Impact of Winter Injury and Frost Damage on Frontenac and Marquette Grapes in Clayton, NY

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NORTHERN GRAPES PROJECT

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May 14


May 25

Training Systems Trials in NY

Marquette and Frontenac

Vertical Shoot Positioning (VSP):

- Midwire cordon with catch wires
- Shoot position, shoot tip, leaf removal
- *Intensive canopy management.*

Top Wire Cordon (TWC):

- High cordon
- ‘shoot combing’
- *Moderate canopy management.*

Umbrella Kniffen (UK):

- 3-4 long canes arched and tied to middle wire.
- No additional canopy management
- *Minimal canopy management.*

2013 – Frontenac Results in a Nutshell

Frontenac Treatment	Yield t/acre	Yield lb/vine	Clusters/ vine	Avg.berry wt. (g)	Cluster wt. (g)	Berries/ cluster
TWC	4.6	14.8	64.8	1.12	104.0	92.4
VSP	4.0	12.9	57.2	1.17	102.1	86.6
UK	4.9	15.9	64.4	1.13	107.2	94.1

- No differences in yield or yield components
- No differences in Brix, pH, or TA at harvest

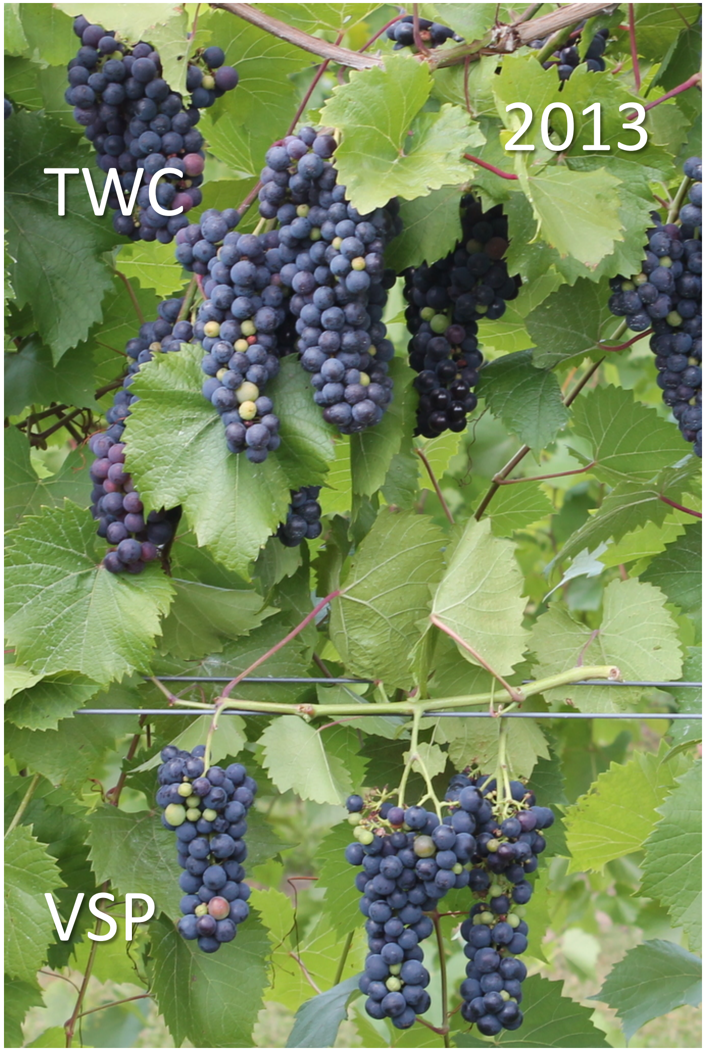
2013 – Marquette Results in a Nutshell

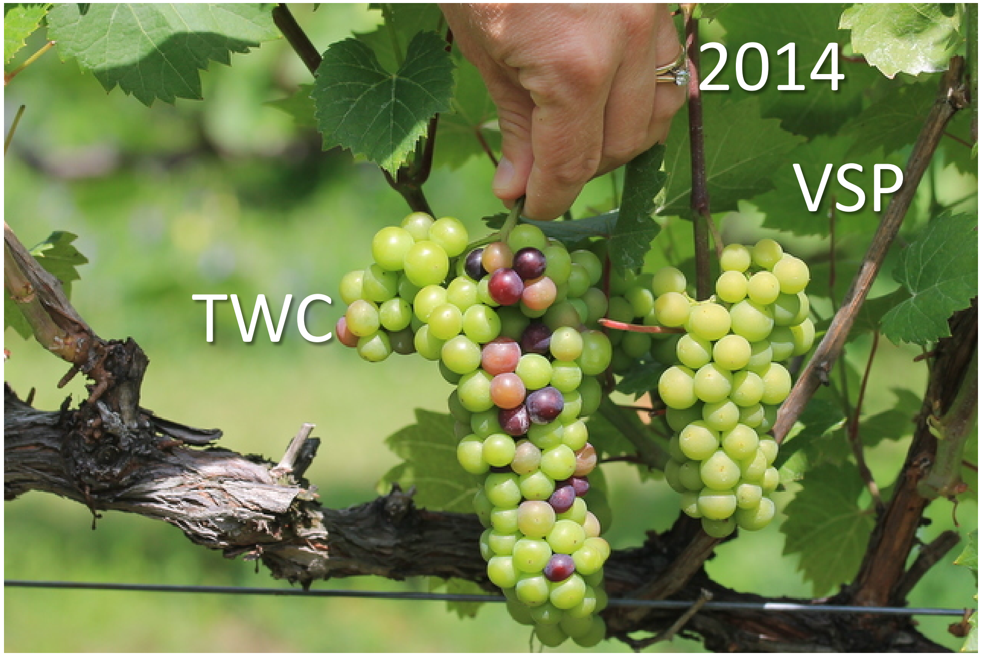
Marquette Treatment	Yield t/acre	Yield lb/vine	Clusters/ vine	Avg.berry wt. (g)	Cluster wt. (g)	Berries/ cluster
TWC	4.4 a	14.0 a	83.5 ab	1.21 ab	76.6 a	63.2 a
VSP	2.3 b	7.5 b	69.1 b	1.13 b	48.9 b	43.2 b
UK	5.0 a	15.9 a	100.9 a	1.23 a	72.0 a	58.6 a

- Yield in VSP half of TWC and UK – all yield components lower
- Small, but significant difference in Brix and TA at harvest
  - Brix: VSP 27.4, TWC 25.6, UK 25.3
  - TA: VSP 12.9, TWC 12.9, UK 13.5

TWC vs VSP

Marquette 2013 and 2014





2014 – the Polar Vortex








2014 - Frontenac

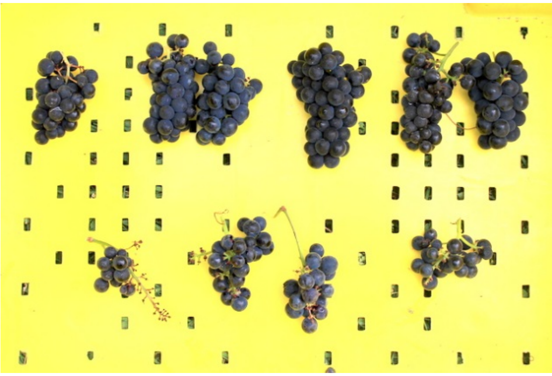
Frontenac Treatment	Yield t/acre	Yield lb/vine	Clusters/ vine	Avg.berry wt. (g)	Cluster wt. (g)	Berries/ cluster
TWC	0.5 a	1.8 a	13.2 a	1.4	58.1 ab	41.4 ab
VSP	0.1 b	0.5 b	4.5 b	1.3	48.3 b	36.0 b
UK	0.4 ab	1.1 ab	8.0 ab	1.3	63.8 a	48.1 a

- Essentially no trunk damage.
- Low yield due to bud damage, but TWC still yielded more than VSP.
- No difference in Brix at harvest among treatments.
- TA was higher in UK (18.0) compared to VSP (16.3).

