Root-zone and vineyard floor effect on Cabernet Sauvignon vine performance.

Cain Hickey

Tony Wolf, Tremain Hatch, Brycen Hill

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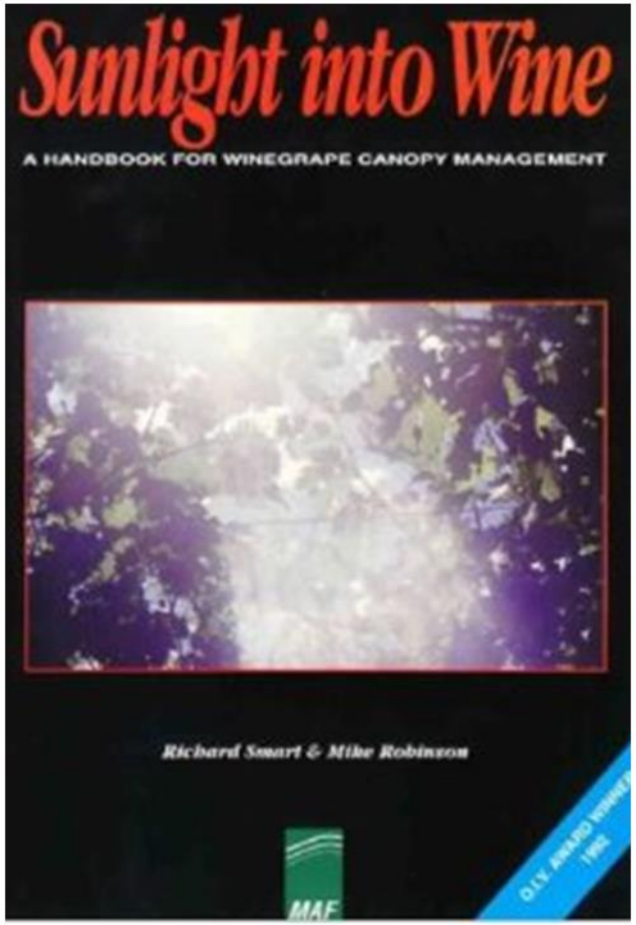
Vine size (vigor, growth)

- Often "excessive" in humid climates
  - VA, NC, GA, PA, NY, etc… OR????

- Likely due to:
  - Low evapotransitive demand of atmosphere (high humidity)
  - Supra-optimal availability of soil water
    - Variable seasonal rainfall
  - Nutrients are often not limiting
    - Grower-applied amendments
    - Inherent soil organic matter

Canopy microclimate differences as a function of canopy density.

Microclimate characteristic	Interior region of a SPARSE canopy	Interior region of a DENSE canopy
Sunlight	Most leaves and fruit receive some direct sunlight at some point during the day	Most leaves and fruit are in the shade for the day
Temperature	Fruit and leaves are warmed by sunlight and may be cooler than air temperature at night	Most leaves and fruit are at approximately ambient temperature, both day and night
Humidity	Leaves and fruit experience ambient humidity values	Humidity can build up slightly within the canopy
Wind speed	Leaves and fruit are exposed to ambient wind speed values	Wind speeds are reduced within the canopy
Evaporative potential	Evaporation rates are similar to ambient values	Evaporation rates are reduced within the canopy



Smart and Robinson (1991)

Why do we care about excessive vine growth?

- It *may* limit crop quality
  - Disease
  - Quality
  - Quantity?
    - maybe – if vine becomes overly vegetative and sunlight is limited

- Because of the above, regulating vegetative growth is important

Why does Oregon care about reducing vine vigor?

- Reduce the need for remedial canopy management measures?
  - Hedging, lateral and leaf removal
    - Labor-related concern

- Reduced vigor increases fruit quality?
  - If so, likely related to microclimate of vineyard:
    - Reduced vigor = smaller canopy = more light penetration (really a light effect)
    - Reduced vigor = smaller berries = greater skin: volume ratio (really concentration effect)

Tight VSP:

Aesthetically pleasing

Not a “workhorse”…

Modified ballerina:

Vines don’t know they are “over-cropped”

Have yet to see a crop load approaching 10

Remedial vine size management

- Canopy management
  - Leaf removal (1-2 x / season)
  - Hedging (3-4 x / season)
  - Lateral shoot removal (2-3 x / season)

All of these take time and cost money

Proactive vine size management

- Site selection
- Cultivar selection
- Rootstock selection
- Vine spacing?
- Trellis system
- Pruning methods (cane vs. spur)
- Under-trellis cover cropping
- Vine spacing?
- Root restriction

All of these can cost money, but may limit time spent on remedial measures in the long run

Why use cover crops in vineyards?

- Row middles:
  - accommodate vineyard equipment
  - Maintain soil place (i.e. limit erosion) and structure (i.e. limit compaction)

- Under-trellis:
  - *further* reduce erosion on highly (> 20 %) sloped sites
  - improve soil "health" (organic matter, improve beneficial microbes)
  - reduce vine vigor through competition
  - improve fruit composition?

Why use rootstocks in (*vinifera*) vineyards?

- Tolerate soil-borne insect pests
  - phylloxera, nematodes
- Tolerate salinity, acidity, alkalinity
- Tolerate drought
- Confer scion vigor

Trait ratings of rootstocks (greater = higher number)			
Rootstock	**Scion vigor**	**Drought tol.**	**Phylloxera tol.**
C-3309	3	2	4
101-14	2-3	1	4
420 A	1-2	2	4
Riparia gloire	1-2	1	5

Adapted from Wolf (2008)

Two parts:

1. <u>cover crop and rootstock</u> study (6 years)
2. <u>root restriction</u> bag study (2 years)

Part 1: Can vine size be regulated with cover crops and rootstocks, and will this change fruit composition?

