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Growing Super-Hardy Cultivar in Michigan; Impact of Vineyard Management on Fruit Quality

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Acknowledgments

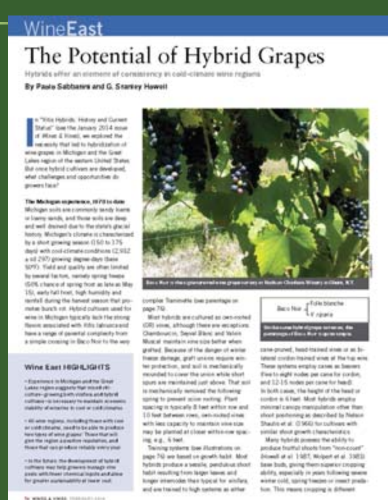
- **Kateri Bigler** Development Assistant Colorado Association for Viticulture & Enology (CAVE)
- **Melinda Tredway** Program Director Colorado Association for Viticulture & Enology (CAVE)
- **Dr Horst Caspari** Professor & State Viticulturist Colorado State University

Outline

- Growing Super-Hardy Cultivar in Michigan
  - Definition of Super-Hardy
  - Super-Hardy in Michigan
  - NE1020 results
- Impact of Vineyard Management on Fruit Quality
  - General overview
  - Experience with cv. Marquette

Summary of my talk

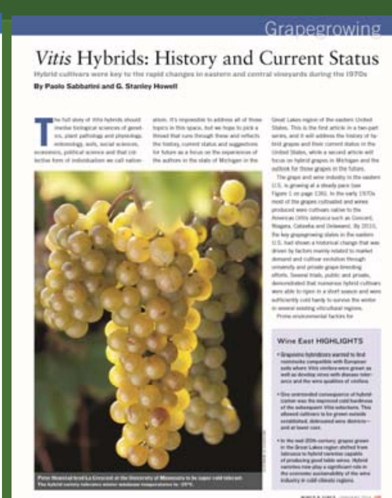
Wines & Vines Jan-Feb 2014


WineEast

The Potential of Hybrid Grapes

Hybrids offer an element of consistency in cold-climate wine regions

By Paolo Sabbatini and G. Stanley Howell


Grapegrowing

Vitis Hybrids: History and Current Status

Hybrid cultivars were key to the rapid changes in eastern and central vineyards during the 1970s

By Paolo Sabbatini and G. Stanley Howell

Growing Grapes in the Lakes Region of US

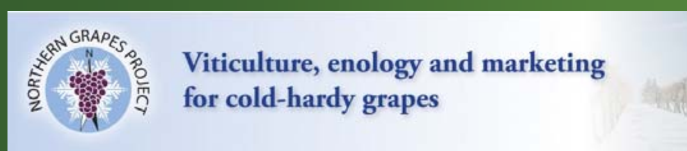
Premise

- Impact of Climate in Viticulture
- "*Conditions of culture*" I am working are completely different from yours
- Share with you few things that could be important for you
- I reduced tables and data (CO *team is the data makers for you!*)
- Please stop me any time! We have several experts in the room!

SHC Super-Hardy CVs

What are those?

Cold hardy, Vitis riparia-based wine grape cultivars in the 1990s created a new and rapidly expanding industry of small vineyard and winery enterprises in more than 12 states in New England, northern New York, and the Upper Midwest, boosting rural economies in those regions.



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

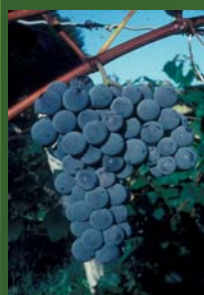
Cultivar (Vinifera)	Temp. F	C	Cultivar (Hybrids)	Temp F	C
Muscat Ottonel	-6	-20	Traminette	-20	-28
Merlot	-9	-21	Vidal blanc	-22	-30
Pinot gris	-10	-23	Chardonel	-22	-30
Pinot noir	-10	-23	Chambourcin	-23	-30
Sauvignon blanc	-10	-23	Seyval	-23	-30
Gewurztraminer	-12	-24	Vignoles	-26	-32
Chardonnay	-13	-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.

