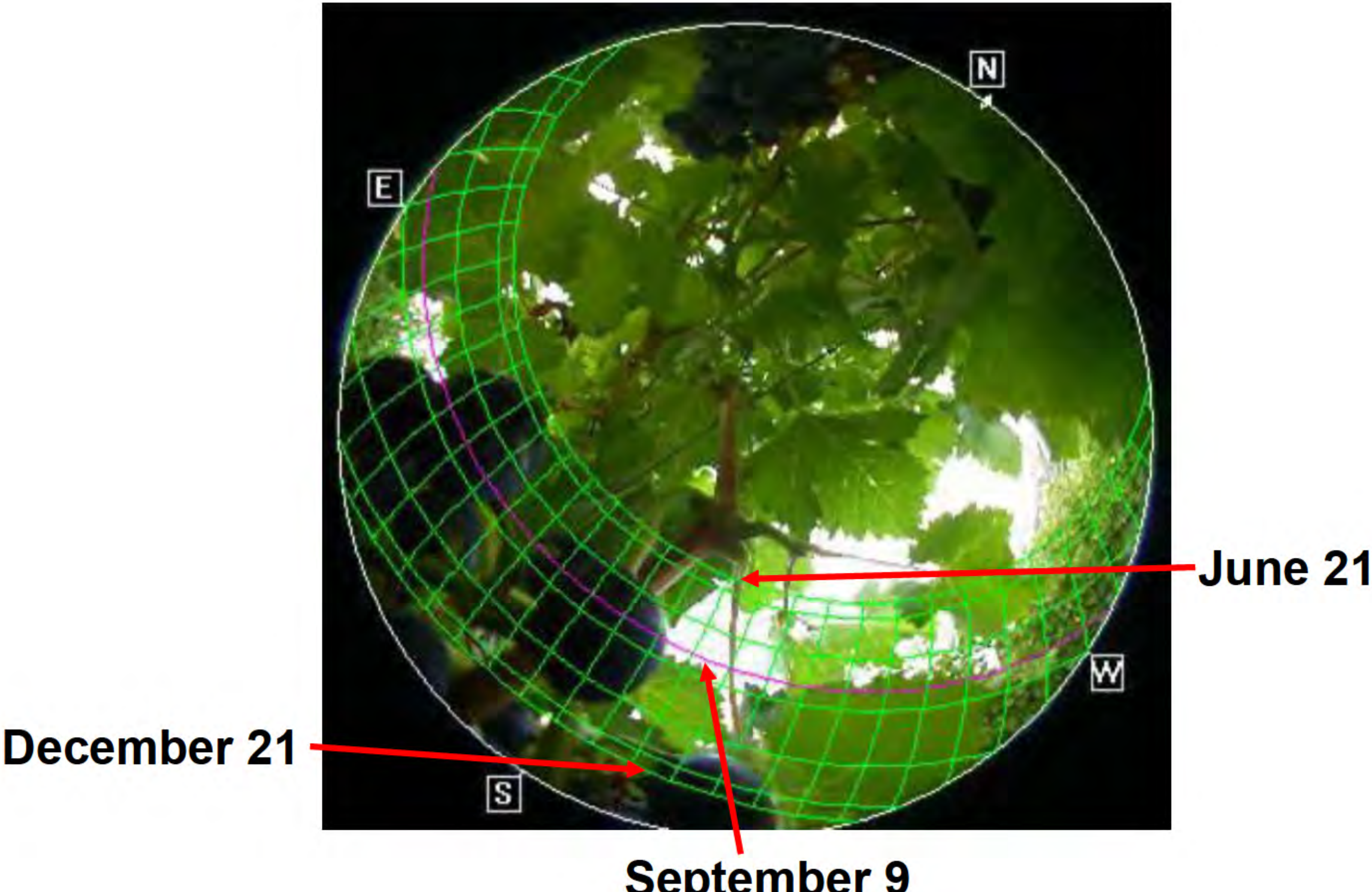
- **Crop:**
  Clusters per vine
  Cluster weight
  Berry weight
  Skin weight
  Seed weight
  Seed number

Fruit zone light penetration:
Direct radiation
Indirect radiation
Canopy gaps
Canopy area

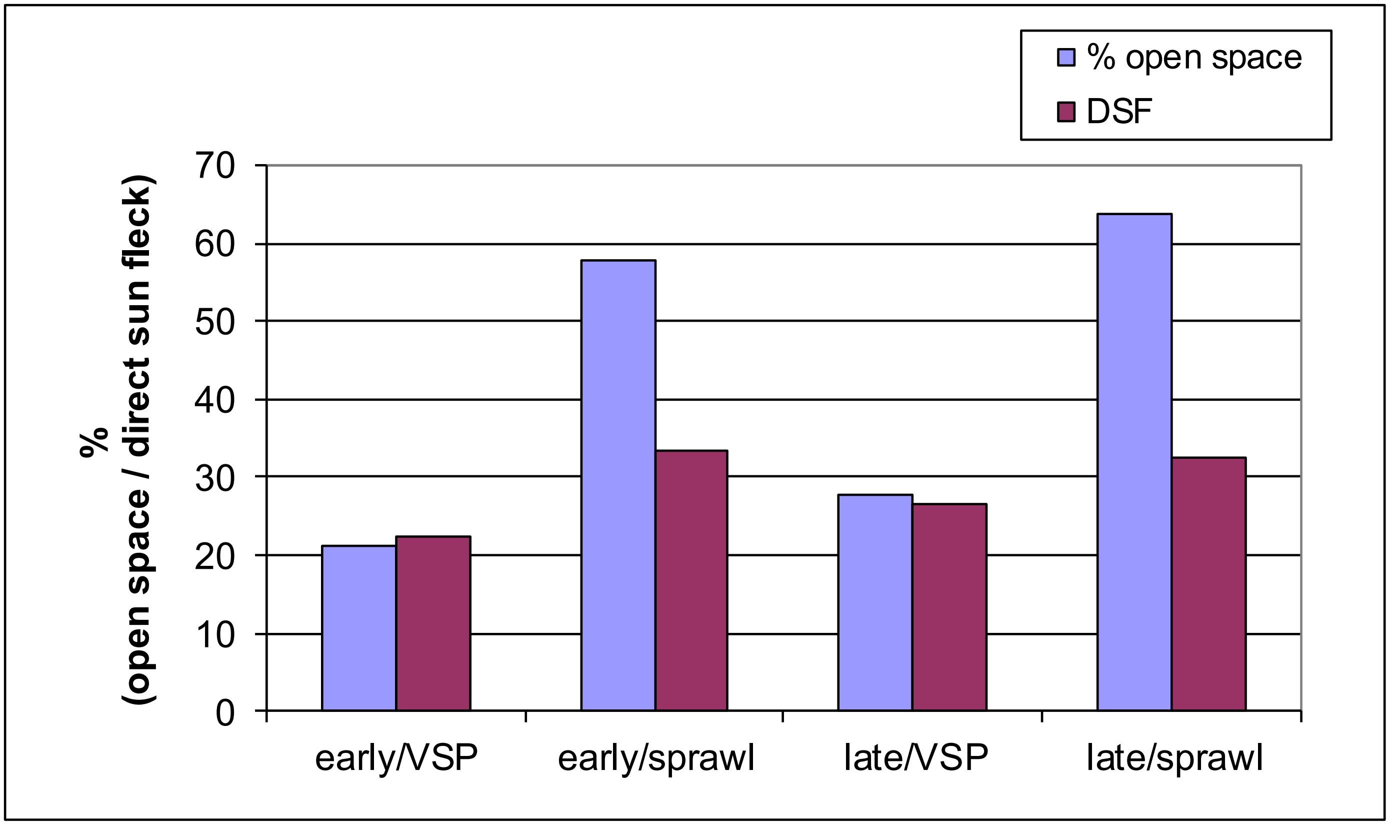
Fruit Composition

- **Basic:** Sugar
  Total acidity
  pH
- **Volatiles:** Pyrazines
- **Phenolics:** Total phenolics
  Flavanols
  Tannins
  Anthocyanins

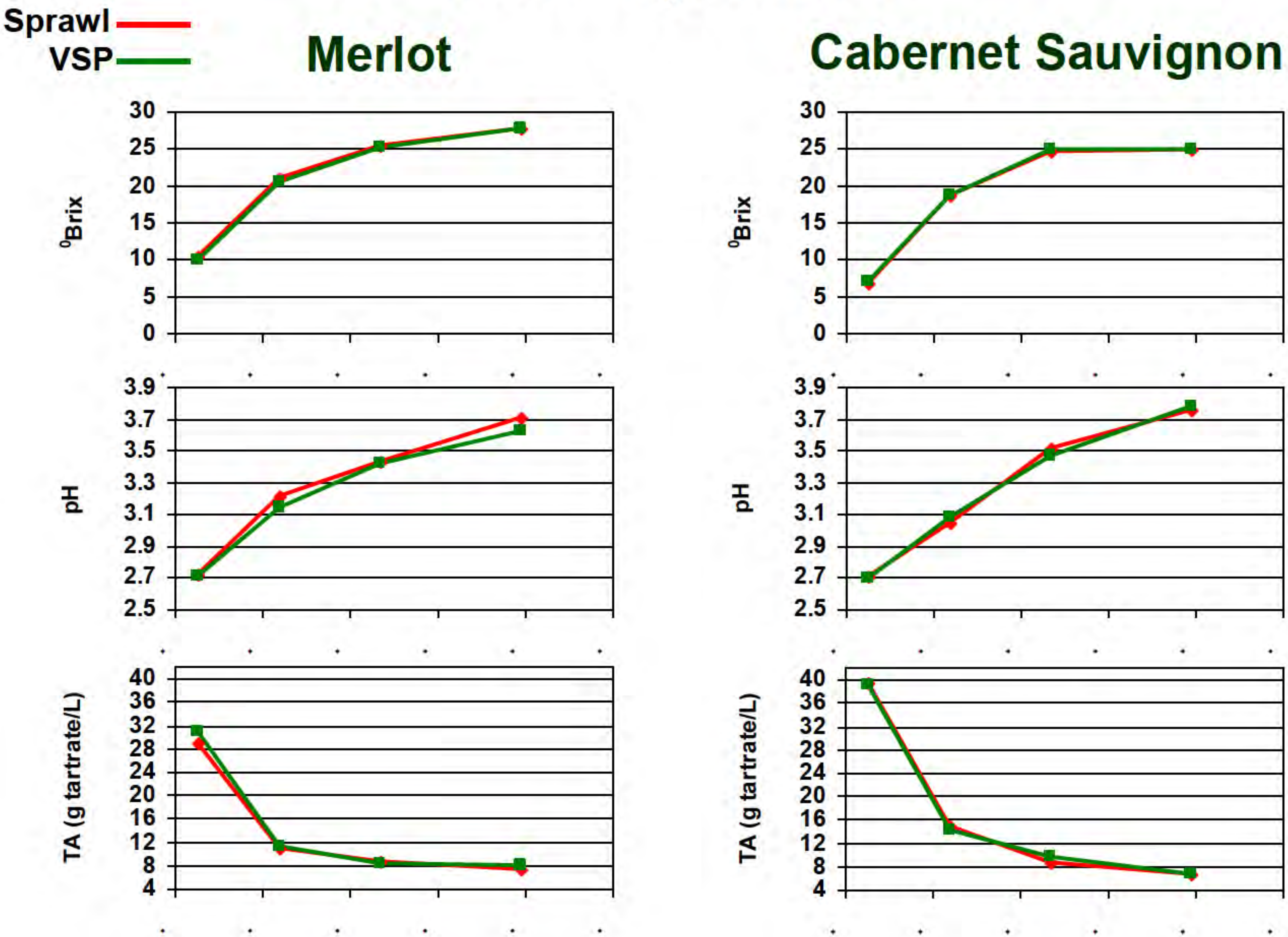
Fish Eye Photography



% Open space in canopy and direct sun flecks in fruiting zone in Cabernet Sauvignon