- Cabernet Sauvignon (2006); clone 337
- low, bilateral cordon trained to VSP
- 6 years (most responses)

- UTGC:
  - Herbicide strip (HTS)
  - **Creeping red fescue** under-trellis (CC)
    - *Established 2008*

- Rootstocks:
  - 101-14
  - 420-A
  - *Riparia gloire*

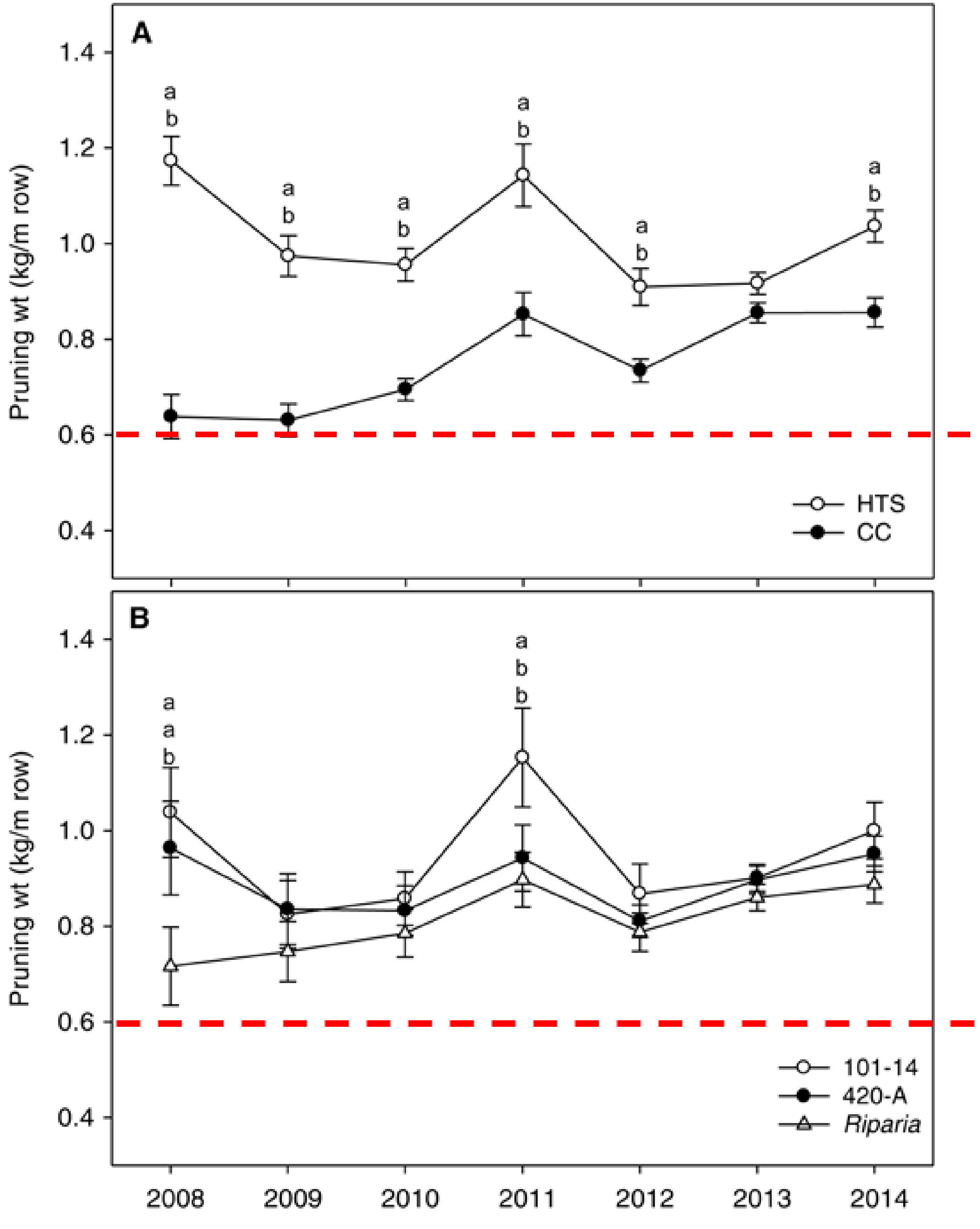
Vine vigor
(shoot growth rate)