Michigan Mixed Viticulture

5 varieties are 75% of US acreage: Cabernet Sauvignon, Merlot, Chardonnay, Pinot noir and Zinfandel

- Native, Hybrid, Vinifera, Super Hardy varieties



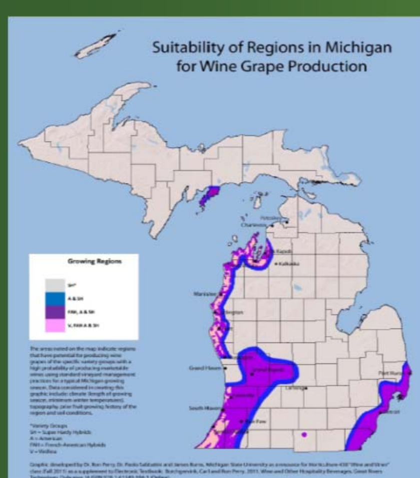
Concord
Vitis labrusca

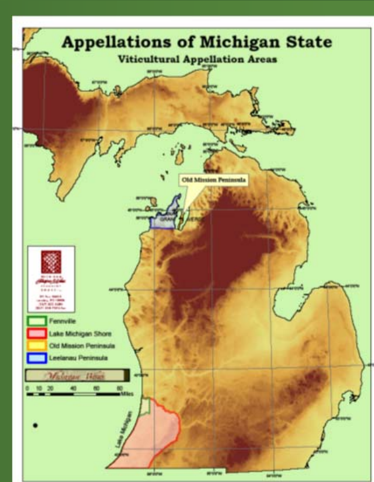
Vignoles
Hybrid

Pinot blanc
Vitis vinifera

Frontenac
Vitis riparia based

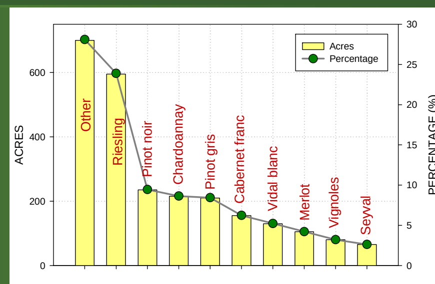
Michigan Grape and Wine Industry





Building an Industry More Vulnerable or More Competitive Industry? USDA 2011 report

Variety Category	2000		2011	
	Acres	%	Acres	%
Concord	9200	68	9030	60
Niagara	3000	22	3480	23
Hybrids	660	5	725	5
Viniferas	640	5	1765	12
Total	**13,500**		**15,000**	



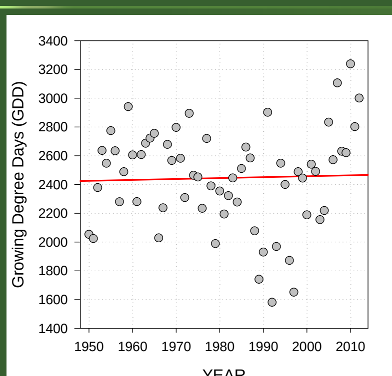
Wine grapes: 2490 acs + 230%
Vinifera: 1765 acs + 370%