Basic Composition



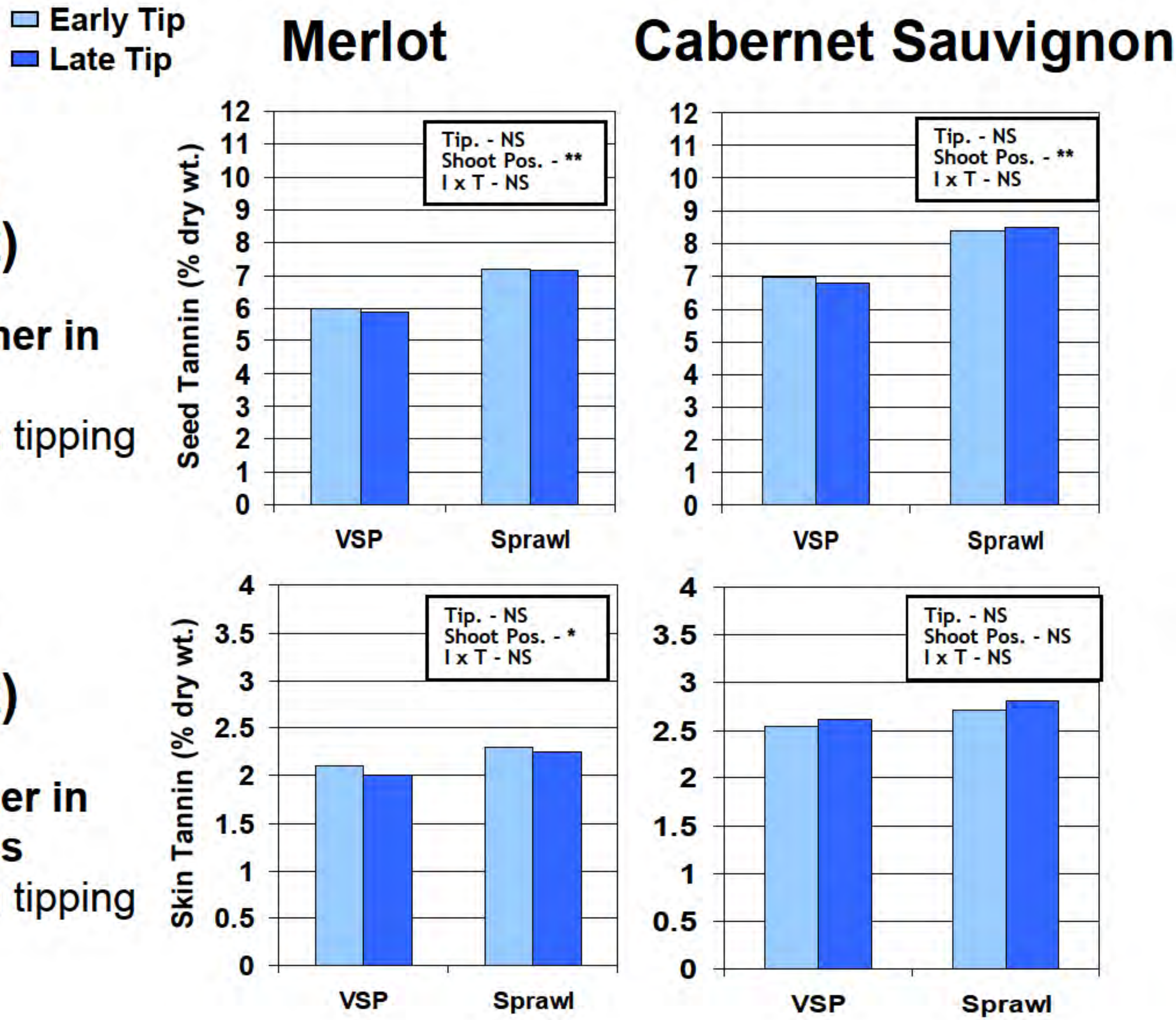
Tannin content in late October fruit

Seed Tannin (% dry weight)

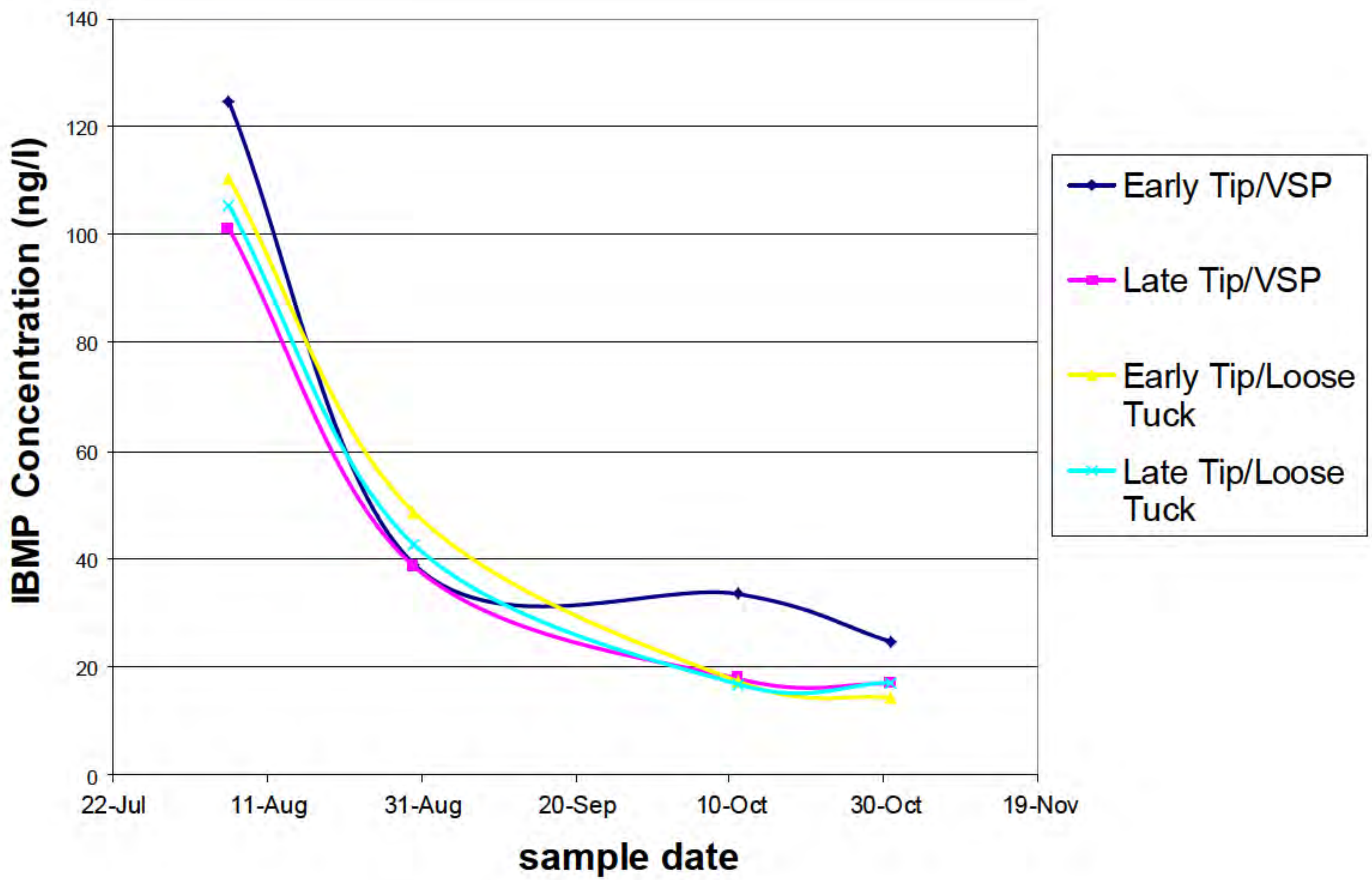
- **Seed tannin was higher in sprawl canopies**
- No difference between tipping treatments

Skin Tannin (% dry weight)

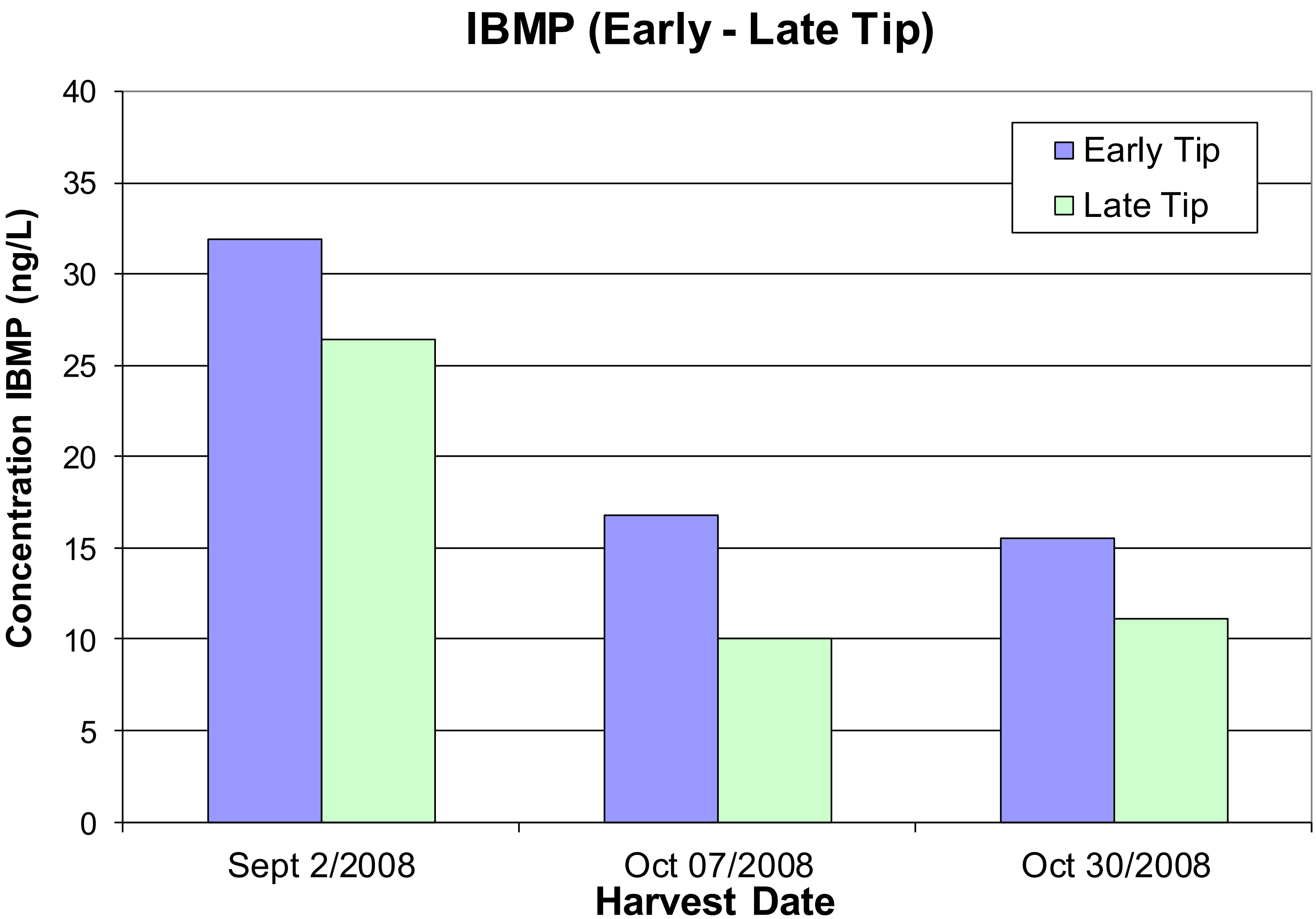
- **Skin tannin was higher in merlot sprawl canopies**
- No difference between tipping treatments



Cabernet Sauvignon IBMP content



Merlot IBMP Development



3. The Economics and Quality Impacts of Leaf Removal, Cluster Positioning and Shoot Positioning

K. Usher, T. Lowery, P. Bowen, C. Bogdanoff, D. Gregory, J. Drover

Investigate fruiting zone canopy management and its impact on fruit quality/maturity and evaluate the economics of leaf removal in commercial vineyards.

1) Survey the industry to evaluate the current leaf removal practices including timing, level of exposure and the goal(s) that growers expect to achieve.

2) Determine the economics of early season leaf removal using cost/benefit analysis.

3) Investigate the impacts of leaf removal timing and severity on grape production for improved quality.

4) Use non destructive cluster positioning and shoot positioning to alter fruit exposure level and determine the effects on quality and physical characteristics of the fruit.

Timing of Leaf Removal

Pre bloom (physical and chemical changes)

- Reduces Yield – lighter and looser clusters, smaller berries
- Increases sugar, phenolics, colour
- Increased quercetin (copigmentation)
- Lower seed mass and number

Fruit set (mainly chemical changes)

- Advanced ripening
- Acclimatize to sun exposure – sunburn
- Quercitin levels increase up to 10x (copigmentation)
- Tannin precursors decreased
- Reduce bunch rot and powdery mildew
- Reduce malate, TA and K^+

Veraison (chemical but Less known)

- Little known
- Risk sunburn

Leaf Removal in the Okanagan

Level of exposure

- How much leaf removal?
- Cooler side of vine or both sides?
- Do site conditions, row direction and canopy structure matter?

Timing

- How does timing affect Okanagan grapes?
- Do the results match the goals?

Concerns

- Sunburn
- Hail damage after early season removal
- Economics – does it pay off?
  - Quality
  - Pesticide efficiency and disease reduction
  - Quicker harvesting

1) Survey the industry to evaluate the current leaf removal practices including timing, level of exposure and the goal(s) that growers expect to achieve.