2014 - Marquette

Marquette Treatment	Yield t/acre	Yield lb/vine	Clusters/ vine	Avg.berry wt. (g)	Cluster wt. (g)	Berries/ cluster
TWC	2.9	9.7	46.6 a	1.6 a	74.7	46.1
VSP	-	-	11.7 b	1.3 b	-	-
UK	2.4	7.7	42.5 a	1.6 a	76.7	47.4

- Marquette buds were less damaged; extensive trunk injury.
- VSP eaten by turkeys, but counts of rachises indicated yield would have been lower.
- No difference in Brix or TA at harvest.



2015 – Late Spring Freeze

- Winter was not as harsh as 2014, and vines looked great in early spring
- Major freeze event on May 22/23, temps dropped to 27 ^{o}F.

Spring Freeze in Clayton NY 2015

May 22

2015 – Late Spring Freeze


June 29
Frontenac
June 29
Marquette
August 14
Frontenac
August 14
Marquette

2015 - Frontenac

1st crop	Yield t/acre	Yield lb/vine	Clusters/ vine	Avg.berry wt. (g)	Cluster wt. (g)	Berries/ cluster	Shoot #	# of shoots w/ clusters
TWC	0.13	0.4	2.8 ab	1.24 a	71.2	57.4	2.5	2.0
VSP	0.07	0.2	1.1 b	1.15 ab	71.5	79.6	1.8	0.8
UK	0.15	0.5	3.2 a	1.10 b	62.9	57.0	3.1	2.1
2nd crop								
TWC	2.4 a	7.86 a	43 a	1.34	82.6	61.5	49.6 a	19.0 (38%) a
VSP	0.9 b	3.46 b	20.3 b	1.30	75.9	58.6	35.5 b	11.0 (30%) b
UK	1.1 b	2.90 b	18.5 b	1.32	69.7	52.8	30.5 b	9.1 (30%) b

- "1st crop" shoots were tagged and 1st and 2nd crop were kept separate.
- 1st crop yield was very small; no differences among treatments.
- 2nd crop yield was larger in TWC, mainly due to more "second crop" shoots, which lead to more clusters per vine. Also, a higher percentage of "second crop" shoots had clusters.
- Cluster weight in 2nd crop was not smaller.


TWC
1

2015 – Frontenac Fruit Chemistry

1st crop	Brix	pH	TA	YAN
TWC	23.7	3.17	18.2	404.3
VSP	23.3	3.22	16.3	461.7
UK	23.4	3.24	17.4	463.5
Avg.	**23.5**	**3.20**	**17.4**	**441.5**
2nd crop				
TWC	22.1	3.06	21.6 a	337.4
VSP	22.5	3.10	20.5 b	372.8
UK	22.3	3.05	21.6 a	365.0
Avg.	**22.3**	**3.07**	**21.2**	**358.4**
p-value 1st vs. 2nd	*0.00069*	*<0.0001*	*<0.0001*	*0.0016*

- No differences in fruit chemistry in 1st crop, only slight difference in TA in second crop among treatments.
- When averaged across treatments, there were significant differences between first and second crop, BUT….

Marquette Sept. 28

Conclusions

- 2014
  - Marquette: Moderate crop, trunk injury, vine collapse
  - Frontenac: Low crop, little to no trunk injury, no vine collapse
  - Overall, VSP seemed to be “worse”
- 2015
  - Both Marquette and Frontenac pushed “2nd crop” shoots after the freeze, but lasting damage in Marquette resulted in continued vine collapse
  - Very little yield from “1st crop”
  - TWC had higher yield from “2nd crop,” mostly due to more shoots
  - Impact on fruit chemistry – Marquette seemed to “catch up” better than Frontenac, and TA lagged behind more than Brix.

Exposed vs Shaded Clusters

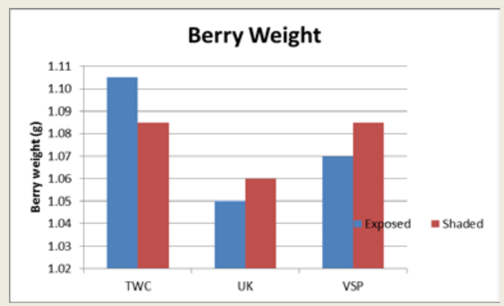
Impact on Brix, pH, TA

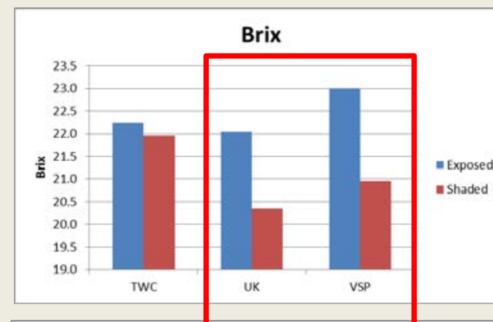
- Measured fruit composition from <u>individual</u> sunlight-exposed and shaded clusters from the same vines
- Frontenac 2013
- Marquette 2014
- Frontenac 2015

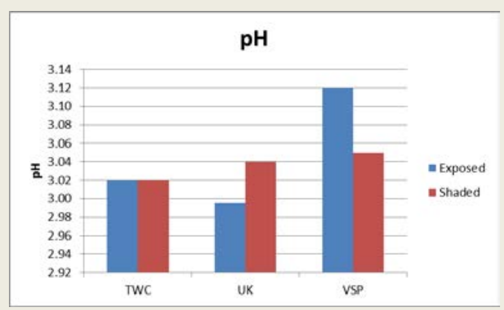
Shaded vs Exposed Clusters

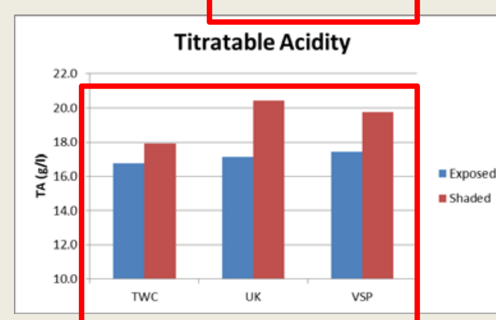
Frontenac 2013

	Berry Weight		pH		Brix		TA	
Train	Exposed	Shaded	Exposed	Shaded	Exposed	Shaded	Exposed	Shaded
TWC	1.11	1.09	3.02	3.02	22.3	22.0	16.7	17.9
UK	1.05	1.06	3.00	3.04	22.1	20.4	17.1	20.4
VSP	1.07	1.09	3.12	3.05	23.0	21.0	17.4	19.7