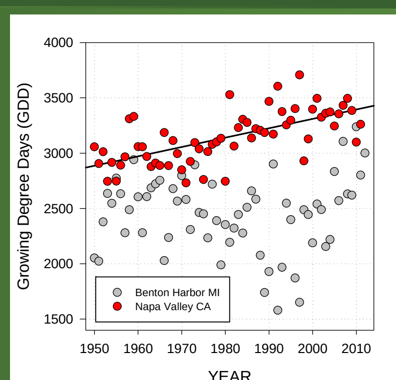

Riesling


Pinot noir

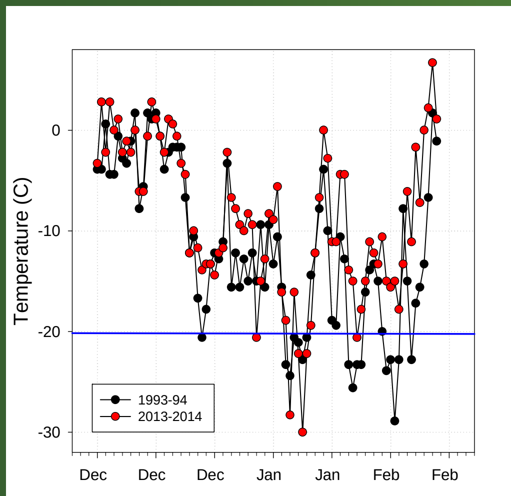
Michigan Weather

Growing seasons with considerable annual variability





Comparing 1993-94 and 2013-14:
Old Mission Peninsula
Data from NCDC



Assessing Grapevine Cold Injury

Cross sections of grapevine compound buds showing the location of primary (P), secondary (S), and tertiary (T) buds. A) All three buds are alive; B) P bud is dead, S, T buds are alive; C) All three buds are dead.

A) Dead phloem but healthy, green xylem is visible; B) Dead phloem and damaged xylem (milky-white) is visible; C) Both the phloem and xylem are dead.

What do you do once the level of damage has been determined?

- With 10-15 % damage to primary buds only there is probably no need to adjust your winter pruning.
- Higher level of damages leave a higher number of buds at winter pruning; e.g. prune to 4-5 bud spurs rather than the standard 2-3 bud spurs and/or leave more spurs/canes per vine.
- At very high levels of damage, say 80 % or more, reestablish the bearing structure of the vine.
- No winter pruning until spring with high levels of damages.

Adapted from Caspari and Larsen (2005). Evaluating grape bud damage prior to winter pruning. Colorado State University.

1995 results from variety trial at SWMREC (Howell, 1995)

Cultivar (Vinifera)	Yield (kg/vine) 1994	Yield (kg/vine) 1989-93	Cultivar (Hybrids)	Yield (kg/vine) 1994	Yield (kg/vine) 1989-93	Δ %
Gewurztraminer	0	3.8	Chardonel	2.5	11.0	-77
Muller Thurgau	0	3.2	Melody	2.8	7.3	-62
Muscat Ottonel	0	1.6	Ravat 34	16.3	11.8	+38
Ortega	0	3.5	Valvin muscat	6.8	10.5	-35
Pinot gris	0	2.9	NY 63.1016.1	5.9	13.5	-56
Riesling	4.5	4.1	NY 65.403.1	1.9	13.1	-85
Scheurebe	6.4	4.6	NY 655.33.13	4.3	8.3	-48
Cabernet franc	0	3.3	NY 70.804.15	1.5	10.3	-85
Merlot	0	2.9	NY 70.834.5	1.0	5.8	-83
Nebbiolo	0	1.1				
Pinot Meunier	0	2.1				

2014 results from variety trial at SWMREC

Cultivar (Vinifera)	Crop level as Percentage 2007-2013	Cultivar (Hybrids and Native)	Crop level as Percentage 2007-2013
Gruner Veltliner	0%	Traminette	50%
Gewürztraminer	0%	Niagara	70%
Pinot Blanc	0%	Cayuga white	70%
Gamy Noir	0%	Chambourcin	70%
Merlot	5%	Corot Noir	80%
Lemberger	5%	Vidal	85%
Pinot noir	10%	Noiret	90%
Albarino	25%	Brianna	95%
Chardonnay	95%	La Crescent	95%
Riesling	100%	Concord	100%
		Frontenac	100%

Crown Gall (*Agrobacterium vitis*)

“Spare Parts” or “Messy Viticulture”


Vinifera


Hybrid

Growing Super-Hardy Cultivar in Michigan; Impact of Vineyard Management on Fruit Quality