Shoot growth rate (cm/day) May – June, 2010	
CC	1.81
HTS	2.44

Vine size

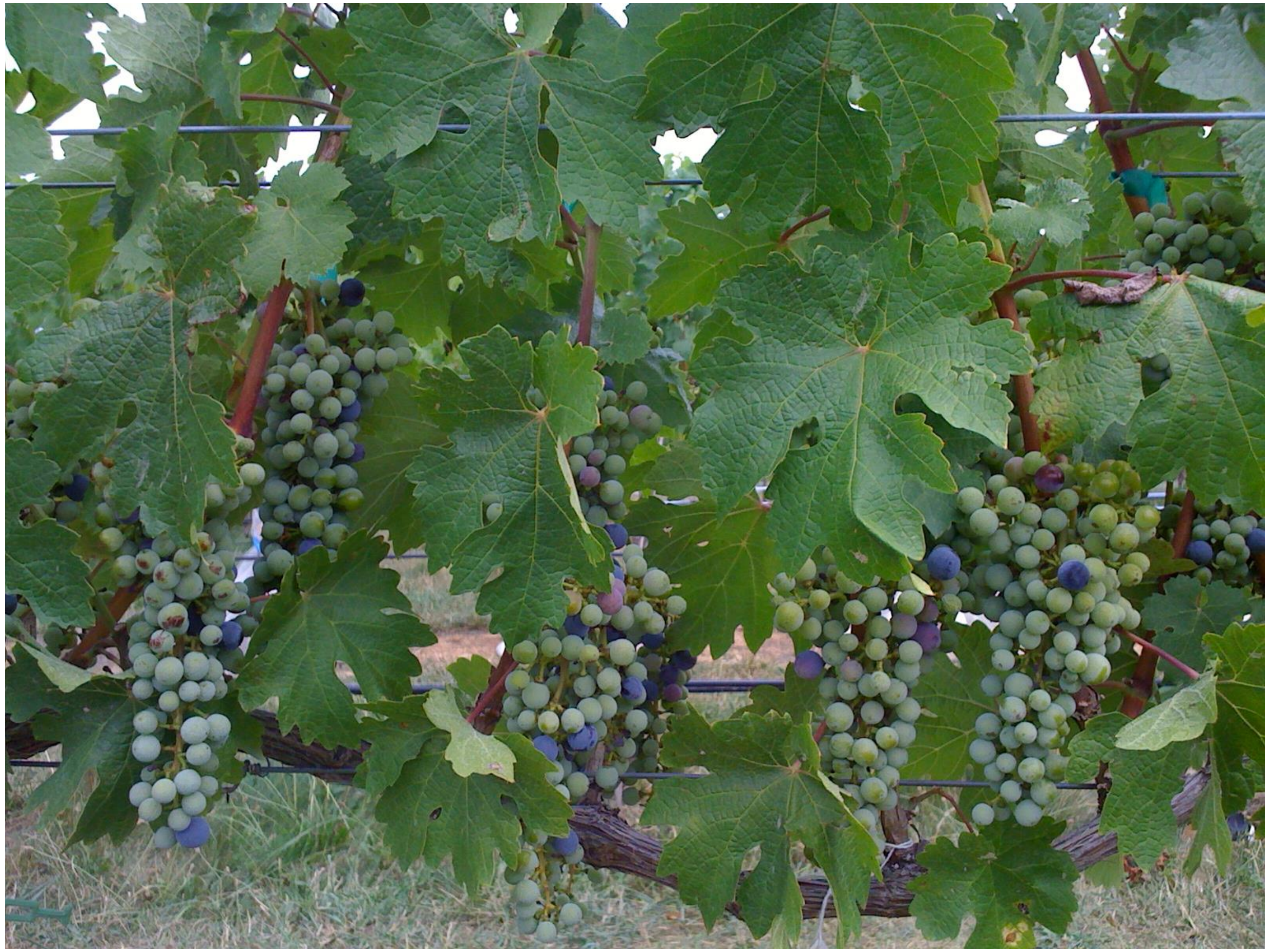
(pruning weight)

Characteristics of the ideal canopy (Smart and Robinson 1991).	
Canopy characteristic	**Optimal value**
Cane pruning weights	0.3 – 0.6 kg / m of canopy



Fruit-zone microclimate at veraison (pre- lateral / leaf removal)

Treatment	CEL[a]	CEFA[a]
UTGC[b,c]		
CC	0.43 b	0.37 a
HTS	0.65 a	0.26 b
Rootstock		
101-14	0.58 a	0.28 a
420-A	0.56 a	0.32 a
Riparia	0.48 a	0.34 a