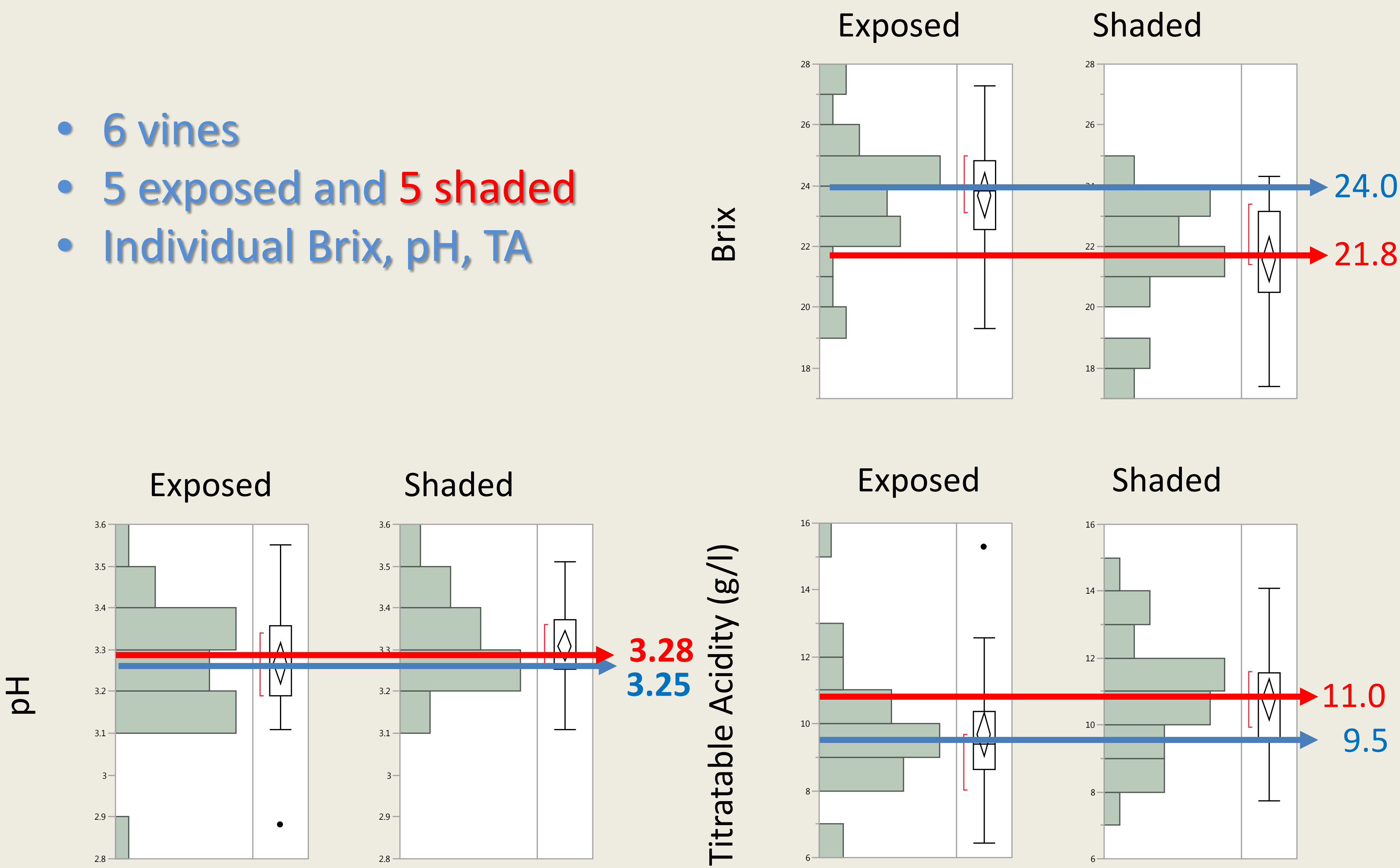




Shaded vs Exposed Clusters

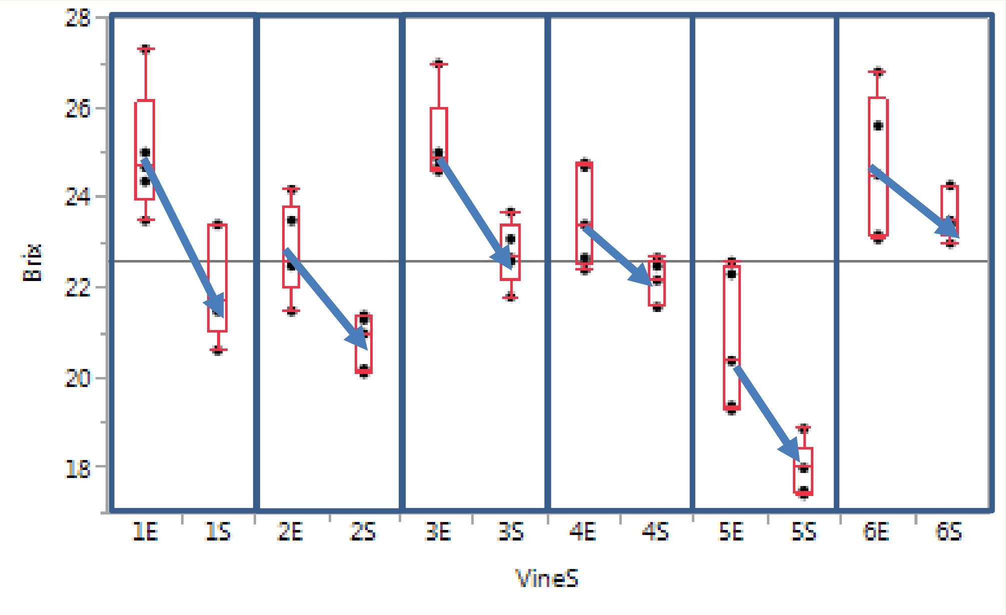
Marquette 2014

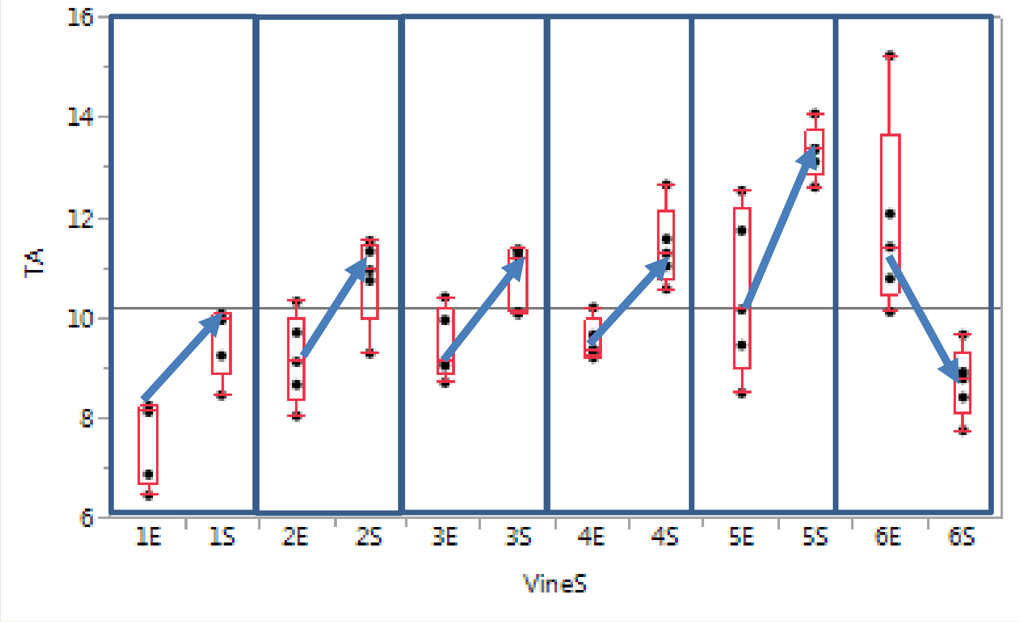
- 6 vines
- 5 exposed and 5 shaded
- Individual Brix, pH, TA