- Frontenac (control)
- St Croix
- La Crescent
- Brianna
- Marquette
  - Canopy management and fruit quality

Frontenac

- The King of Super Hardy has canes that are "green" from base to tip (not seen with most grapes in MI) at winter pruning.
- Healthy and vigorous in vineyard only issues in MI are Powdery Mildew and Leaf Phylloxera.
- ***Negatives***: Strong varietal aroma and high acidity. High costs (relative to crop value) of netting waiting for hang time acidity drop. (small berries complete loss to birds)
- Because of strong aromas, in MI wine industry demand is relatively low (many other better varietals available) but after the limited use for Port styles, it is finding a niche in Rosès and fruit blends.

ST CROIX

- Good fruit aromas and flavors.
- Low acidity at maximum maturity allows blending with high acid grapes
- Good balance between vine growth and cropping.
- High number of small clusters with our high bud number pruning method.
- Berries very soft when fully ripe.
- Least Powdery mildew damage of all hybrids in plot after major outbreak.

Lacresent

- Good on sandy soil
- Vine loss in heavy wet soil
- Can over-crop with lack of varietal aromas
- Wet rainy harvest season dilute sugars and flavors

BRIANNA

- Strong non-wine aromas, a negative to traditional wine drinkers is a pleasant plus in tasting rooms for semi to sweet “taste” customers
- Healthy and productive

MARQUETTE

- Super HIGH wine quality
- Major issue earliest bud break and frost damage of primary shoots
- Can produce full crop potential from non count positions
- Brittle shoots, wind damages and also during shoot positioning
- Sensitive to shade (cold hardiness)
- Bird damages (small berries)
- High acidity in cool climate, but….

Some results: Yield

Mean 2007-2013

Varietal	Lbs/vine	Tons/acre	Vine yield (%)	Yield/acre (%)
Brianna	17.5	6	+11	+11
Frontenac	15.7	5.4	0	0
Lacresent	14.5	5	-8	-7
Marquette	12.5	4.6	-20	-18
St Croix	14.3	4.9	-9	-9

Some results: Fruit Chemistry

Mean 2007-2013

Varietal	Brix	pH	TA
Brianna	20.0	3.6	5.3
Frontenac	22.8	3.2	13.4
Lacresent	23.5	3.2	11.1
Marquette	24.0	3.3	6.1
St Croix	19.7	3.6	6.8

Varietal	Harvest date
Brianna	Sep 22
Frontenac	Sept 15
Lacresent	Sept 20
Marquette	Sept 8
St Croix	Oct 4

Chardonnay is harvested 2-3 weeks after Frontenac

Growing Super-Hardy Cultivar in Michigan; Impact of Vineyard Management on Fruit Quality

What is Quality? The Drivers

The Drivers of Quality			
More Important Less Control	↔		Less Important More Control
Site Selection	Vineyard Establishment	Vineyard Management	Juice and Wine Production
GDD Accumulation Frost Free Days Minimum Winter Temperature	Cultivar Rootstock Planting Density	Trellis System Training System Canopy management Crop load and vine balance Harvest time	Yeast, Enzyme Fermentation Temperature Aging Barrel

80% 20%

Viticulture, enology and marketing for cold-hardy grapes

Impact of Crop Load and Training Systems on Viticultural and Enological Performances of Marquette in Michigan

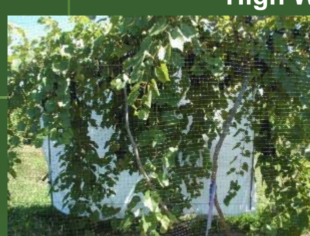
The Northern Grapes Project is funded by the USDA's Specialty Crops Research Initiative Program of the National Institute for Food and Agriculture, Project #2011-51181-30850