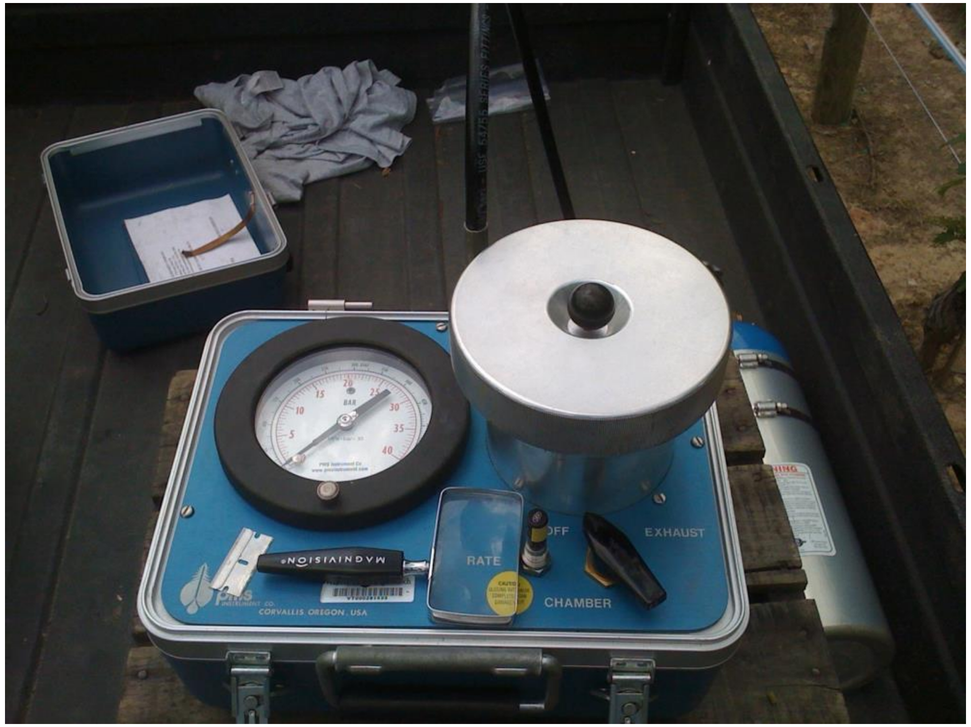


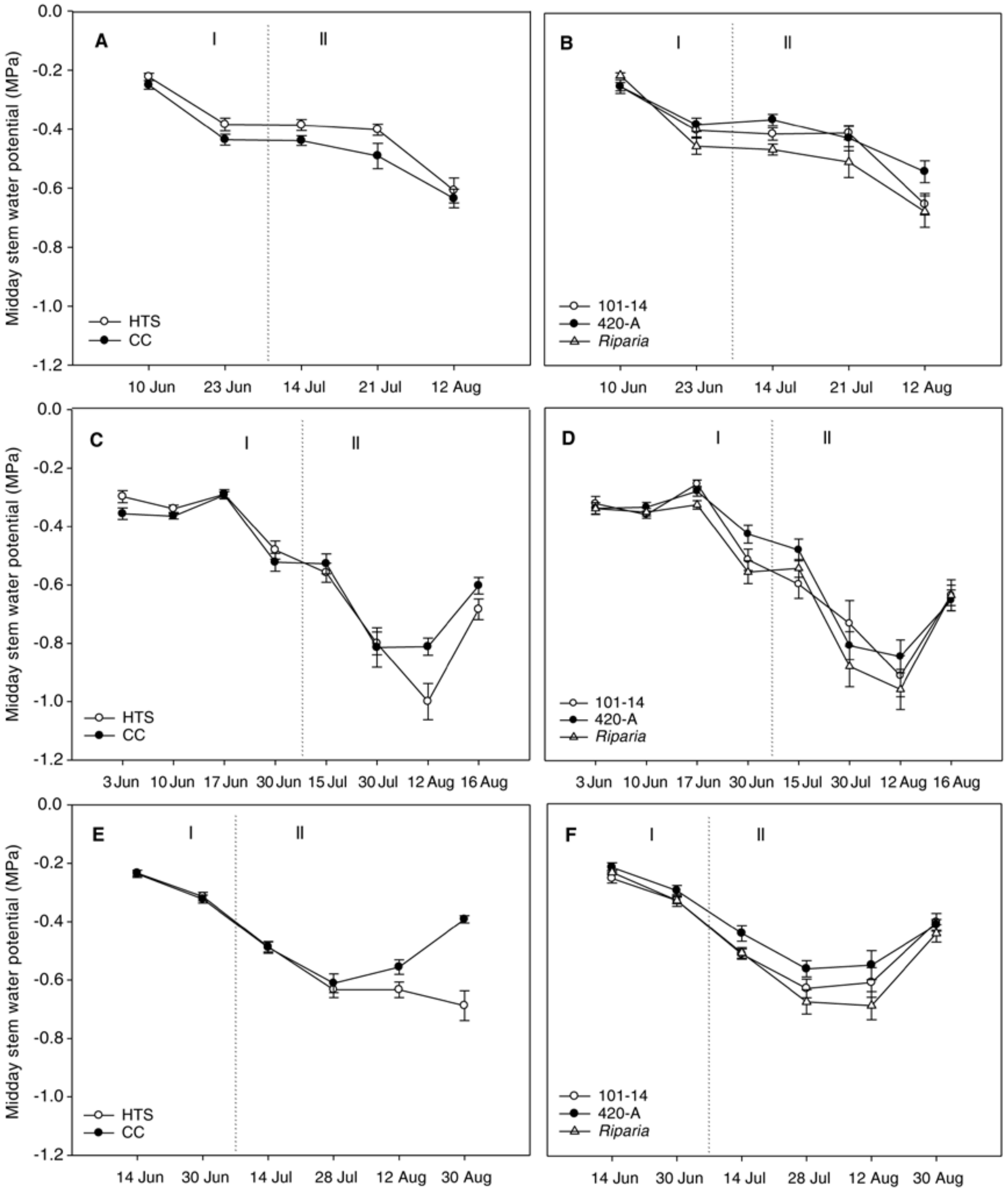
Tissue nutrient concentration, 2011

Adapted from: © 2016 American Society for Enology and Viticulture. AJEV 67:281-295.						
	BLOOM LEAF PETIOLES (%)		VERAISON LEAF PETIOLES (%)		VERAISON LEAF BLADES (%)	
	Nitrogen	Potassium	Nitrogen	Potassium	Nitrogen	Potassium
UTGC						
CC	0.70 b	2.25	0.37	5.40	2.12 b	1.22
HTS	0.81 a	1.99	0.37	5.50	2.31 a	1.11
Rootstock						
101-14	0.73	2.81 a	0.38	6.41 a	2.20	1.34 a
420-A	0.76	1.18 b	0.36	4.49 c	2.17	1.02 b
Riparia	0.77	2.37 a	0.37	5.44 b	2.28	1.12 ab