Exposed vs Shaded Clusters

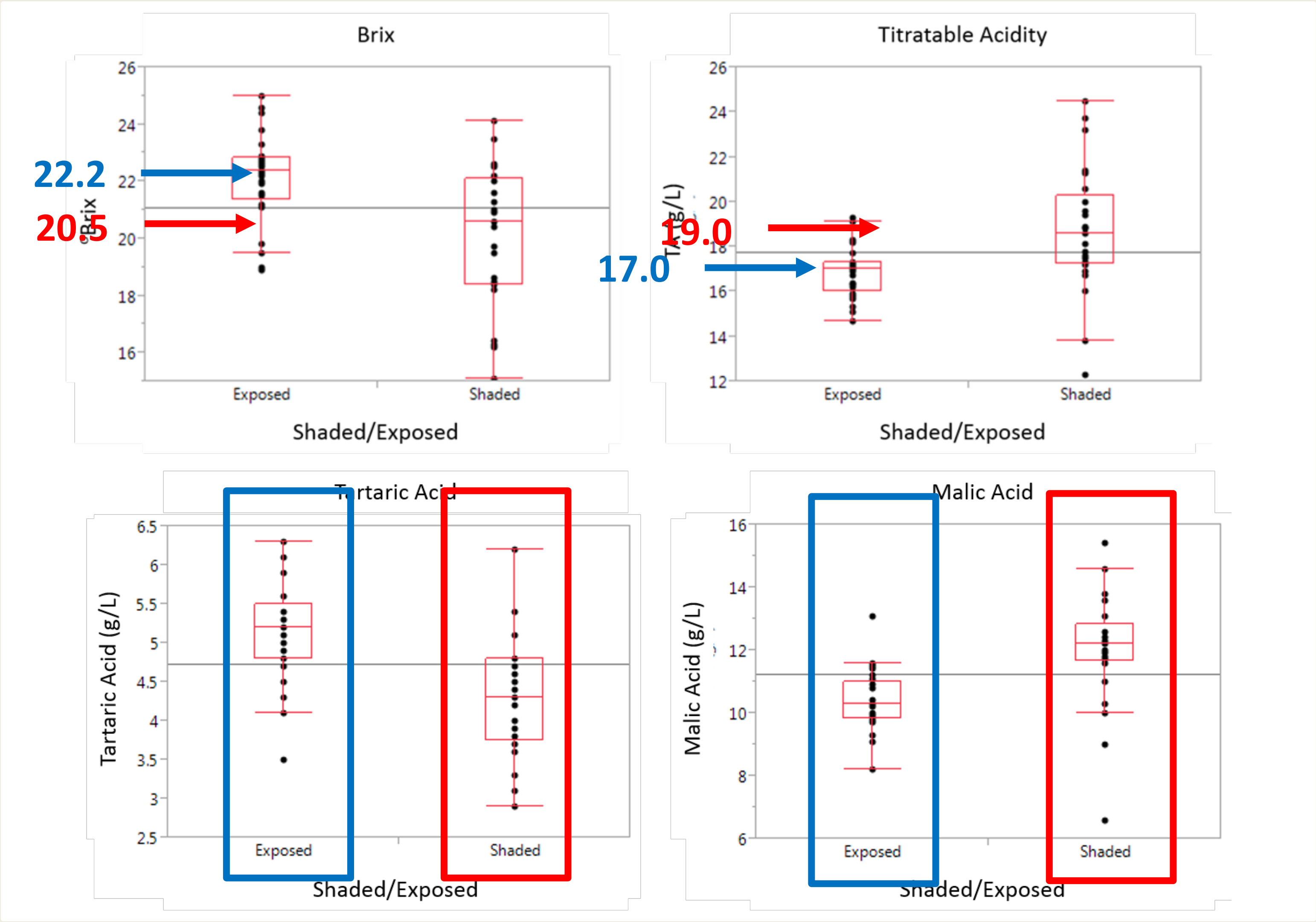
Marquette 2014





Shaded vs. Exposed Clusters

Frontenac 2015



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Viticulture, enology and marketing for cold-hardy grapes

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Managing Frontenac and Marquette for profitability and quality: Training systems, recovering from winter and spring frost injury.

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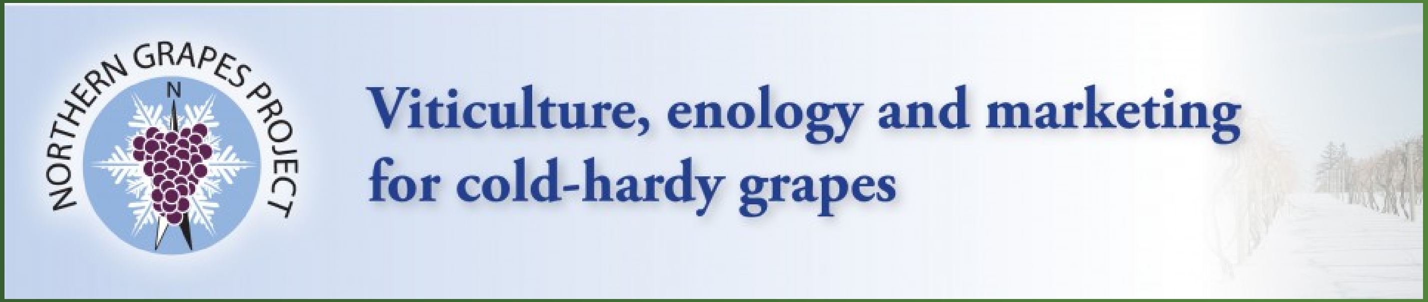
Michigan State University

Department of Horticulture

Acknowledgments



- Tim Martinson
- Chrislyn Particka

Summary of the activities at MSU 2012-2015

Objective: **IMPACT OF TRELLIS SYSTEMS AND CROP LOAD ON FRUIT AND WINE QUALITY OF SUPER COLD HARDY CULTIVAR "MARQUETTE"**

Experimental activity

- 3 locations: Southwest Michigan Research and Extension Center (SWMREC) Benton Harbor, Horticulture Teaching and Research Center (East Lansing) and Flying Otter Vineyard and Winery (Adrian)
- Experiments on trellis systems, crop load (cluster and/or shoot thinning) and canopy microclimate

Challenges of Growing Grapes in the Lakes Region of US

Damage to Grapevines by Winter Cold

- The economic impact of winter cold damage varies significantly across regions and cultivars


- Economic loss was estimated over a six-year period in Pennsylvania at U.S. $46,500 for a 0.4 ha vineyard (Steward and Wenner 2004).

*Assessing and Managing Cold Damage in Washington Vineyards. Moyer et al. 2009. Extension Bulletin EM042E.

Approximate warmest temperature where 80-100% primary bud kill my be expected to occur in midwinter

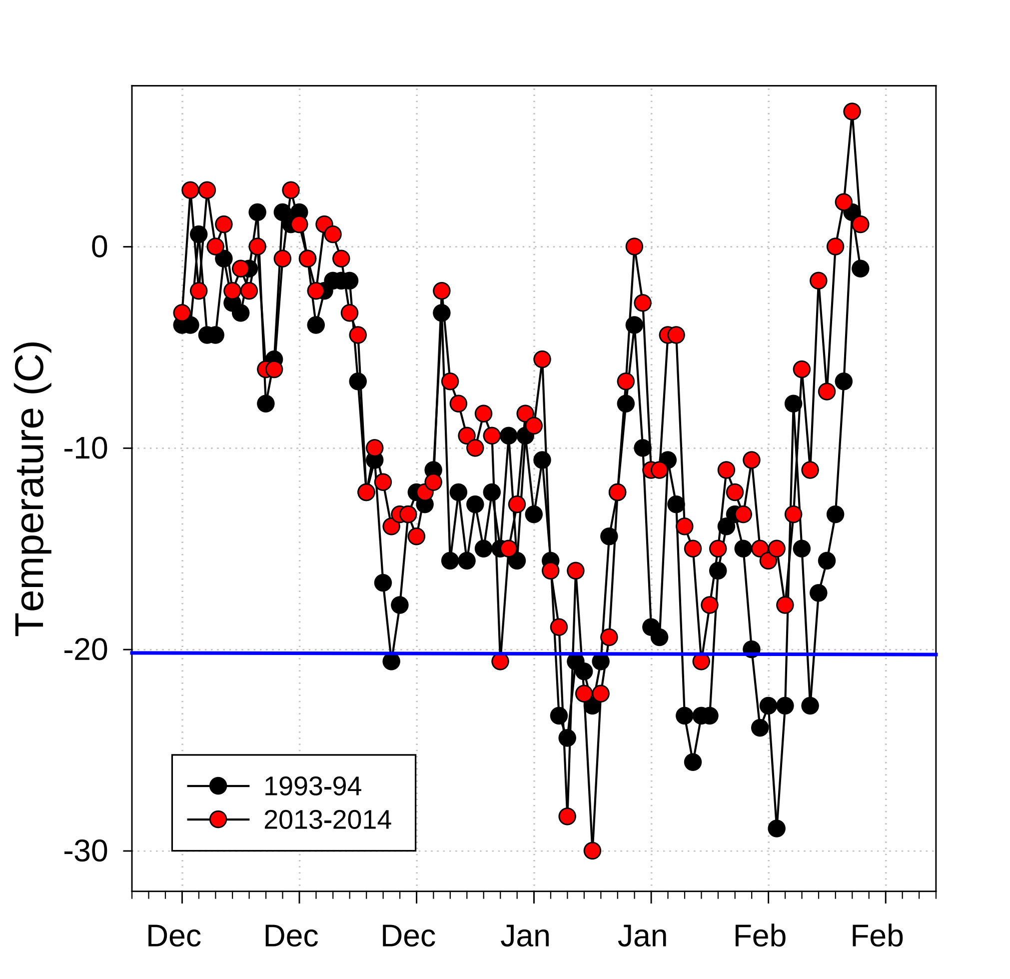
Cultivar (Vinifera)	Temp. F	C	Cultivar (Hybrids)	Temp F	C
Muscat Ottonel	-6	-20	Traminette	-20	-28
Merlot	-9	-21	Vidal blanc	-22	-30
Pinot gris	-10	-23	Chardonel	-22	-30
Pinot noir	-10	-23	Chambourcin	-23	-30
Sauvignon blanc	-10	-23	Seyval	-23	-30
Gewurztraminer	-12	-24	Vignoles	-26	-32
Chardonnay	-13	-25	Frontenac	-35	-37
Riesling	-14	-25	Frontenac gris	-35	-37
Cabernet Franc	-17	-27	Marquette	-35	-37