Survey Design

- 53 growers participated , 51/53 did leaf removal.
- 10 questions about leaf removal: how, when, why, how much does it cost, etc….
- Survey followed up with a site visit to measure when and how leaf removal was done

Survey Summary

- 53 vineyard owners/managers surveyed
- 96% do leaf removal
- 87% hand,13% mechanical,
- 33% do LR more than once in the season
- Estimated cost $160/acre (average for hand removal)

Reasons for doing leaf removal:	RED	WHITE
Advance ripening	20%	23%
Wine Quality	43%	35%
Pest/disease control	37%	42%
How is LR applied:		
1 side only	47%	39%
2 sides	53%	61%
Timing of LR:		
Bloom	6%	14%
Fruit set	65%	61%
Veraison	29%	25%

Impacts of leaf removal timing and severity on Syrah

Treatments

- No defoliation
- 4 Leaf pre-bloom
- 6 Leaf pre-bloom
- Fruit set leaf removal

Vineyard Measurements

- Temperature/humidity
- Light penetration to the fruiting zone
- Vigor assessments
- Return fruitfulness/winter hardiness
- Yield components

Basic Winemaking - Stopped after secondary fermentation, no oak or adjustments

Chemistry - Phenolics, fruit composition

Sensory - Judges selected from the industry winemakers

- 6 basal leaves removed pre-bloom

- 6 basal leaves pre-bloom, picture taken at fruit set

50% leaf removal at fruit set

No leaf removal (Control)

Prebloom Leaf removal reduces yield by reducing berries per cluster and cluster weight

Treatment	Year	Clusters per Vine	Cluster Weight (g)	Berries Per Cluster	Berry Weight (g)	Yield (kg/vine)	Yield (Tonnes/Acre)
No Defoliation	2012	23.7 a	218.9 c	124.5 b	1.92 a	3.62 b	5.73 b
4 leaf PB	2012	24.0 a	186.3 ab	122.1 ab	1.77 a	3.52 b	5.52 b
6 leaf PB	2012	22.6 a	170.4 a	108.5 a	1.74 a	2.90 a	4.40 a
Fruit Set	2012	23.9 a	207.7 bc	115.4 ab	1.87 a	3.79 b	5.55 b
No Defoliation	2013	20.5 a	144.7 b	170.8 b	1.28 b	2.86 c	4.38 c
4 leaf PB	2013	19.4 a	111.7 a	95.5 a	1.14 ab	2.38 b	3.47 b
6 leaf PB	2013	19.9 a	86.0 a	87.0 a	0.93 a	1.92 a	2.76 a
Fruit Set	2013	18.8 a	131.1 b	146.5 b	1.29 b	2.79 c	3.96 c