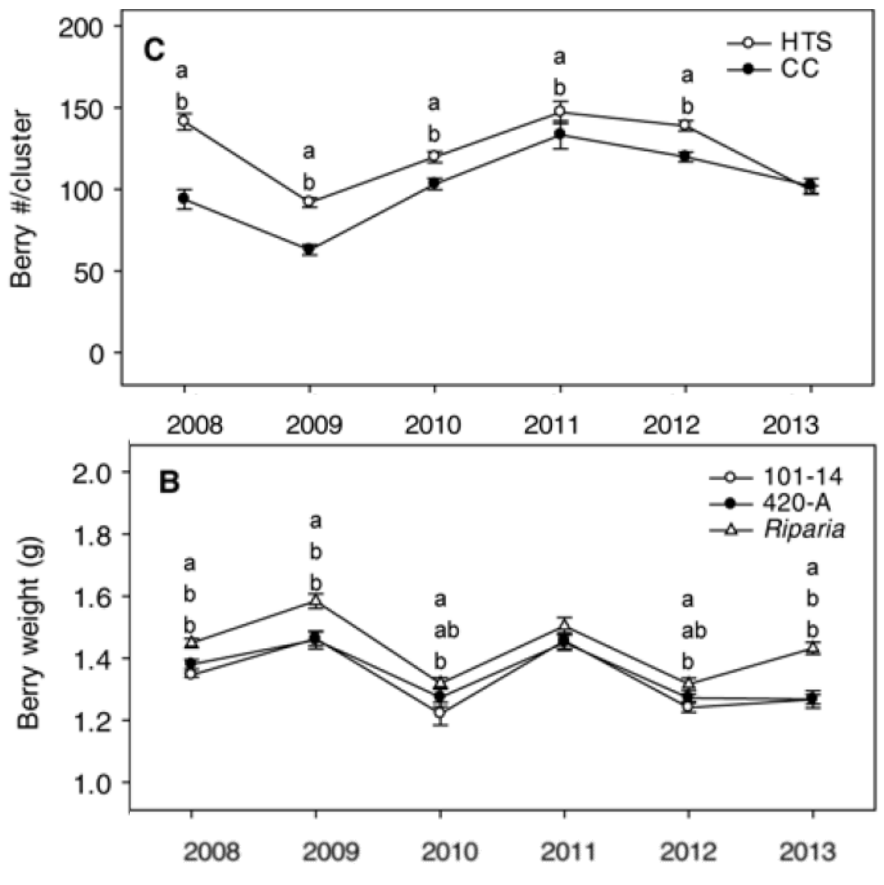
Midday stem water potential

(vine hydration status)





Crop yield and some components



Treatment	Crop yield (t/acre)	Cluster weight (g)
UTGC[a]		
CC	3.73 b	139 b
HTS	4.29 a	172 a
Rootstock		
101-14	3.80 b	141 b
420-A	3.71 b	155 ab
Riparia	4.53 a	170 a

Fruit composition

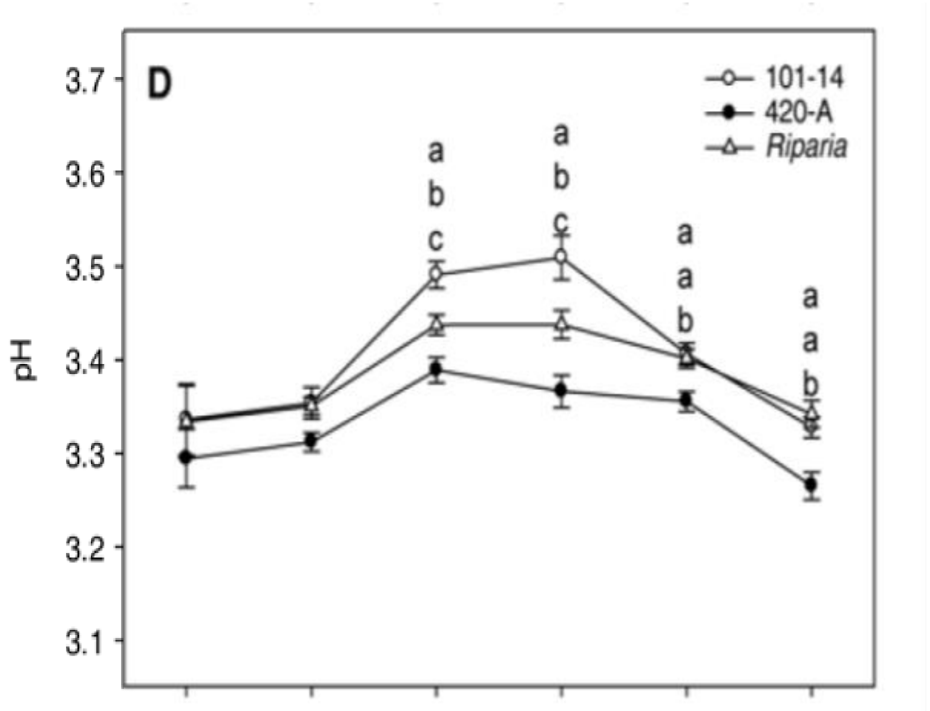


Table 5 Effects of UTGC, rootstock, and UTGC/rootstock on mean estimated skin (2009 to 2011) and berry (2013) phenolics and anthocyanins.

Treatment	2009 to 2011		2013	
	Total phenolics (A_{280}, AU[a])	Anthocyanins (A_{520}, AU[a])	Total phenolics (A_{280}, AU[a])	Anthocyanins (mg/g berry)
UTGC[b,c]				
CC	45.15 a	37.59 a	82.50 a	0.84 a
HTS	42.00 a	36.45 a	83.38 a	0.83 a
Rootstock[c]				
101-14	44.18 a	38.31 a	85.38 a	0.82 ab
420-A	41.74 a	35.65 a	73.15 b	0.76 b
Riparia	44.80 a	37.09 a	90.28 a	0.93 a

Part 1: Discussion / take home

- Under-trellis cover crops appear to "compete" with vines for nitrogen more so than water.
    - Root displacement in soil profile? (Klodd et al. 2016)
- 420-A may limit wine pH (indirect K+ effects) but also may limit color
    - "*berlandieri*-based" rootstocks exclude K+ (Wolpert et al. 2005)
- Under-trellis cover crops regulated vine growth more so than rootstock choice.
- Fruit composition was marginally affected by treatments
- *Riparia* increased crop yield (berry weight) while CC reduced crop yield (berry # / cluster)