Approximate warmest temperature where 80-100% primary bud kill my be expected to occur in midwinter. Elaborated from Wine Grape Production Guide for Eastern North America. 2008. T. Wolf et al. and Zabadal T., Sabbatini P., Elsner D., 2008. Wine Grape Varieties for Michigan and Other Cold Climate Viticultural Regions. MSU Extension Bulletin CD-007.

Comparing 1993-94 and 2013-14

Old Mission Peninsula

Data from NCDC



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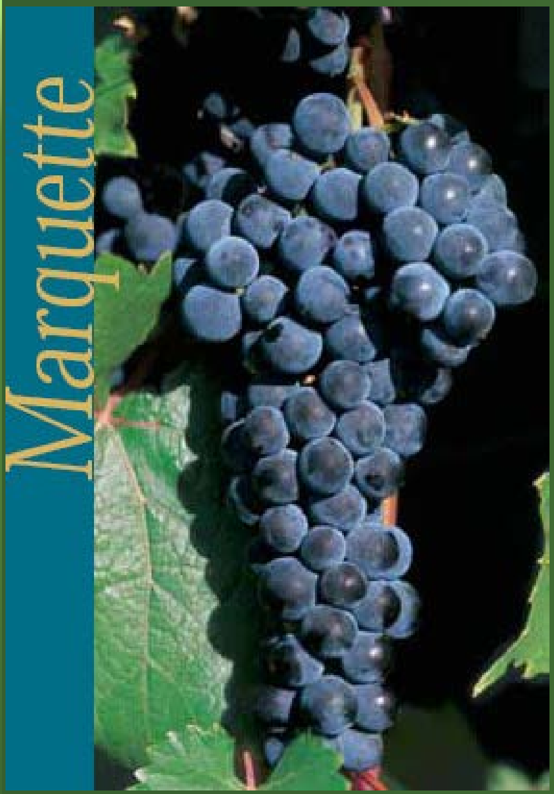
The role of cold hardy CVs in expanding the MI grape industry



Introduced 2006

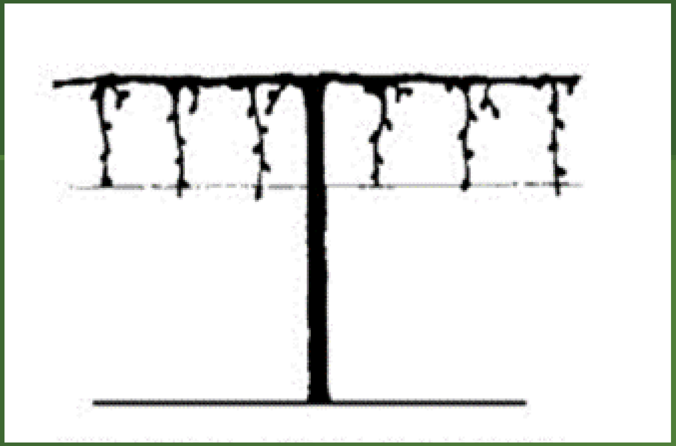
- The 2014 USDA report 24 acres of Marquette in MI.
- MSU Viticulture industry contacts approximated at 50 acres.
- 1.4% wine-grapes acreage
- 6% of hybrids acreage
- Marquette was recently planted in MI, accounting for 40% of the new hybrid acreage.

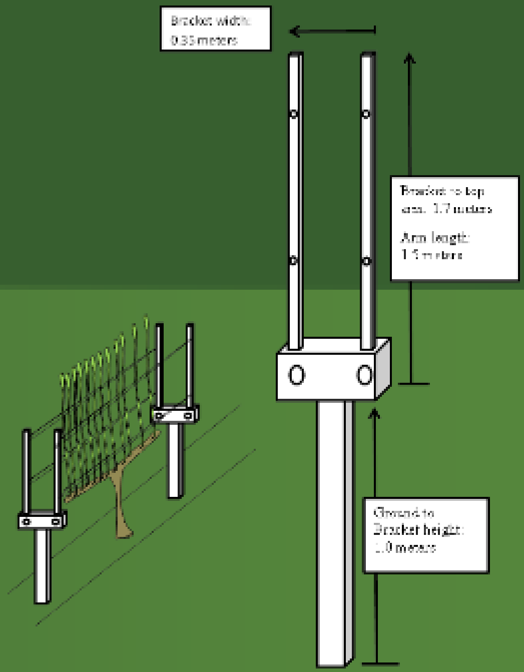
Outline

- **Working on trellis systems and crop load: Why?**
  - High sugar and high acids, looking for a balance to produce high quality wines; coupling fruit technological maturity parameters
- **2012: impact of spring frost on yield and fruit quality**
  - Early ripe good for cool climate, but early bud-burst subjected to spring frost
- **2013, 14 and 15: the impact crop-load on fruit technological maturity at harvest**
  - Light and temperature (microclimate)

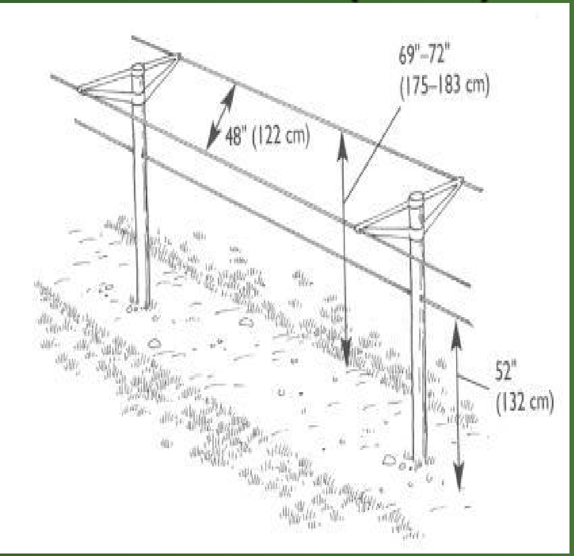
Training Systems Trial

High Wire Cordon (HWC)





Geneva Double Curtain (GDC)



Moving Trellis (MT)

Palliotti, A. 2011. A new closing Y-shaped training system for grapevines. AJGWR, Vol 18: pp 57-63