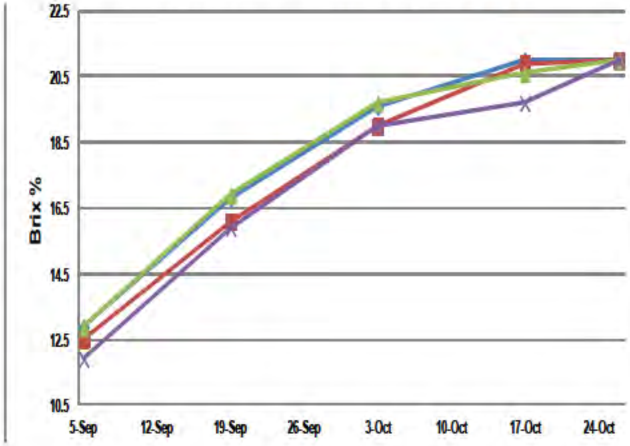
% Decrease

6 leaf PB	2012		33%	13%	9%	20%	23%
	2013		40%	49%	27%	33%	37%

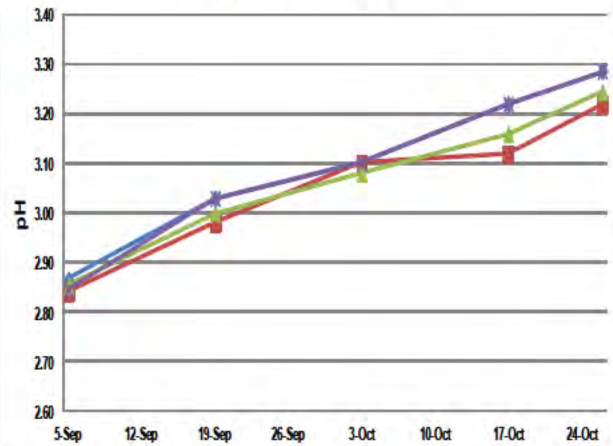
Shiraz Berry Composition

No defoliation
4 leaf PB
6 leaf PB
Fruit Set

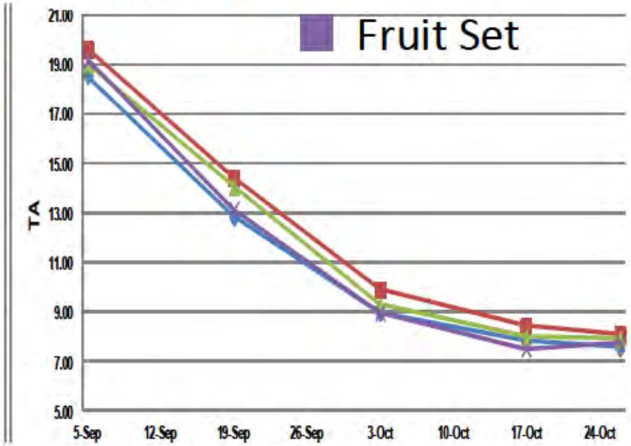
Soluble Solids, 2012



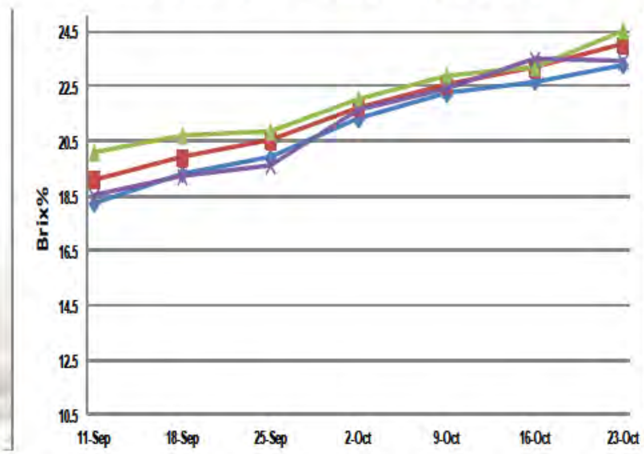
pH, 2012



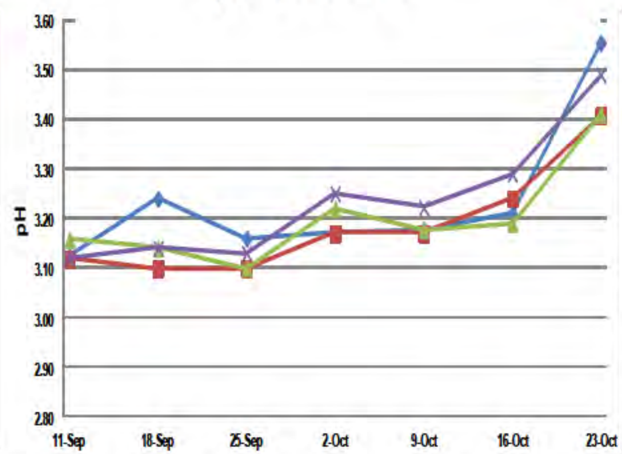
TA, 2012



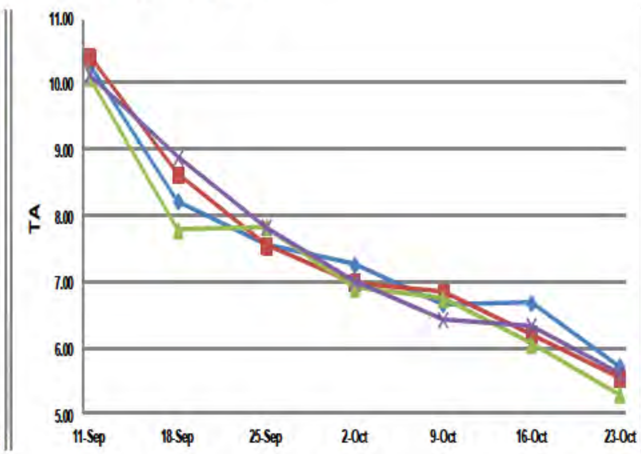
Soluble Solids, 2013



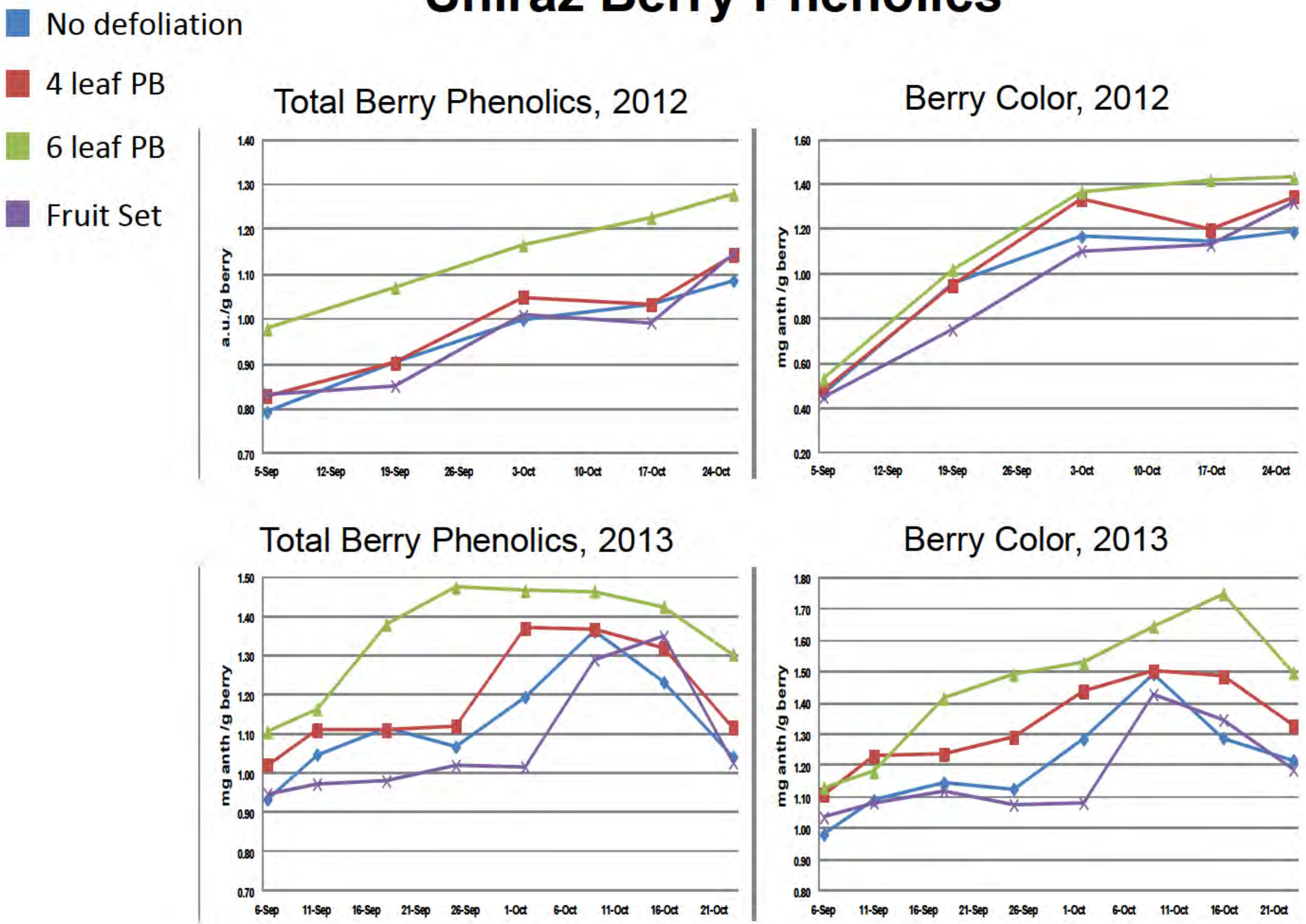
pH, 2013



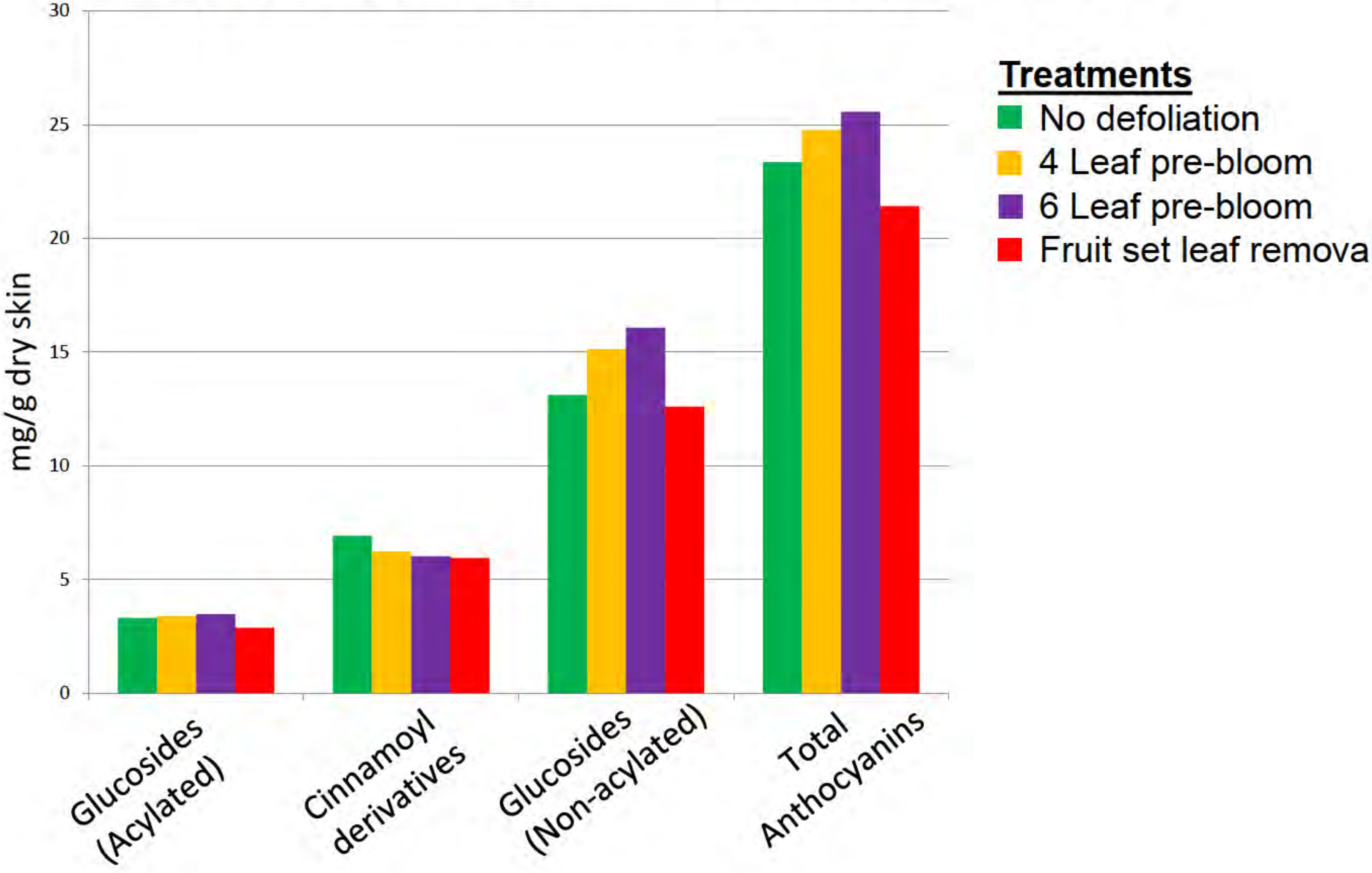
TA, 2013



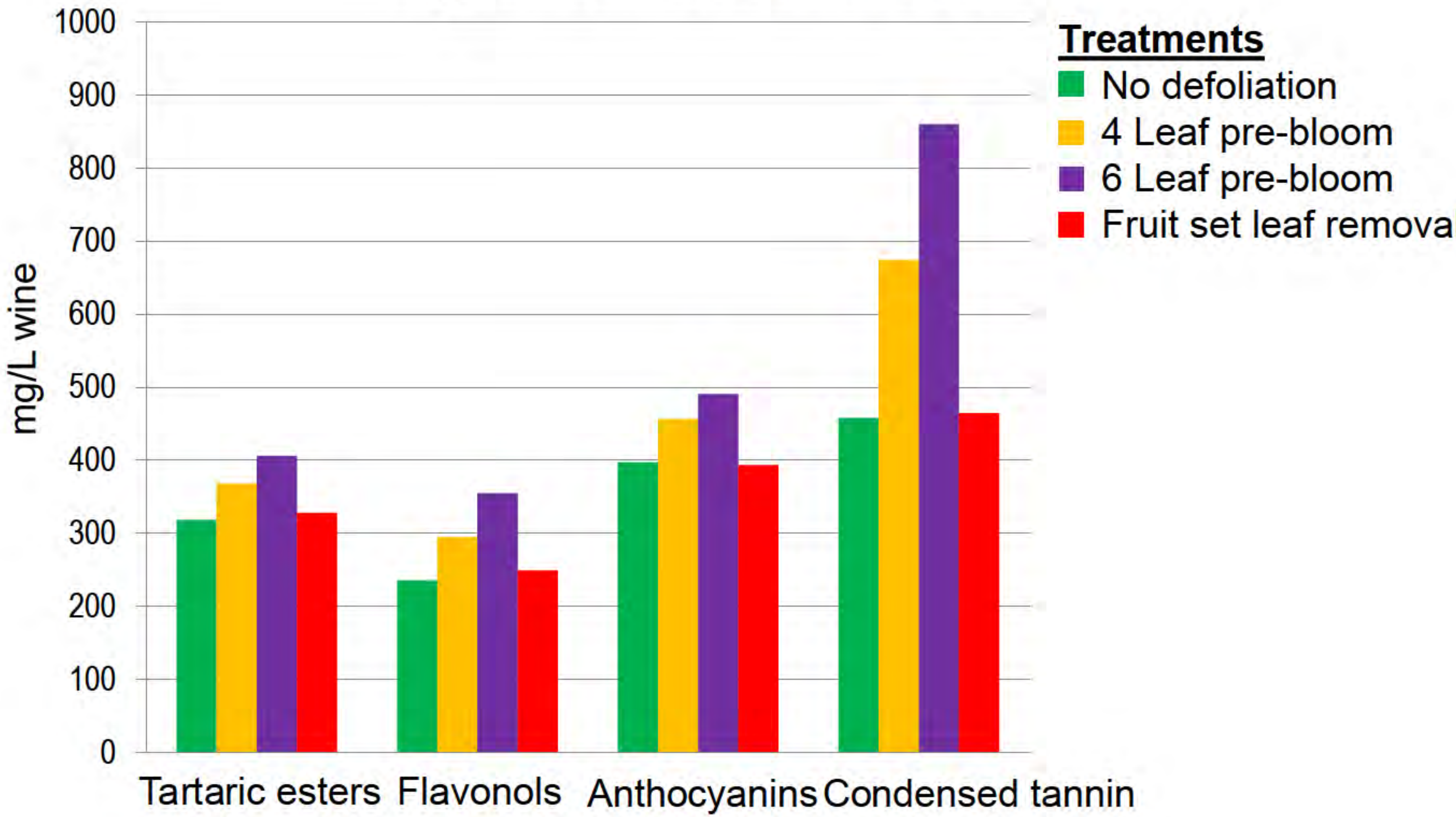
Shiraz Berry Phenolics



Syrah Skin Anthocyanin Content

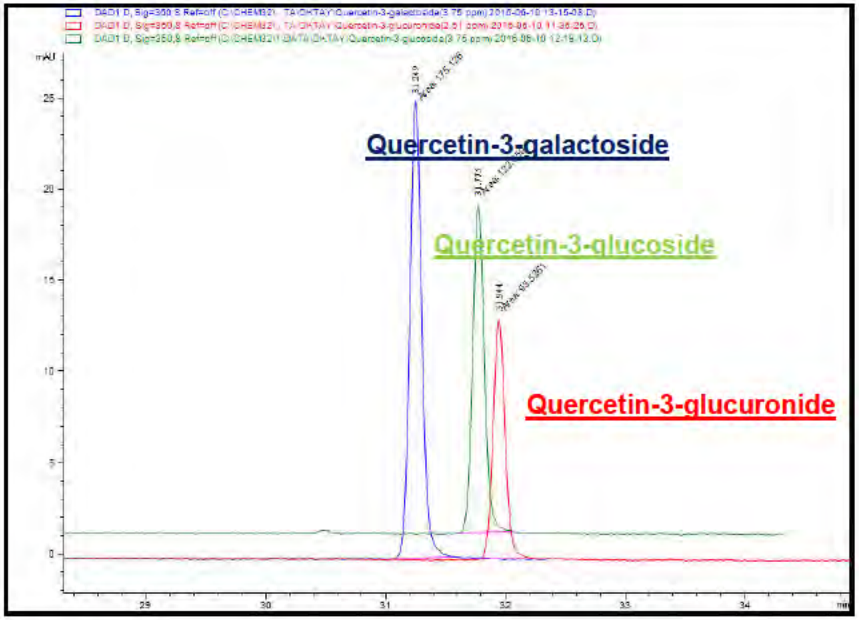


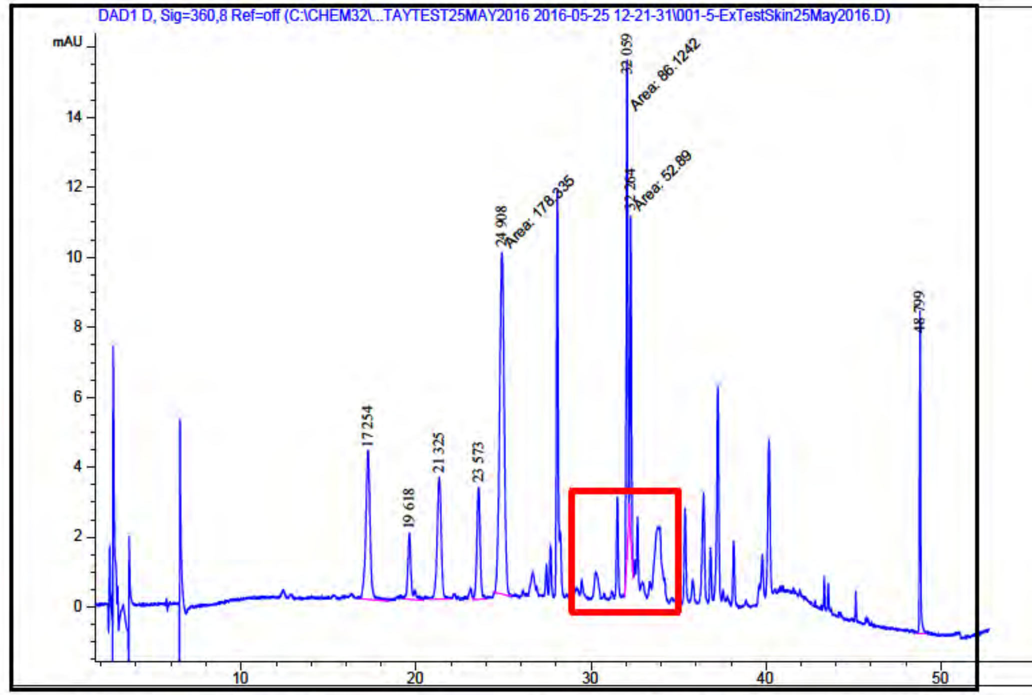
Syrah Wine Phenolics



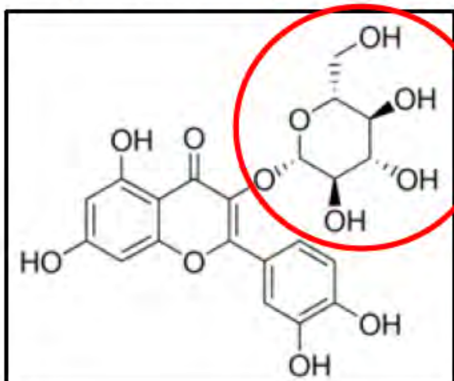
A twofold increase in condensed tannins with the 6 leaf removal pre-bloom