Part 2: root bag restriction effects on vine size, crop yield, and fruit composition

Part 2: root restriction effects on vine size, crop yield, and fruit composition

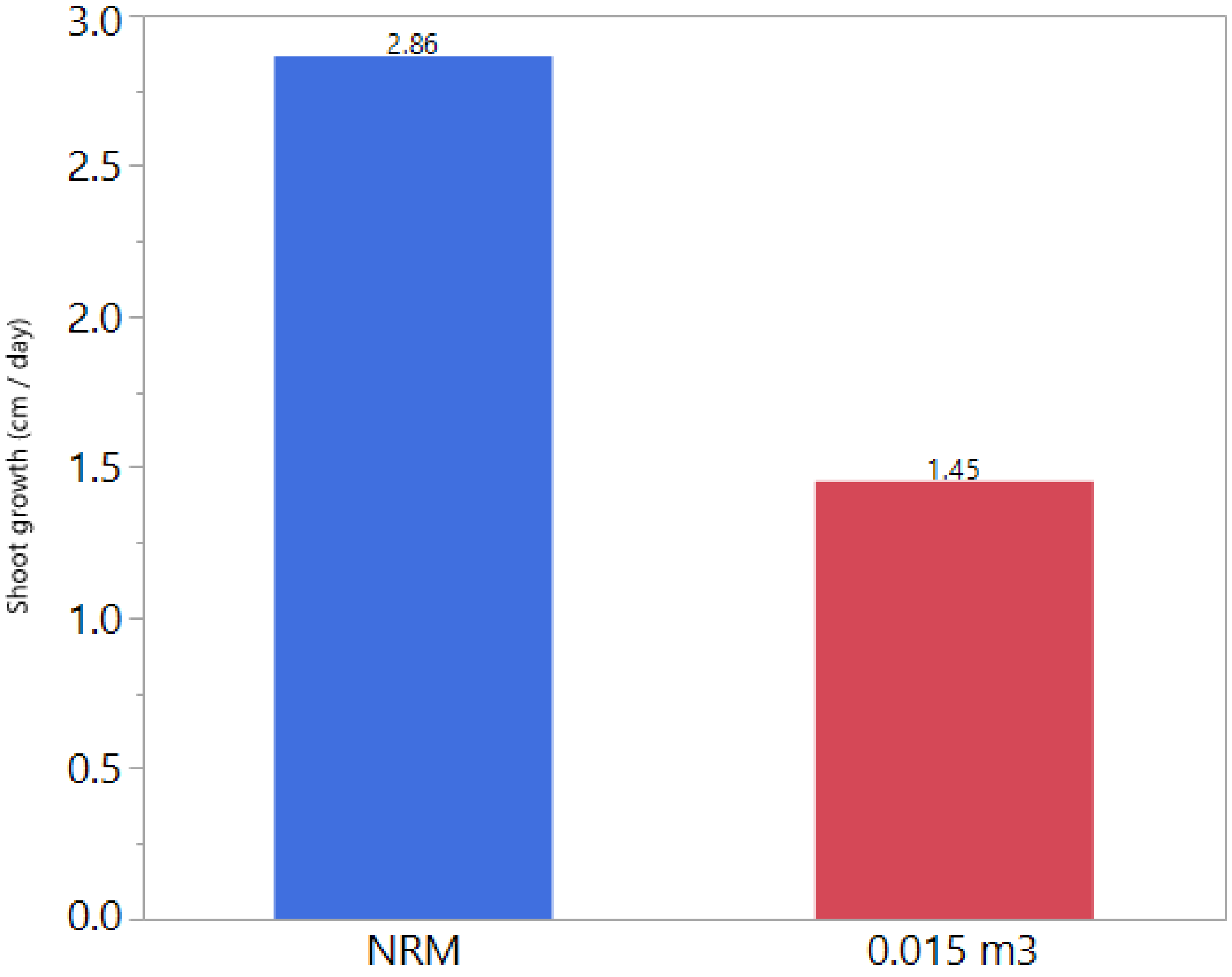
- Cabernet Sauvignon; clone 337; low, bilateral cordon trained to VSP
- 2 years

- Two “side studies”:

  - Root restriction (0.015 m^3)
  - No root manipulation (NRM)

  - 3 different root restriction volumes
    - 0.026, 0.035, and 0.058 m^3
  - No root manipulation (NRM)