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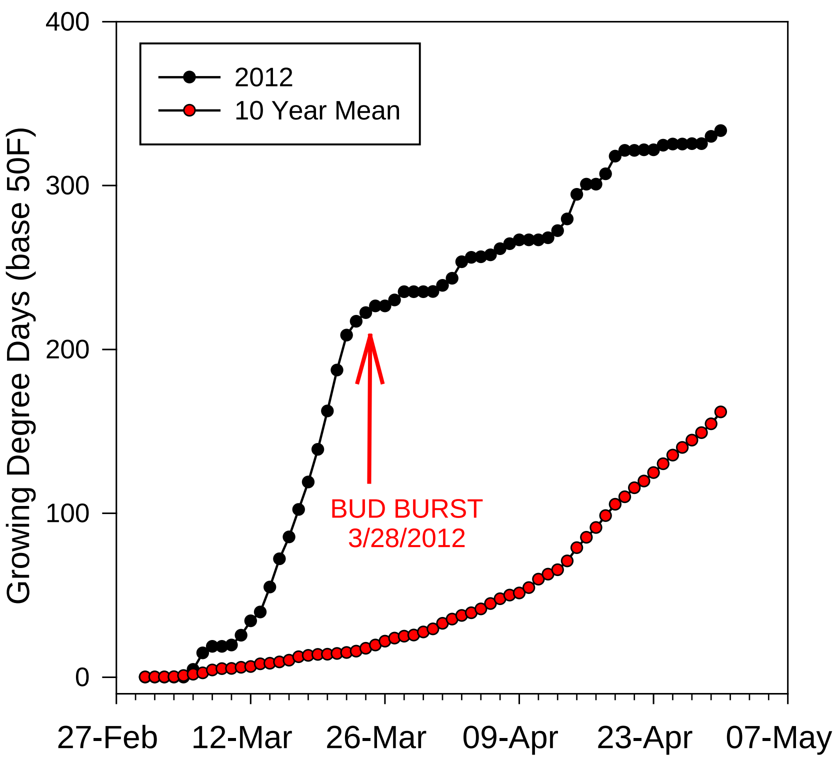
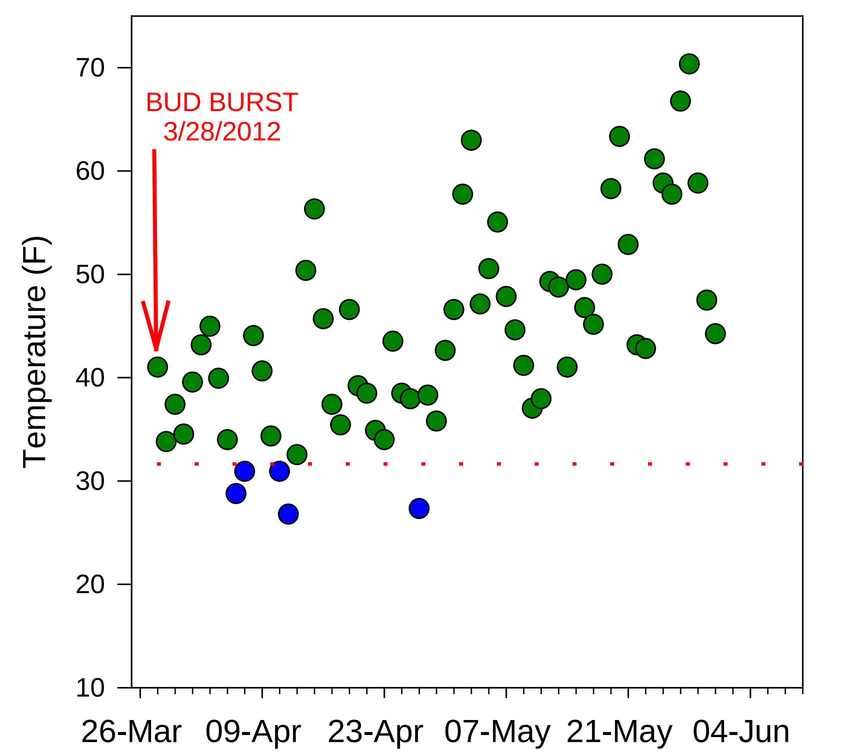
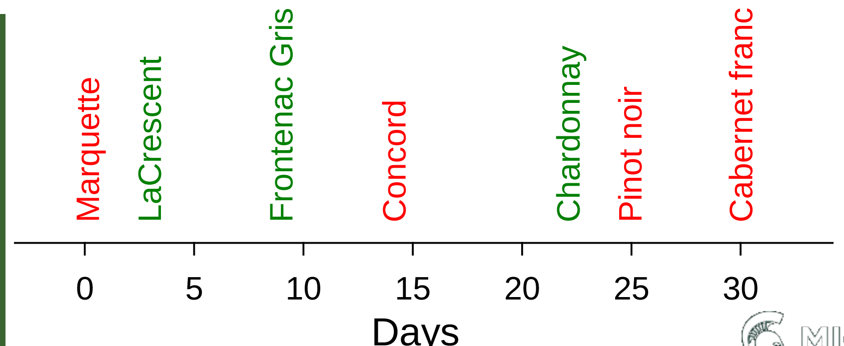
Spring of 2012