Syrah Skin Quercetin

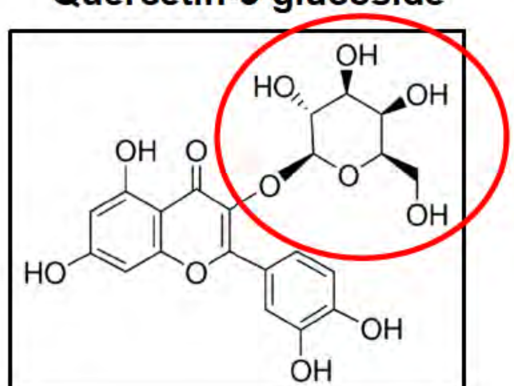




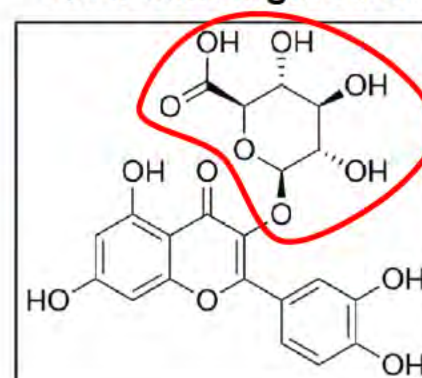
Quercetin-3-galactoside



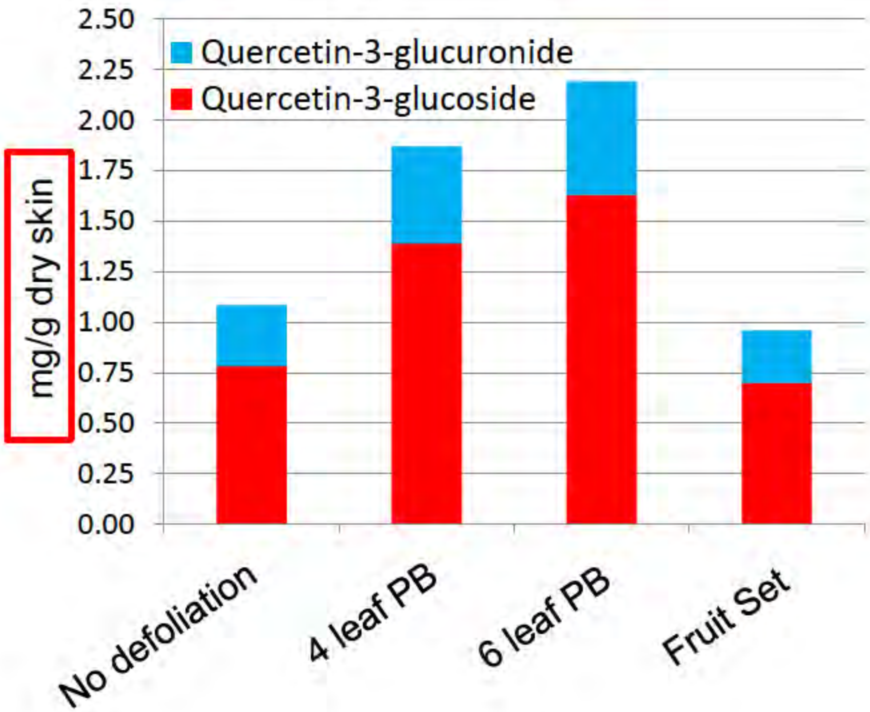
Quercetin-3-glucoside

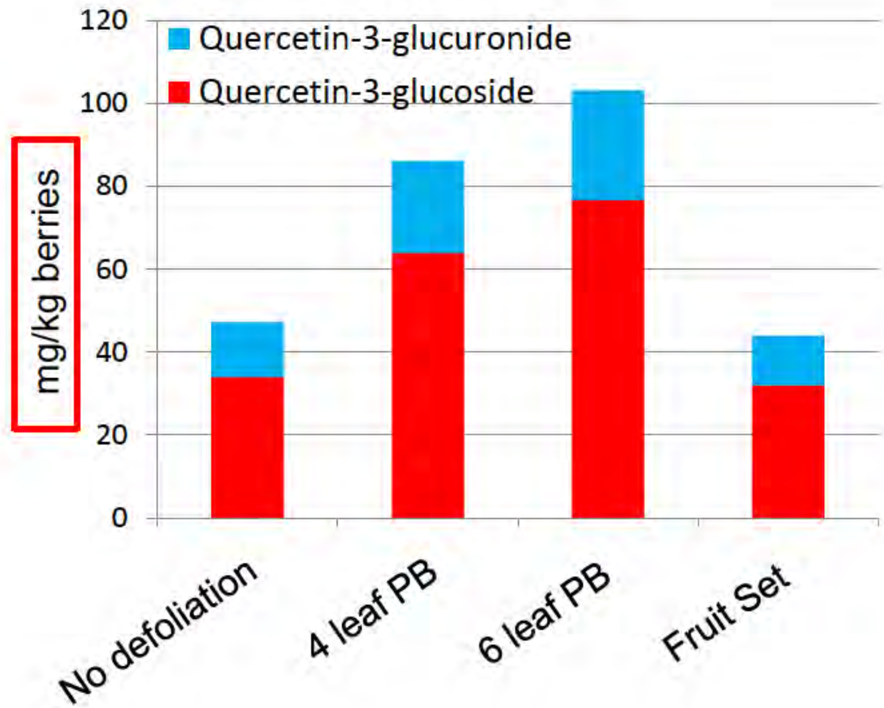


Quercetin-3-glucuronide

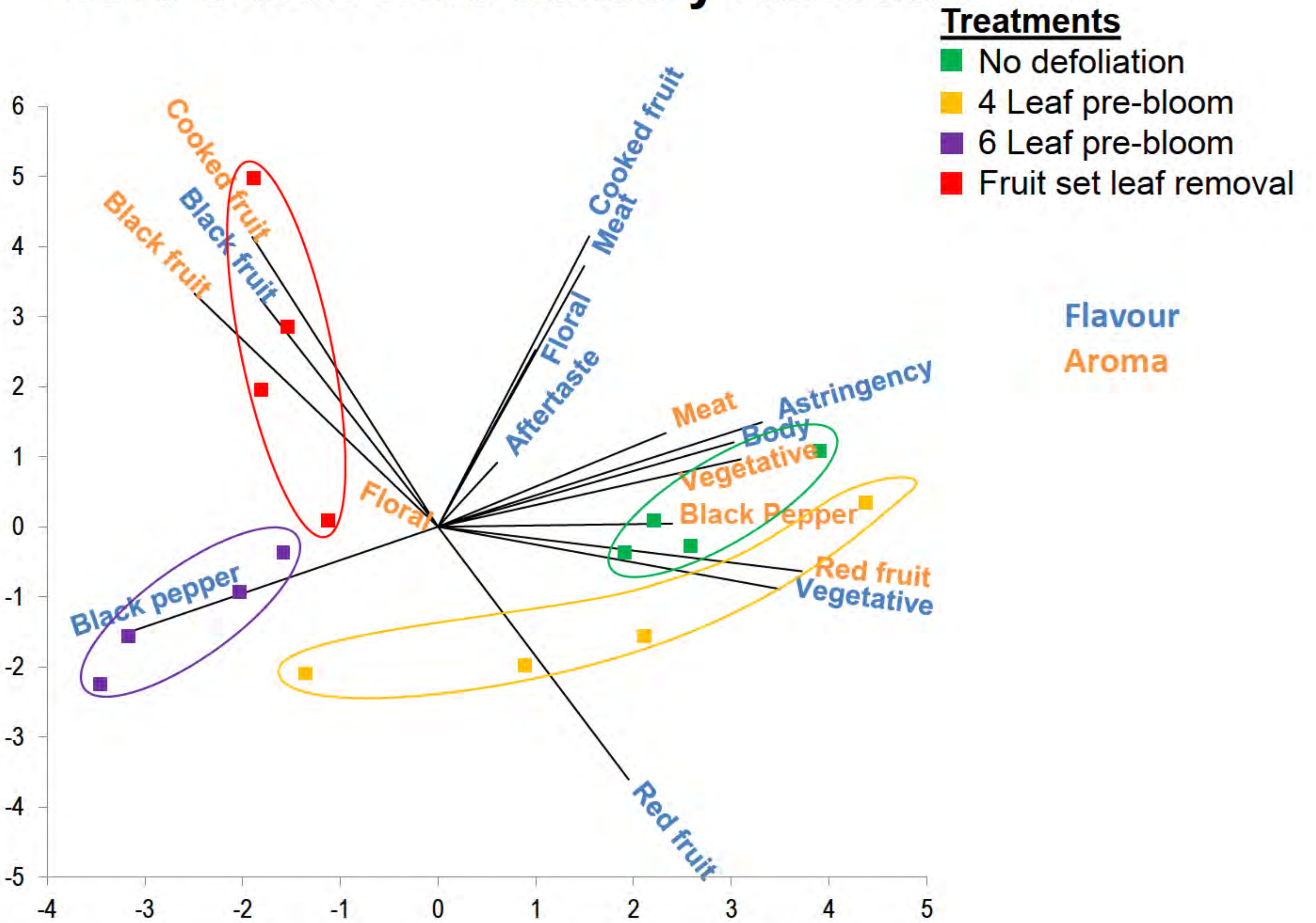


Quercetin Content

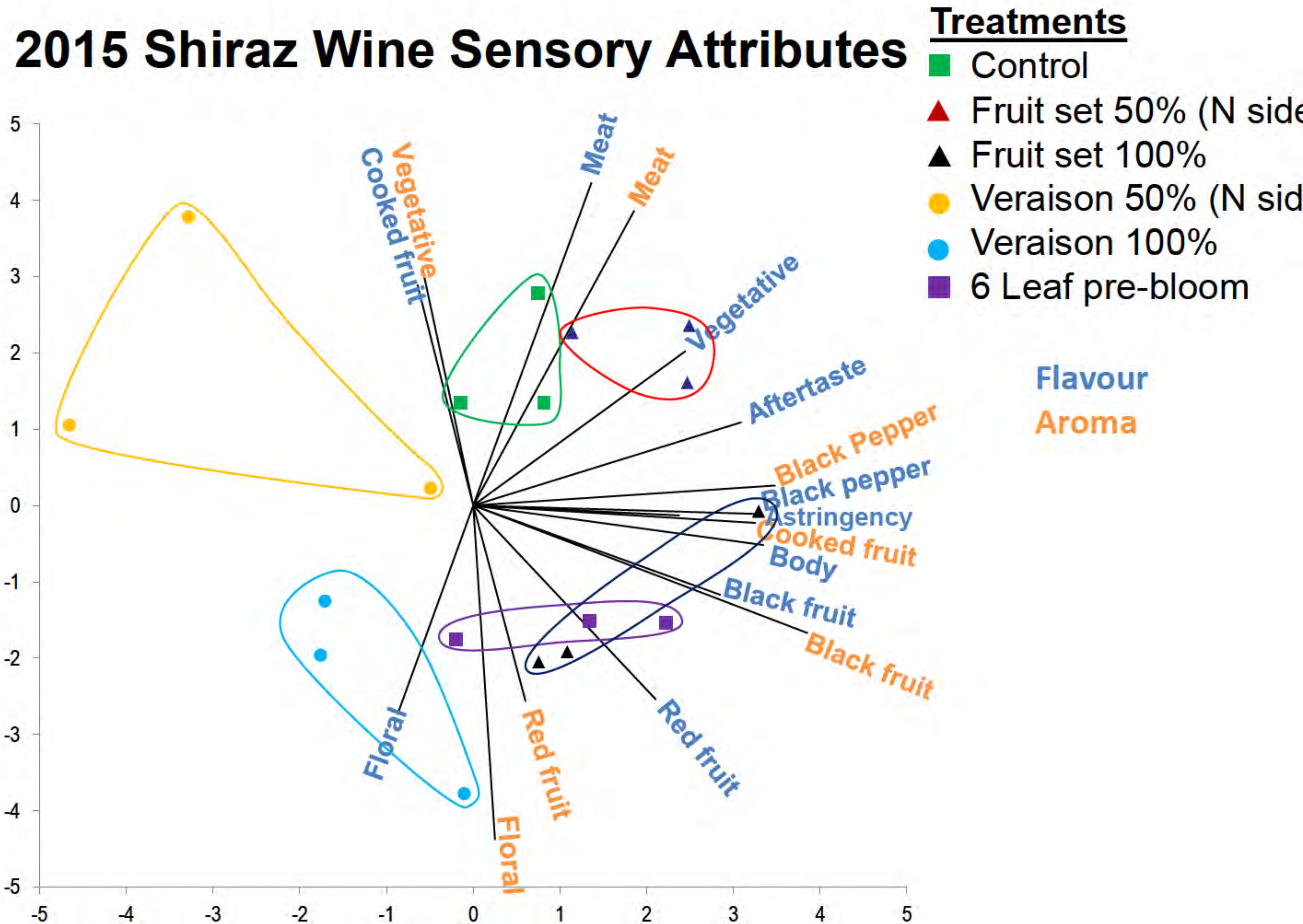




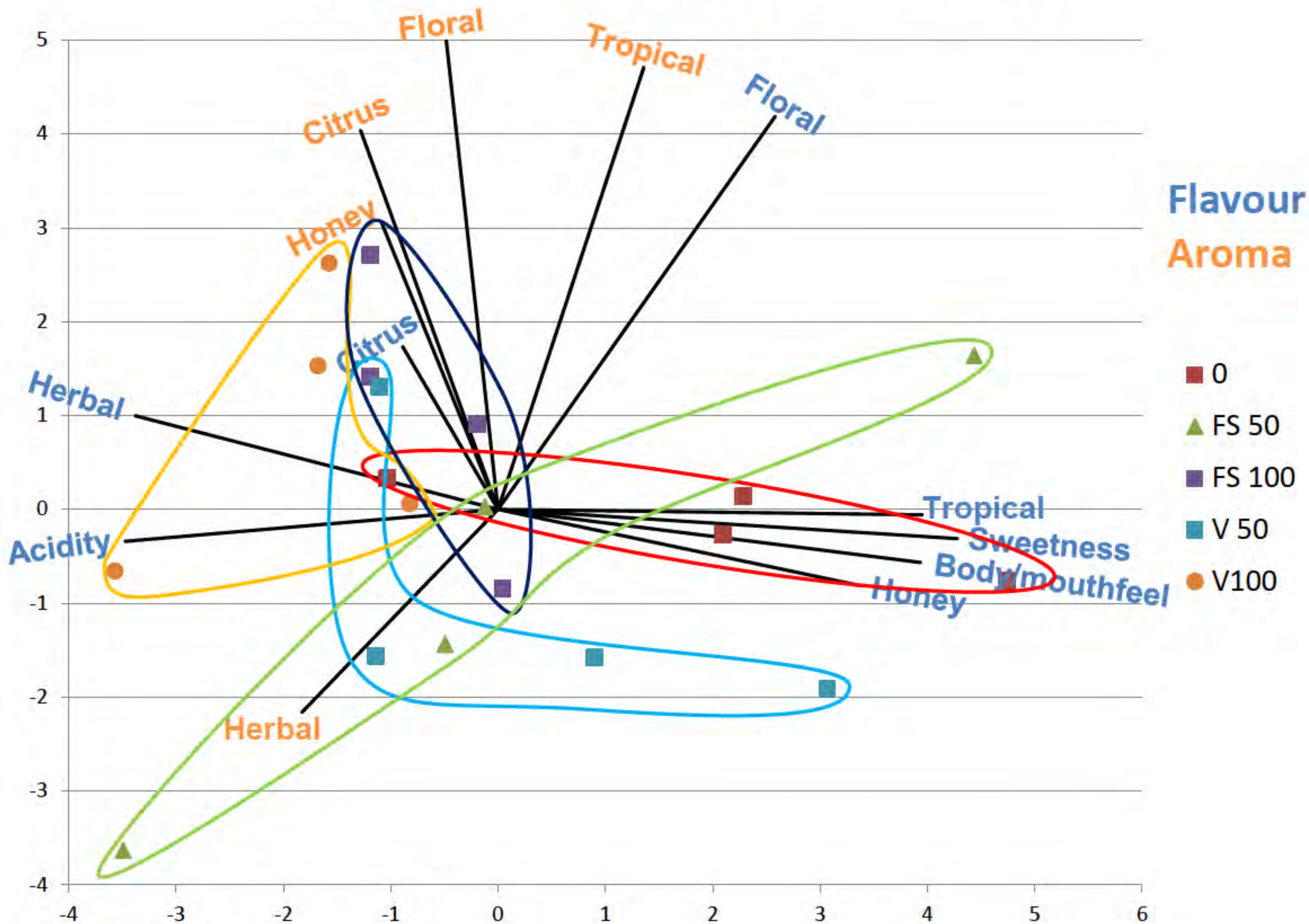
2013 Shiraz Wine Sensory Attributes



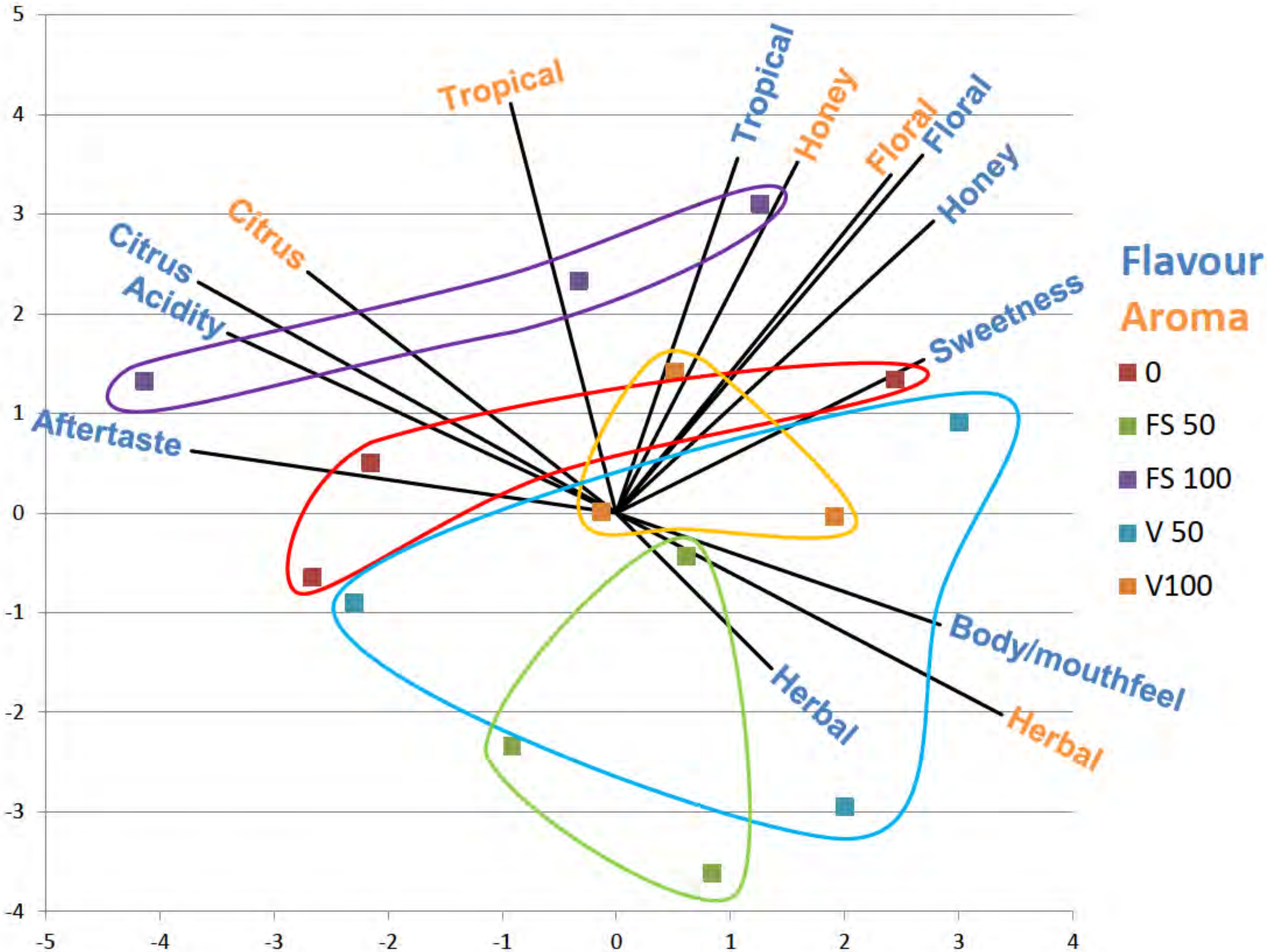
2015 Shiraz Wine Sensory Attributes



2014 Riesling Sensory



2015 Riesling Sensory



Timing of Leaf Removal

Pre bloom (physical and chemical changes)

- Reduces Yield – lighter and looser clusters, smaller berries
- Increases sugar, phenolics, colour
- Increased quercetin - stabilizes wine color
- Lower seed mass and number

Fruit set (mainly chemical changes)

- Advanced ripening
- ? Acclimatize to sun exposure – sunburn
- Quercitin levels increase up to 10x – polymeric pigment stability
- Tannin precursors decreased
- ? Reduce bunch rot and powdery mildew
- Reduce malate, TA and K^+
- Reduced IBMP
- Increases aromatics (free and bound) e.g. terpenes

Veraison (chemical but Less known)

- ? Very little known – reduce veggie aroma and change aroma profile
- ? Risk sunburn

PARC Wine Grape Research Team

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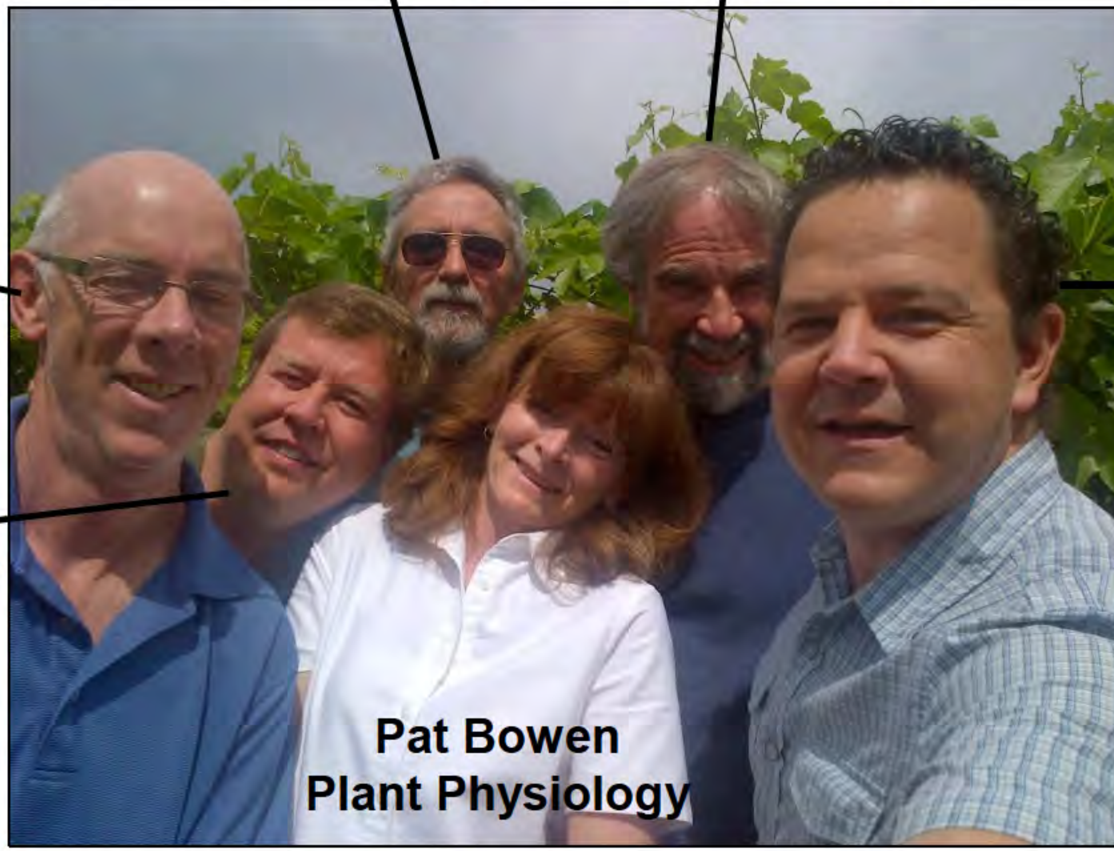
Entomology

Carl Bogdanoff
Plant Physiology

Dan O'Gorman
Plant Pathology

José Úrbez Torres
Plant Pathology

Kevin Usher
Phytochemistry



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Soil Resources

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Nematology

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Sensory Analysis

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Agiculture et Agroalimentaires Canada

Canada

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- BC Wine Grape Council & AAFC
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- David Gregory, John Drover, Tom Kopp

3. Light management – Effects of Row Direction and Cluster Exposure in Merlot

Goals of Canopy Management

1. Advance maturity

2. Produce high quality fruit

What is the optimum light exposure pattern to achieve the highest quality: mature and desirable?

Row direction affects the timing of cluster and canopy exposure – does it affect maturation and quality?

ROW DIRECTION X CLUSTER EXPOSURE

We can't do this with our resources!

Gain some insights by comparing treatment effects in blocks with contrasting row directions.

Light Management = Canopy Management

Goals:

- produce mature, high-quality fruit
- reduce/eliminate sunburn

- Fruit quality is affected by sun exposure
- Are effects consistent by row direction?