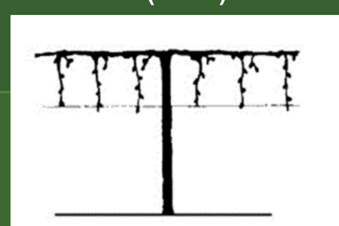
Outline

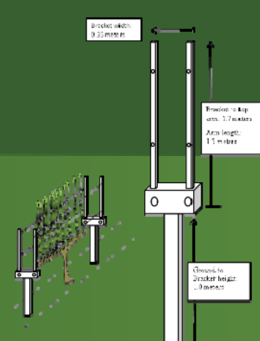
- Working on trellis systems and crop load: Why?
  - High sugar and high acids, looking for a balance to produce high quality wines; coupling fruit technological maturity parameters
- 2012: impact of spring frost on yield and fruit quality
  - Early ripe good for cool climate, but early bud-burst subjected to spring frost
- 2013: the role of (a) trellis system and (b) yield per vine on fruit technological maturity at harvest and wine sensory components.
  - Light and temperature (microclimate) and yield per vine x vine growth (crop load) to improve fruit quality at harvest.

Training Systems Trial

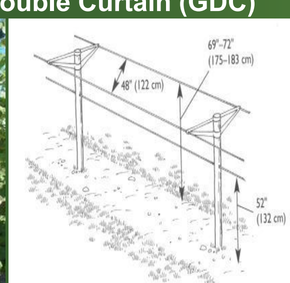
High Wire Cordon (HWC)







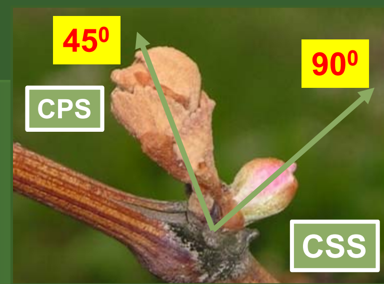
Geneva Double Curtain (GDC)



Moving Trellis (MT)

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

How the Vines Responded to the Frost



Impact of Frost

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

≈30-40 buds

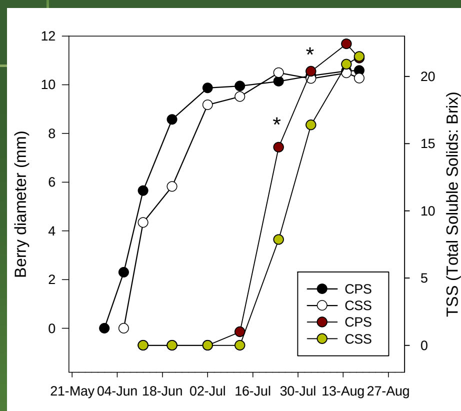
Independently of the height of the training system (from 1 m MT or 1.8 for GDC and HWC) the frost impacted similarly primary buds

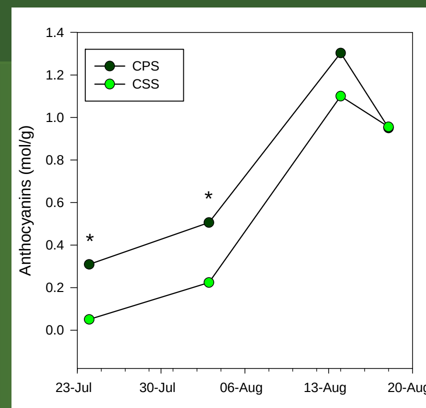
Days from bud-burst (d)*	Anthesis	Pea-size	Veraison	Harvest
CPS	64	71	108	143
CSS	70	85	119	143
Δ (d)	6	14	11	0

CPS = Cluster on Primary Shoot
CSS = Cluster on Secondary Shoot
*No differences between training systems in timing of phenological stages

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

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 (ºBrix)	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