0.015 m^3 volume root restriction vs. NRM

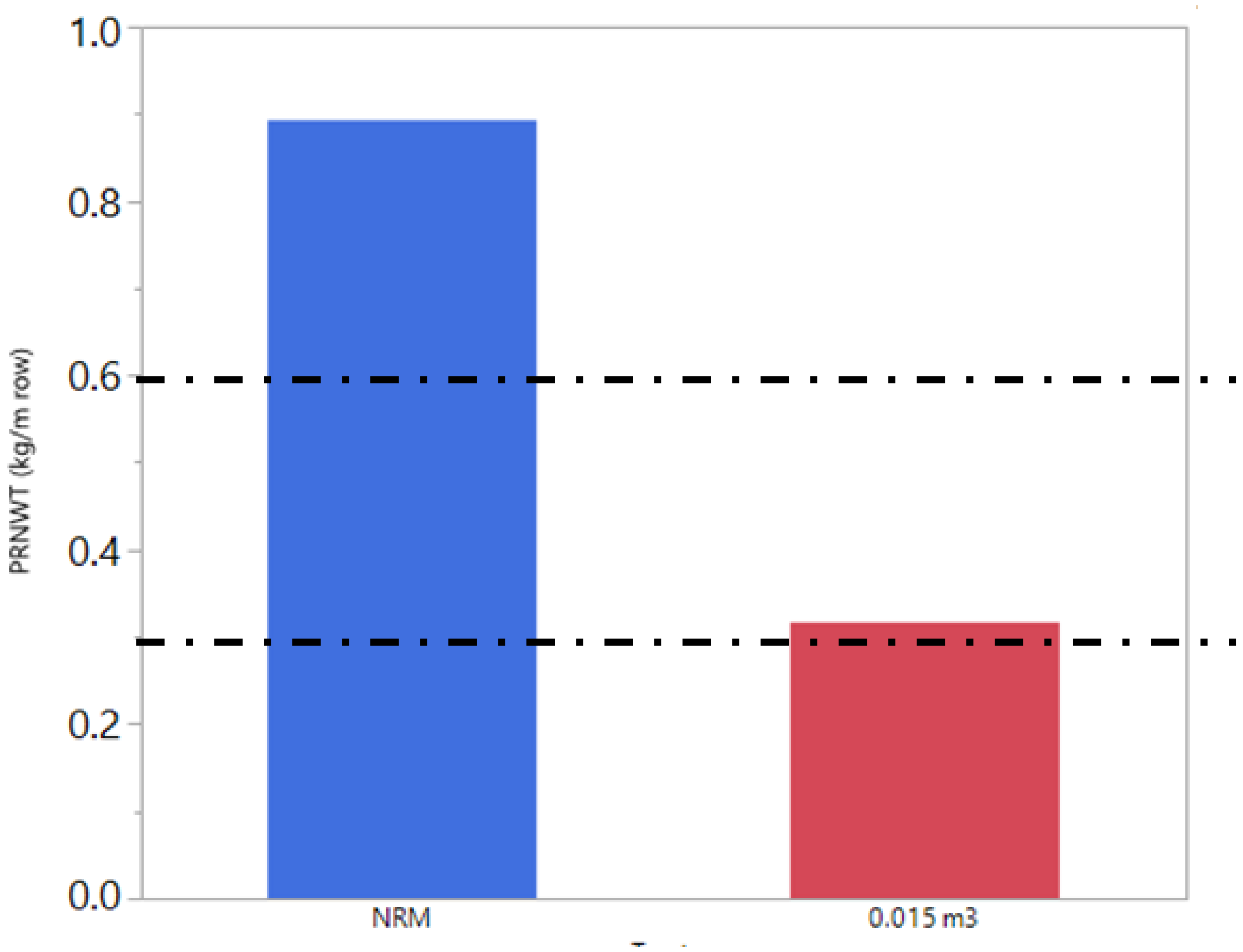


Shoot growth in 2010

0.015 m^3 volume root restriction vs. NRM

Pruning weight averaged over 2010 and 2011.

Smart and Robinson (1991)



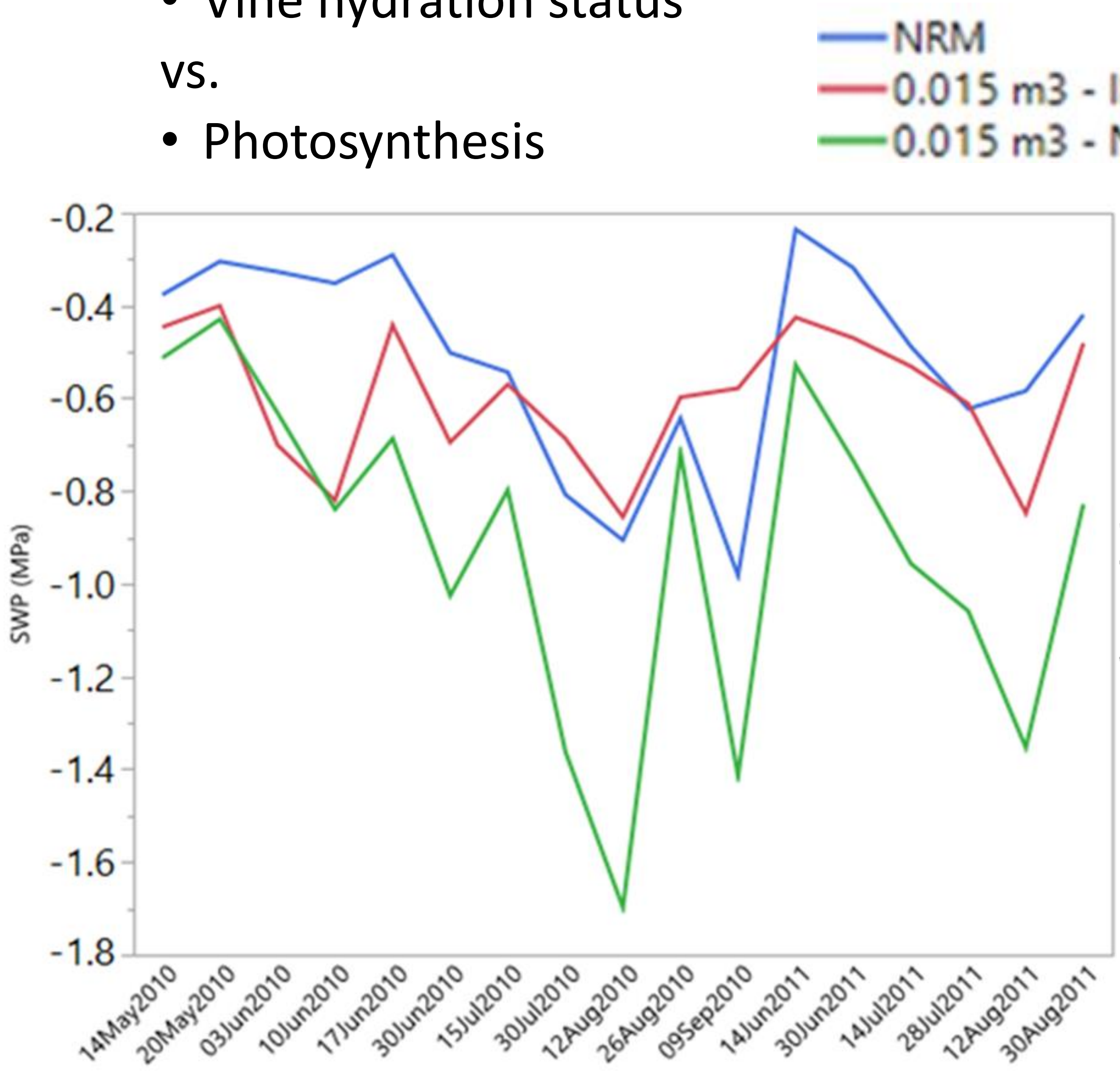
Root restriction (m3 vol.) had many of these