Compare exposure effects in contrasting row directions

Bull Pine Vineyard, Constellation

Cluster Exposure Experiments

Variety – Merlot 346 on Riparia Gloire

2 experiments - contrasting row directions

Treatments :

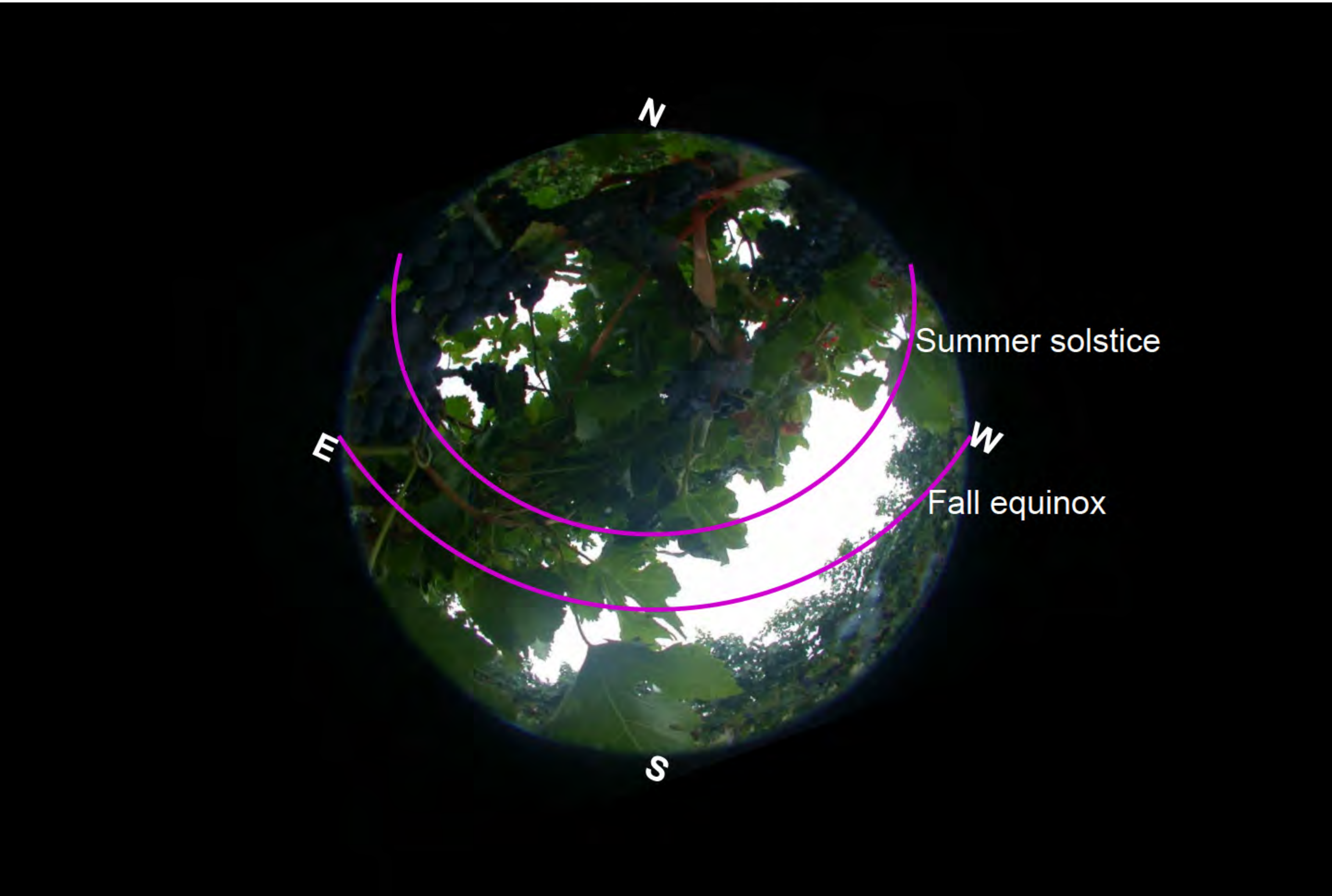
- shaded clusters, each side of vines
- exposed clusters, each side of vines

via shoot, cluster and leaf positioning

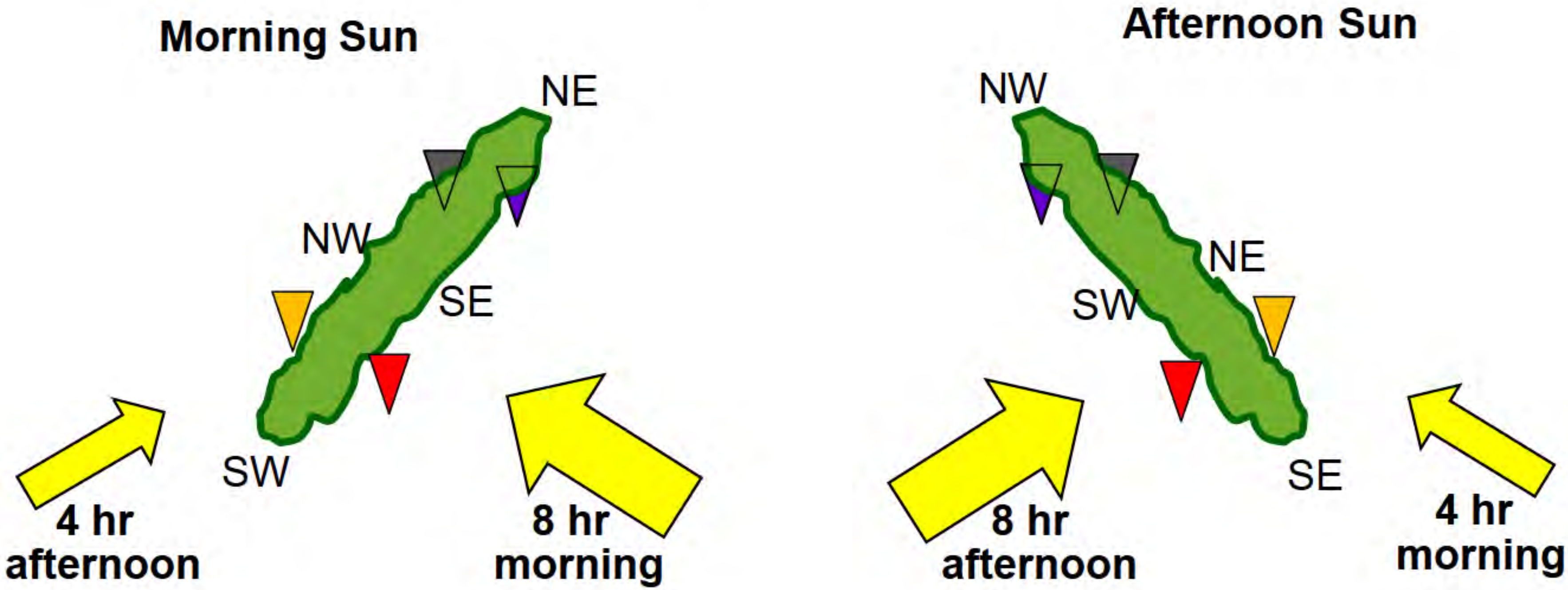
Wines – 3 treatments:

- exposed, each side of vines
- shaded

Fisheye Image

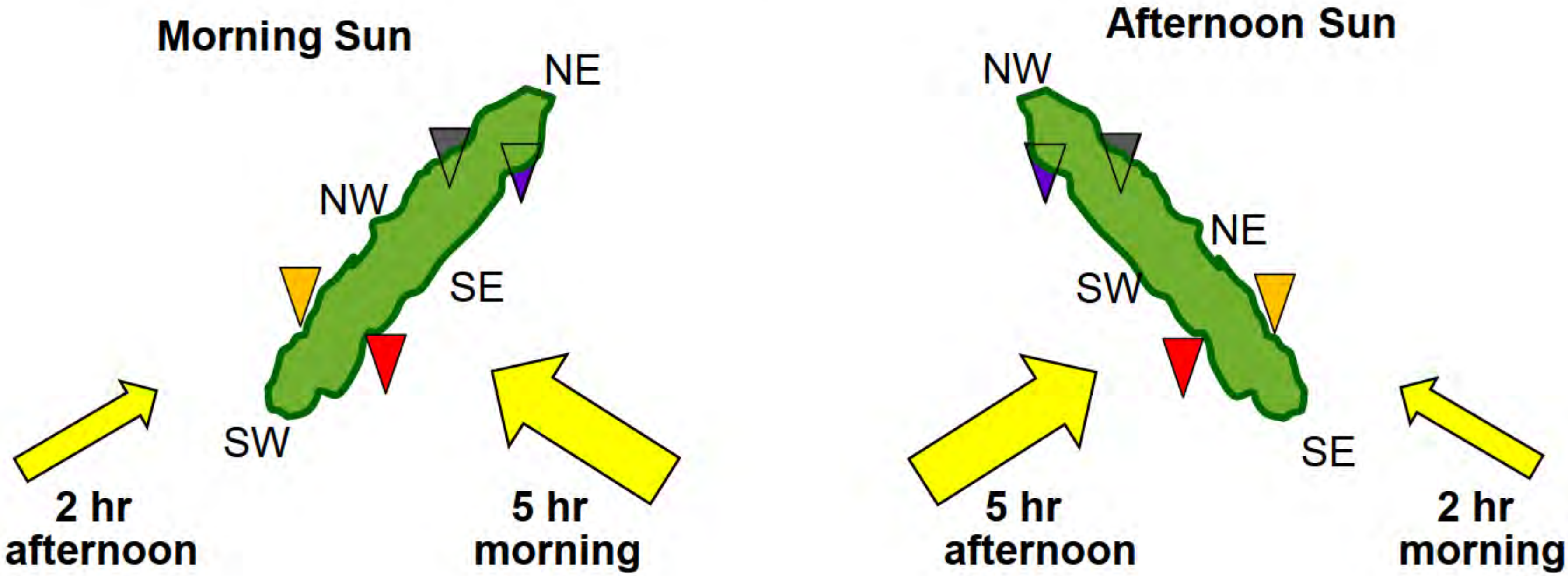


Summer



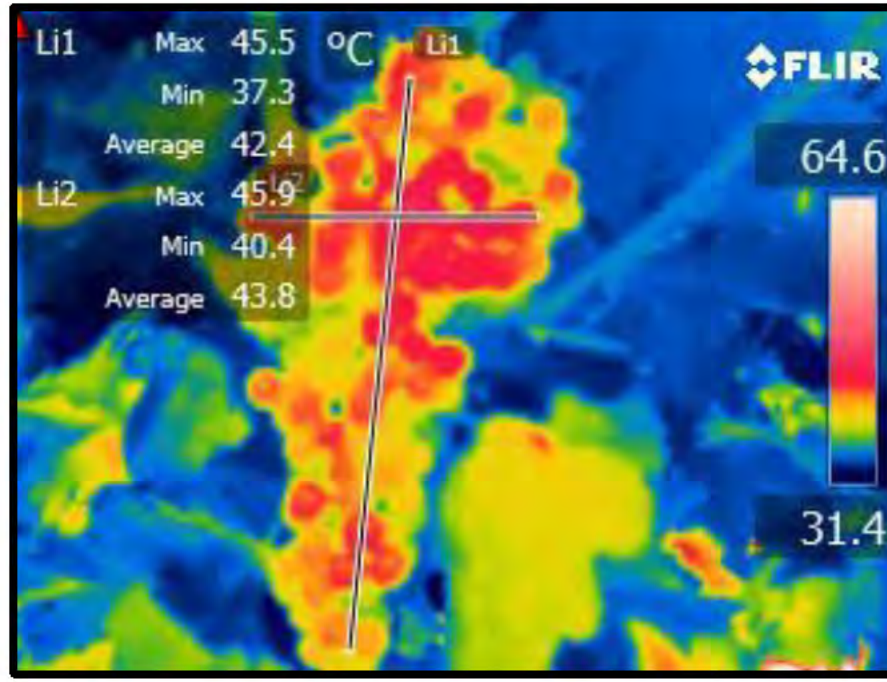
Morning Sun
NE
NW
SE
SW
4 hr afternoon
8 hr morning
Afternoon Sun
NW
NE
SW
SE
8 hr afternoon
4 hr morning