Impact on Marquette vines





Relative budburst time in Michigan



Impact of Spring Frost

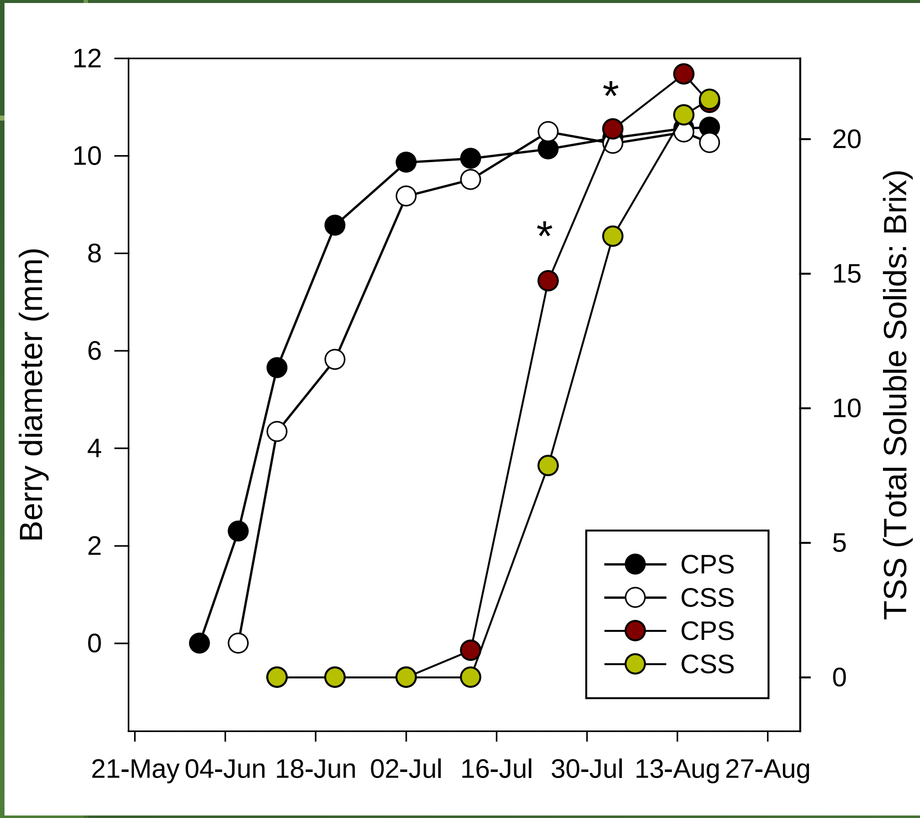
≈30-40 buds

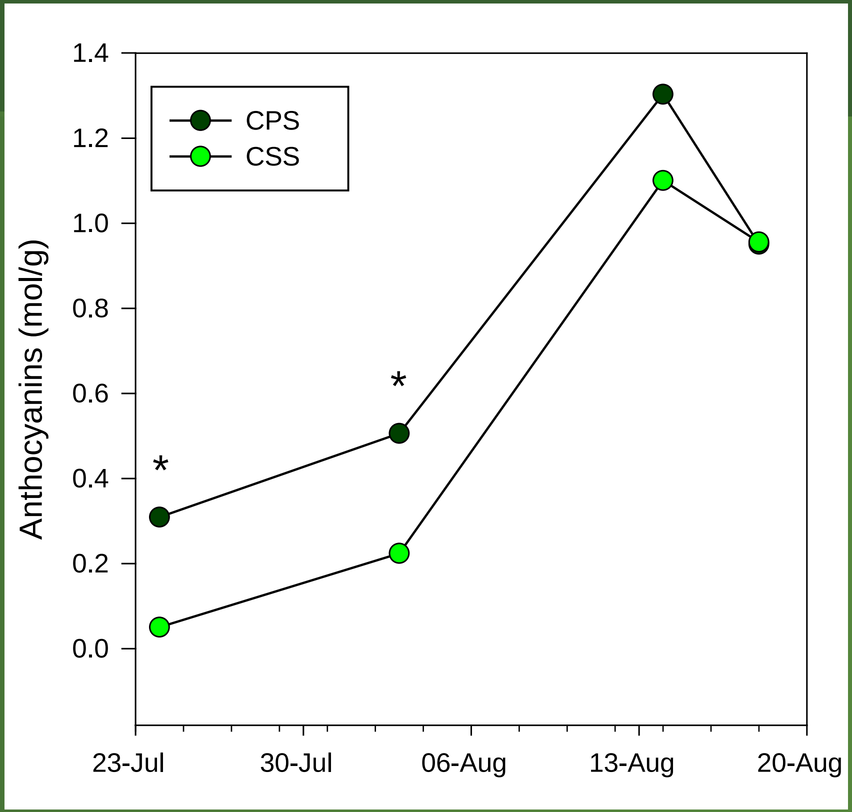
Trellis System	Total Number of buds	Percent of live primaries
HWC	176 a	19.9 a
GDC	196 a	17.5 a
MT	223 a	21.9 a

Independently of the height of the training system (from 1 m MT or 1.8 for GDC and HWC) the frost impacted similarly primary buds

Impact of Frost: CPS *vs* CSS

No differences between training systems





No differences in berry growth; CSS recovered the late start (≈ 10d). Difference in fruit chemistry only in the early phase of the ripening process

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Yield Components and Fruit Quality

Trellis System	Yield (Kg/vine)	Number of clusters	Cluster weight (g)	Berries per cluster	Pruning weights (kg)	Ravaz Index
HWC	3.30	67	62.9	60	0.93	3.5
GDC	3.20	69	53.4	54	1.02	3.8
MT	3.53	75	58.0	62	1.12	3.8

Trellis System	TSS (°Brix)	pH	TA (g/L)	Phenolics (a.u./g)	Anthocyanin (mol/g)
HWC	19.5 b	3.4	9.2	0.90 b	0.91
GDC	21.4 a	3.3	9.4	1.05 a	0.92
MT	19.7 b	3.4	9.8	0.96 b	1.01

+10% at the time of harvest

+15% at the time of harvest

Conclusions 2012

- 2012 frost events similarly impacted the 3 training systems
- No differences in canopy growth and size (data not shown)
- Basic fruit chemistry of CPS and CSS was similar for all the training systems.
- Yield per vine was similar between the training systems
- With 80% primary bud kill vines yielded about 2 T/acre
- Experimental wines made from CPS had more color, alcohol, acidity, astringency and body when compared with CSS wines (basic fruit chemistry at harvest different only for pH and TA)

Experimental Activity in 2013, 14 and 15

Experimental activities focused on crop load

- Yield per vine was modified with:
  - Shoot thinning at fruit-set or cluster thinning at fruit-set vines:
    - 3 or 6 per foot of cordon and High, Medium and Low yield per vine (250, 150, 70 clusters per vine)

The objectives: study interaction between (a) canopy growth and yield levels (crop-load), (b) cluster exposure and (c) fruit technological maturity at harvest.

Yield Components and Fruit Chemistry of HWC (Benton Harbor)

Treatment	Yield Tons/acre	Yield Kg/vine	Cluster/ vine	Cluster weight (g)	Berries / cluster	Berry weight (g)	Pruning Weight (kg)
High	13.8 a	18.2 a	264.0 a	114.6	93.0	1.19	1.85 b
Medium	9.8 b	12.9 b	184.8 b	115.6	94.3	1.18	1.97 b
Low	6.9 c	9.1 c	114.3 c	109.2	91.4	1.17	2.41 a

≈4-5 lb

Treatment	TSS (ºBrix)	pH	TA (g/L)	Phenolics (a.u./g)	Anthocyanin (mol/g)
High	22.4 b	3.6 b	6.70	0.86	1.20
Medium	22.9 b	3.6 ab	6.93	0.82	1.13
Low	25.8 a	3.8 a	6.78	0.79	1.14

Impact on TSS (Brix) of +10% with a reduction of yield of -50%

No other impact on yield components or fruit quality parameters

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Canopy and Cluster Microclimate