Yield Components and Fruit Quality

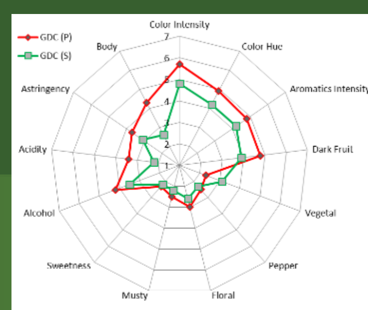
Impact of bud type

Trellis System	Fruit Type	TSS (ºBrix)	pH	TA (g/L)	Phenolic (a.u./g)	Anthocyanin (mol/g)
HWC	CPS	20.3 abc	3.5 a	8.7 a	0.97 ab	0.91
	CSS	19.7 bc	3.3 b	9.9 b	1.01 ab	1.01
GDC	CPS	21.7 a	3.5 a	8.7 a	1.03 ab	0.93
	CSS	21.5 a	3.3 b	10.0 b	1.07 a	0.98
MT	CPS	20.9 ab	3.5 a	8.1 a	0.94 b	1.07
	CSS	19.1 c	3.3 b	10.5 b	0.96 ab	0.99

GDC Higher Brix per vine due to higher Brix in CSS
CSS had lower pH and higher TA
No significative impact on Phenolic and Anthocyanin

Wine Sensory Evaluation

Similar trends for all the training systems



		Visual		Aromatics					
Trellis	Fruit Type	Color Intensity	Color Hue	Aromatics Intensity	Dark Fruit	Vegetal	Pepper	Floral	Musty
GDC	CPS	5.7 a	4.9 a	4.8	4.8	2.3	2.5	3.0	2.5
	CSS	4.8 b	4.2 b	4.2	3.9	3.1	2.3	2.6	2.2

		Taste				
Trellis	Fruit Type	Sweetness	Alcohol	Acidity	Astringency	Body
GDC	CPS	2.3	4.2 a	3.4 a	3.7 a	4.3 a
	CSS	2.2	3.5 b	2.2 b	3.1 b	2.6 b

Procedures from:. Etaio, M. Albisu, M. Ojeda, P.F. Gil, J. Salmerón, F.J. Pérez Elortondo.
Sensory quality control for food certification: A case study on wine. Method development.
Food Control, Volume 21, Issue 4, April 2010, Pages 533-541.

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. Differences only due to late phenological stages at the beginning of fruit ripening.
- 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

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 (270, 180, 115 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

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 (°Brix)	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

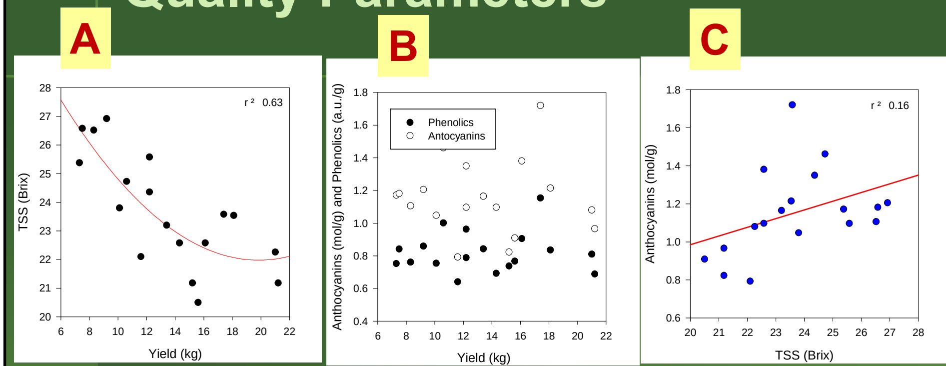
Impact on TSS (Brix) of +10% with a reduction of yield of -50%
No other impact on yield components or fruit quality parameters

Canopy and Cluster Microclimate

Environmental parameters

PAR
Temperature
Photosynthetic Active Radiation

Relationship between Fruit Quality Parameters



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 2013

- Yield per vine affected basic fruit chemistry, but 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*)

Conclusions
The potential of hybrids

- Viticulture in the future will require the management of vines pests with fewer chemical inputs
- Lower cost of production than traditional freeze-susceptible cultivars
- Selection based more on perceived marketability and less on wine quality