Fall

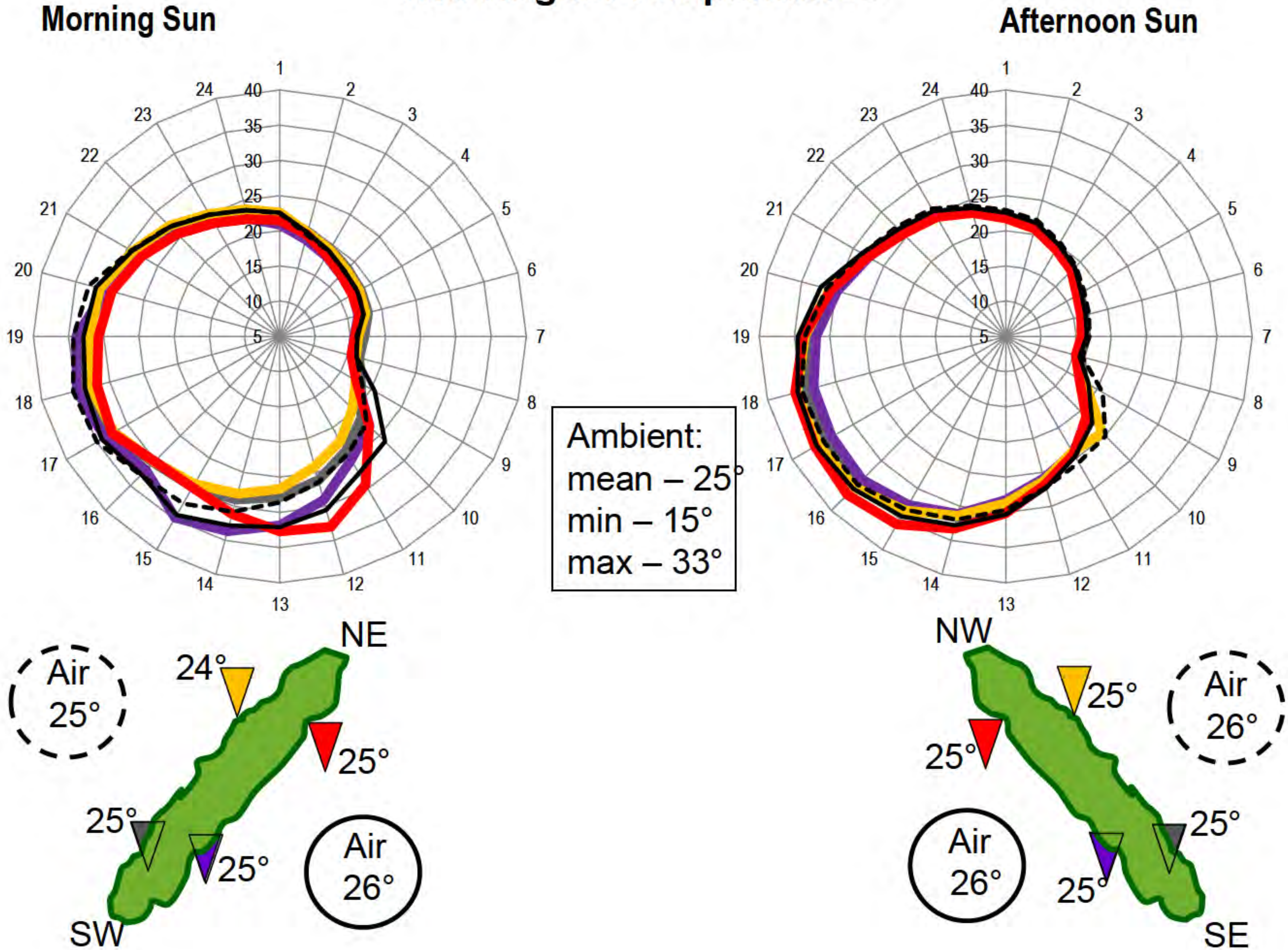

Morning Sun
NE
NW
SE
SW
2 hr
afternoon
5 hr
morning
Afternoon Sun
NW
NE
SW
SE
5 hr
afternoon
2 hr
morning

IR Sensor

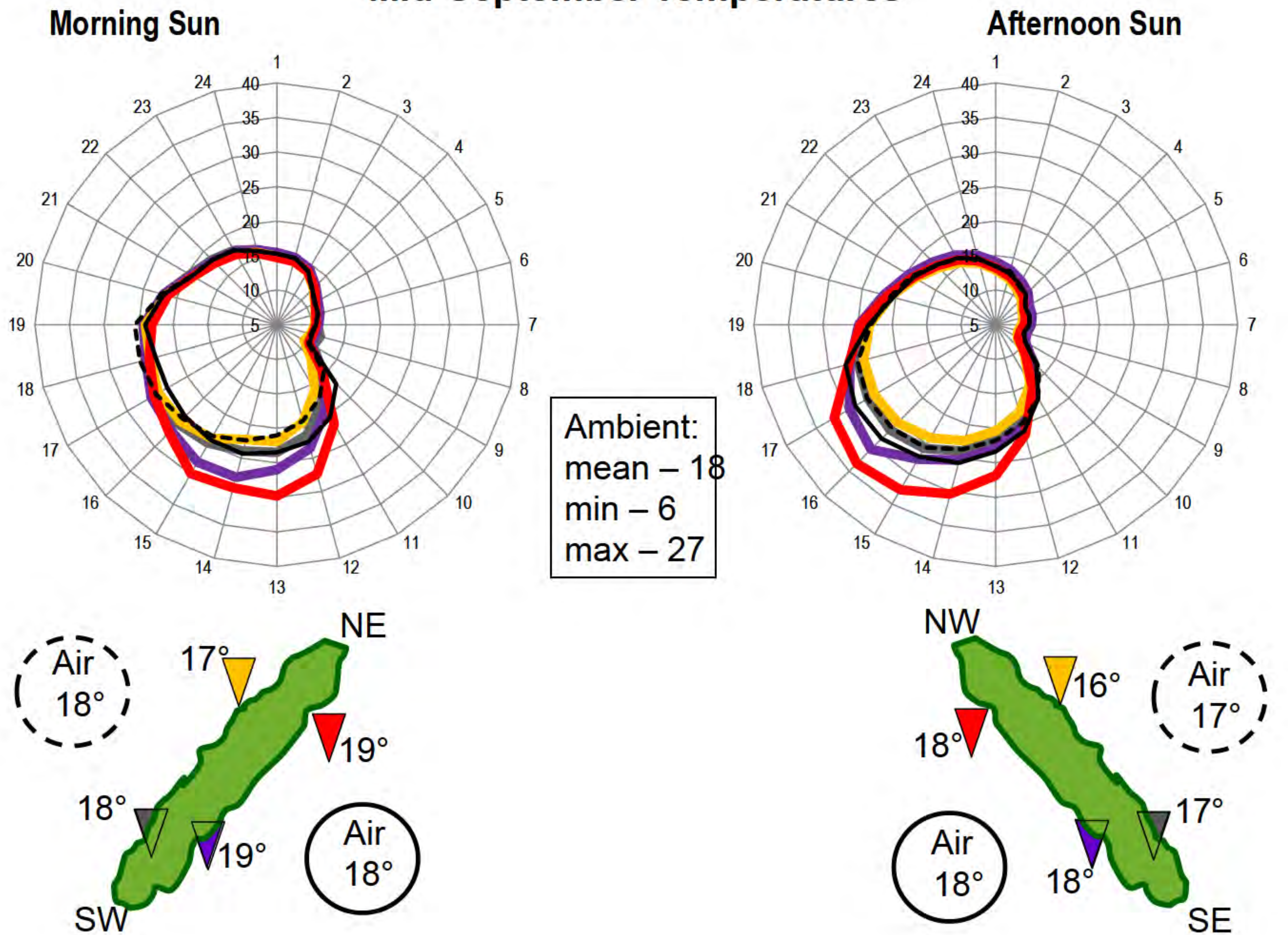
IR Image



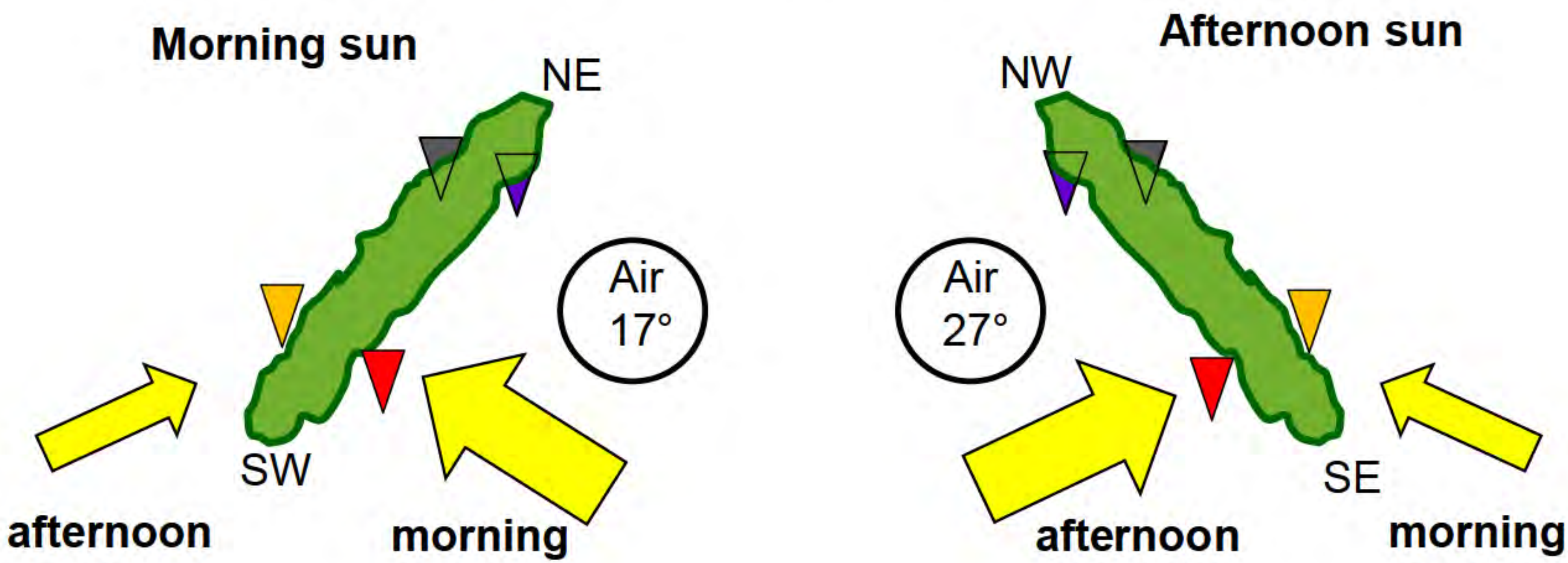
Mid-August Temperatures



Mid-September Temperatures



Yield, Pruning Mass and Fruit Maturnation



Yield: 3.7 Kg/vine

Pruning mass: 430 g

September 10: 20.5 Brix

October 19: 25.3 Brix

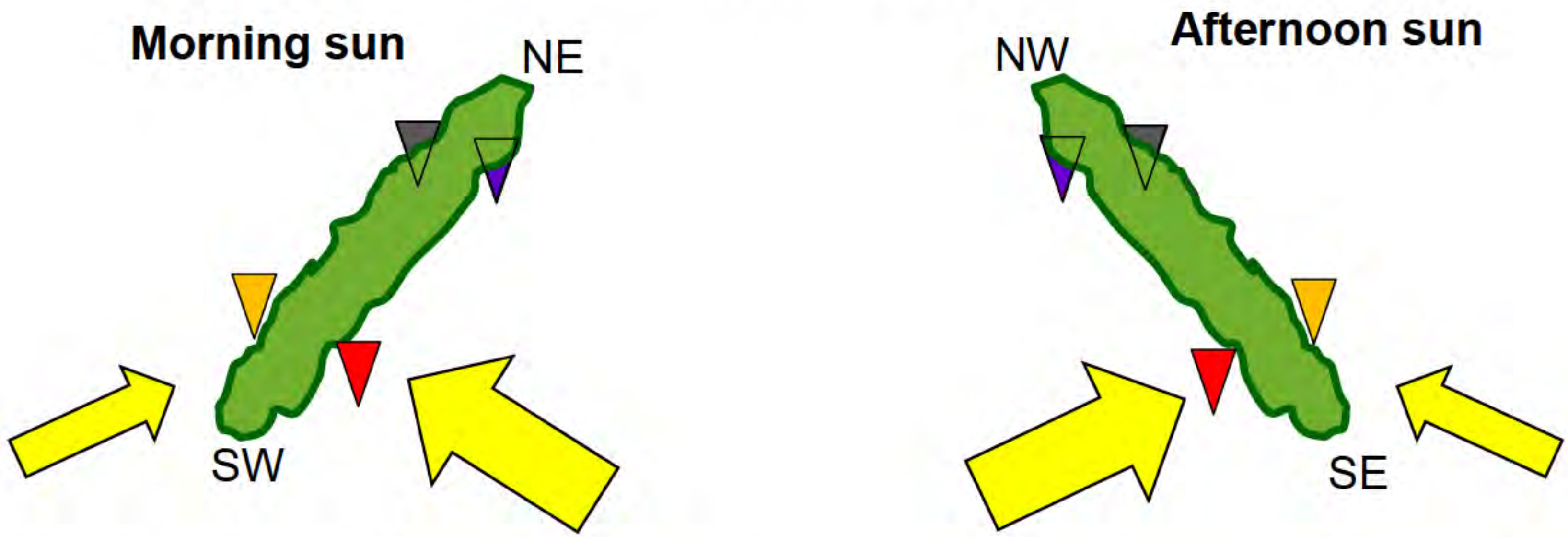
Yield: 3.5 Kg/vine

Pruning mass: 450 g

September 10: 20.2 Brix

October 5: 25.5 Brix

Wine Quality



Afternoon:
- Lowest phenolics
- Lowest anthocyanin
- Least body

Morning:
- Most body
- Highest phenolics
- Highest anthocyanin
- Highest colour
- Least vegetative
- Lowest must TA
- Most fruity

Shaded:
- Most vegetative
- Lowest colour
- Least fruity

Afternoon:
- Lowest phenolics
- Lowest anthocyanin
- Least vegetative
- Lowest must TA
- Low colour

Morning:
- Most body
- Highest phenolics
- Highest anthocyani
- Highest colour

Shaded:
- More vegetative
- Low colour
- Least body

King Family Farm