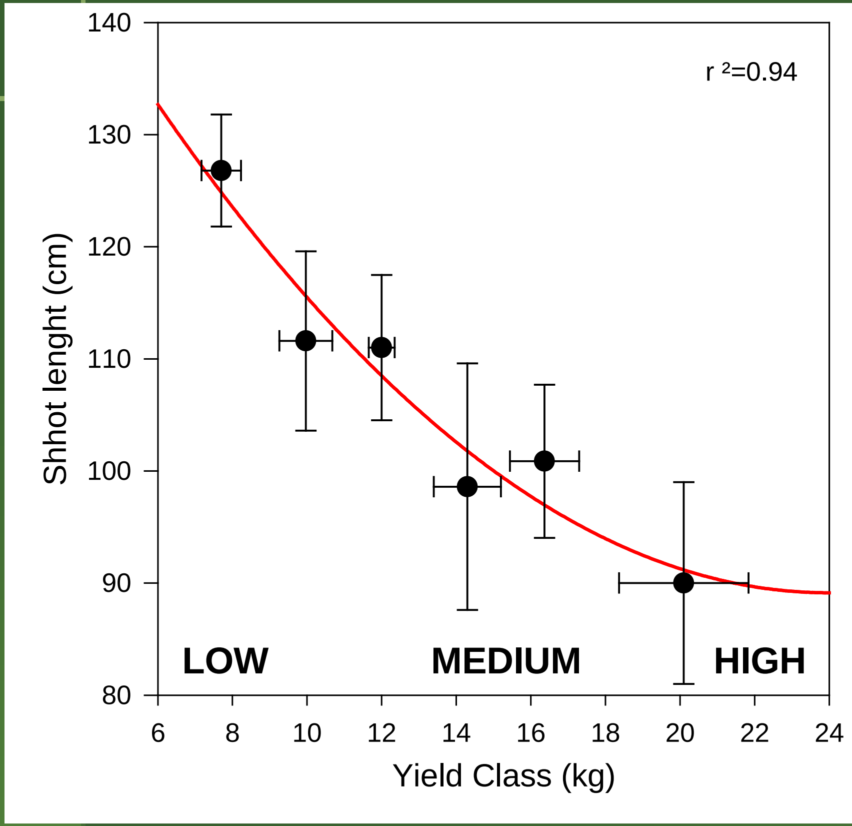
Environmental parameters

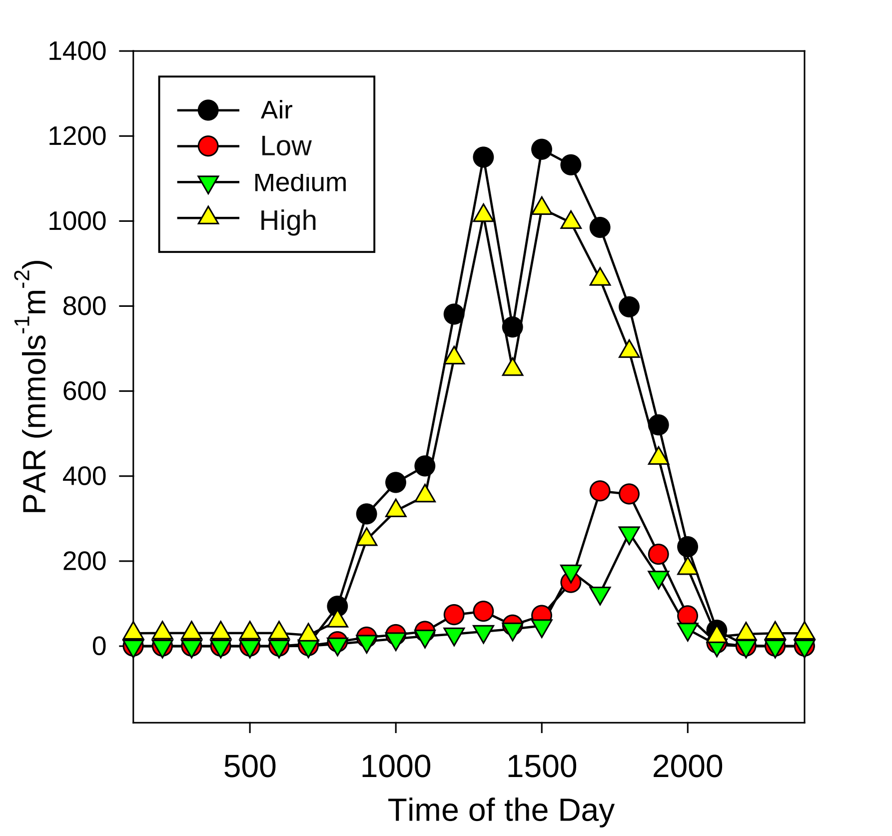
PAR

Temperature

Photosynthetic Active Radiation

Canopy Architecture

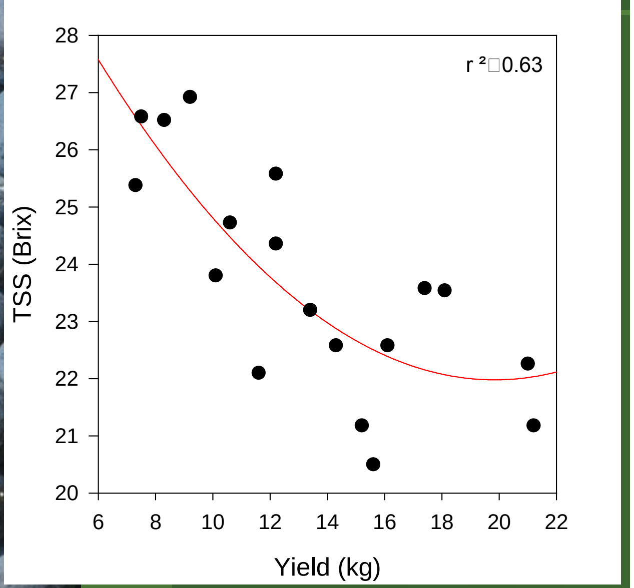




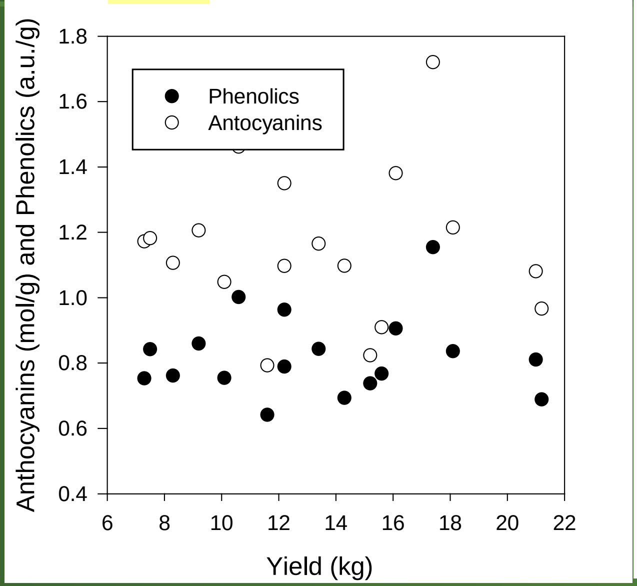
Decreasing canopy size (-30%) with increased yield per vine exposed the clusters to light and temperature reaching phenolic and anthocyanin concentrations similar to lower yields per vine, but at lower sugar (Brix) concentration

Relationship between Fruit Quality Parameters

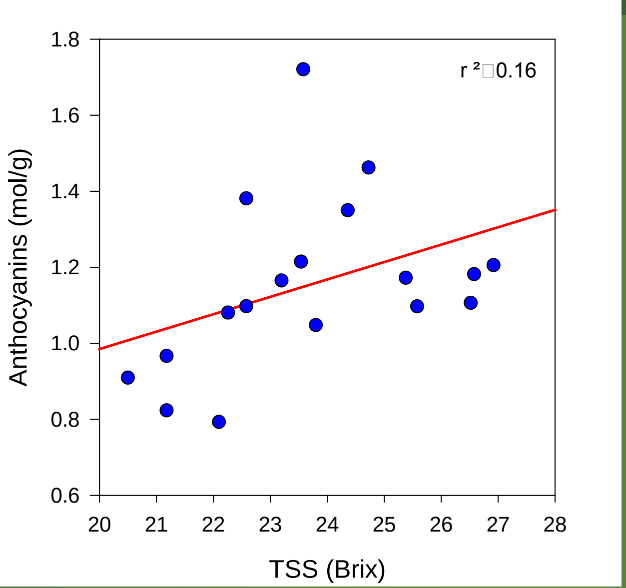
A



B



C



A: Yield per vine is the driving force for sugar accumulation: source-sink physiology
B: Yield per vine is not related to color or wine mouth-feel compounds in grapes
C: Anthocyanin and sugar concentration are un-coupled (their accumulation is asynchronous); they can be coupled also with acid degradation (better grape technological maturity at harvest) working on canopy management.

Preliminary Conclusions
Crop load studies 2013-215

- Yield per vine affected only sugar accumulation at harvest (source-sink)
- Canopy growth was impacted by yield per vine and reduced with high levels of yield.
- No yield components was impacted (cluster and berry size).
- Fruit quality at harvest was related to cluster exposure: 22.5 Brix with 6.7 TA at high yield; excellent values for winemaking (ratio 3.3)

MARQUETTE

A summary of our experience

- Marquette belongs to the Super Hardy class of grapevines and is tested hardy to -24 F in MI. All the Minnesota releases have the traits of a V. riparia parent that is cold hardy to -40 F.
- The same parent responsible for the hardiness is responsible for the early bud break that makes the vines more susceptible to spring frosts and freezes.
- Secondary buds are very fruitful (and non-count positions, cordons and base buds all push and are more fruitful).
- Shoots are brittle and break under severe bending and high winds.
- Fruit ripens early for Michigan conditions relative to other popular grape varietals.
- Wine quality has been rated very high and wineries have sold out of their production quickly.

MARQUETTE
What we are trying to learn

- Can we ripen to a higher crop yield and keep the wine quality? The early maturity and hardiness of Marquette should allow a larger crop and still have time to mature the canes and buds for the winter.
- What are the limits of cropping and still keep wine parameters at their best? We have been cropping the SW vines at three levels, low (more like normal for a hybrid 5 -6 t/ac), medium and high (more like California Central Valley bulk wine levels).
- We do not know the best leaf area to fruit level ratio for maturing the crop for wine. Many try to train them to VSP with little success. The HWC and GDC have produced the best so far but we are tweaking it for Marquette.

MARQUETTE
What we need from growers and winemakers

- Optimum harvest parameters for wine quality?
- Long time Mid-west Marquette winegrowers have reported that optimum wine quality is reached at 25 Brix.
- We are not making experimental wine at MSU with these grapes, so we can recommend anything.
- Southwest Michigan is ripening Marquette grapes to winemaker's preferred TA, while other regions in the USA report problems with high acidity at harvest and the need for adjustment.
- We are not seeing that in our plots.
- What is happening in the rest of the state?