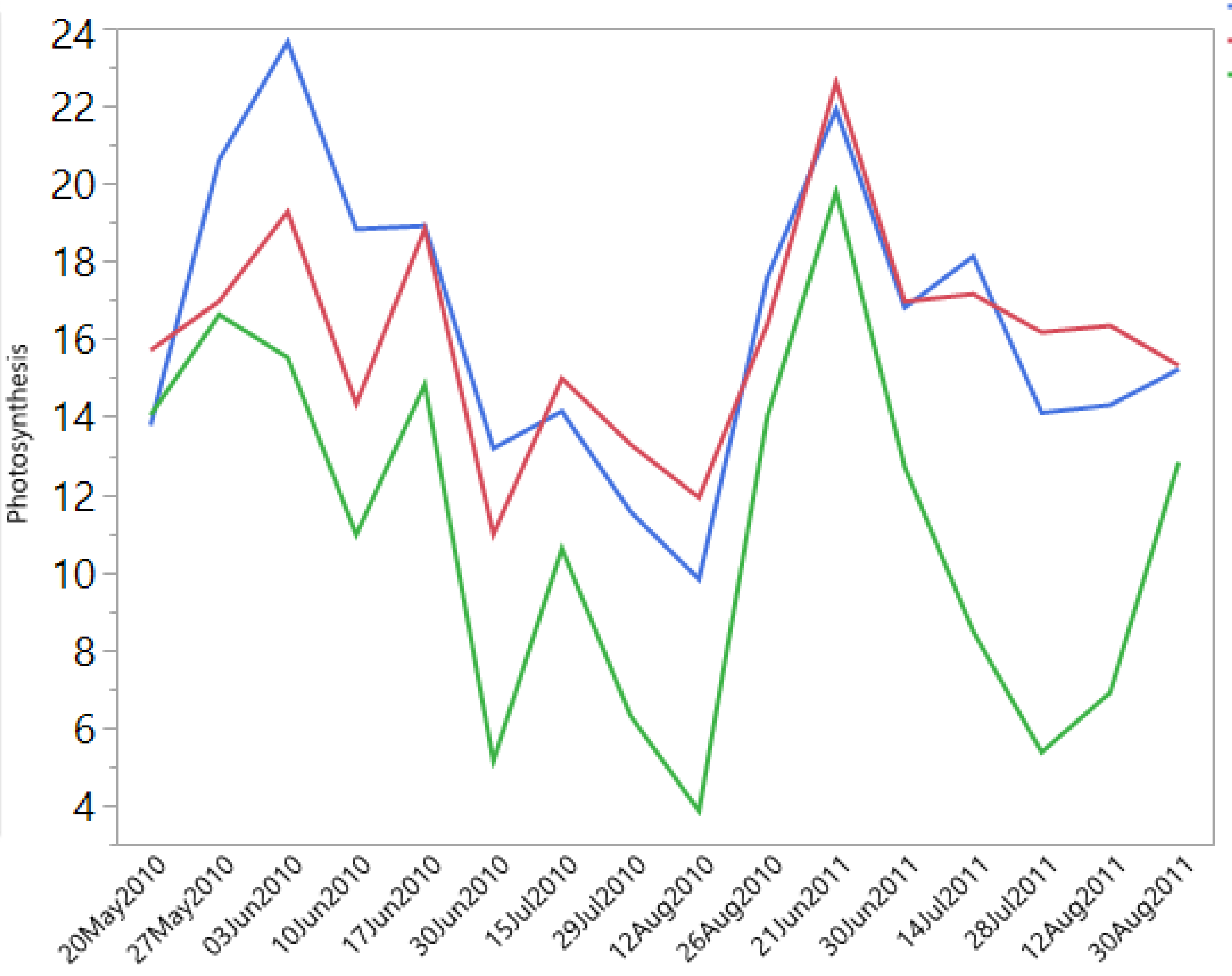
Characteristics of the ideal canopy (Smart and Robinson 1991).	
Canopy characteristic	**Optimal value**
Shoot length	15-20 nodes
Lateral shoot development	Ideally none
Growing shoot tip presence	Ideally none
Cane pruning weights	0.3 – 0.6 kg / foot of canopy

- Vine hydration status

vs.

- Photosynthesis





0.015 m^3 volume root restriction vs. NRM

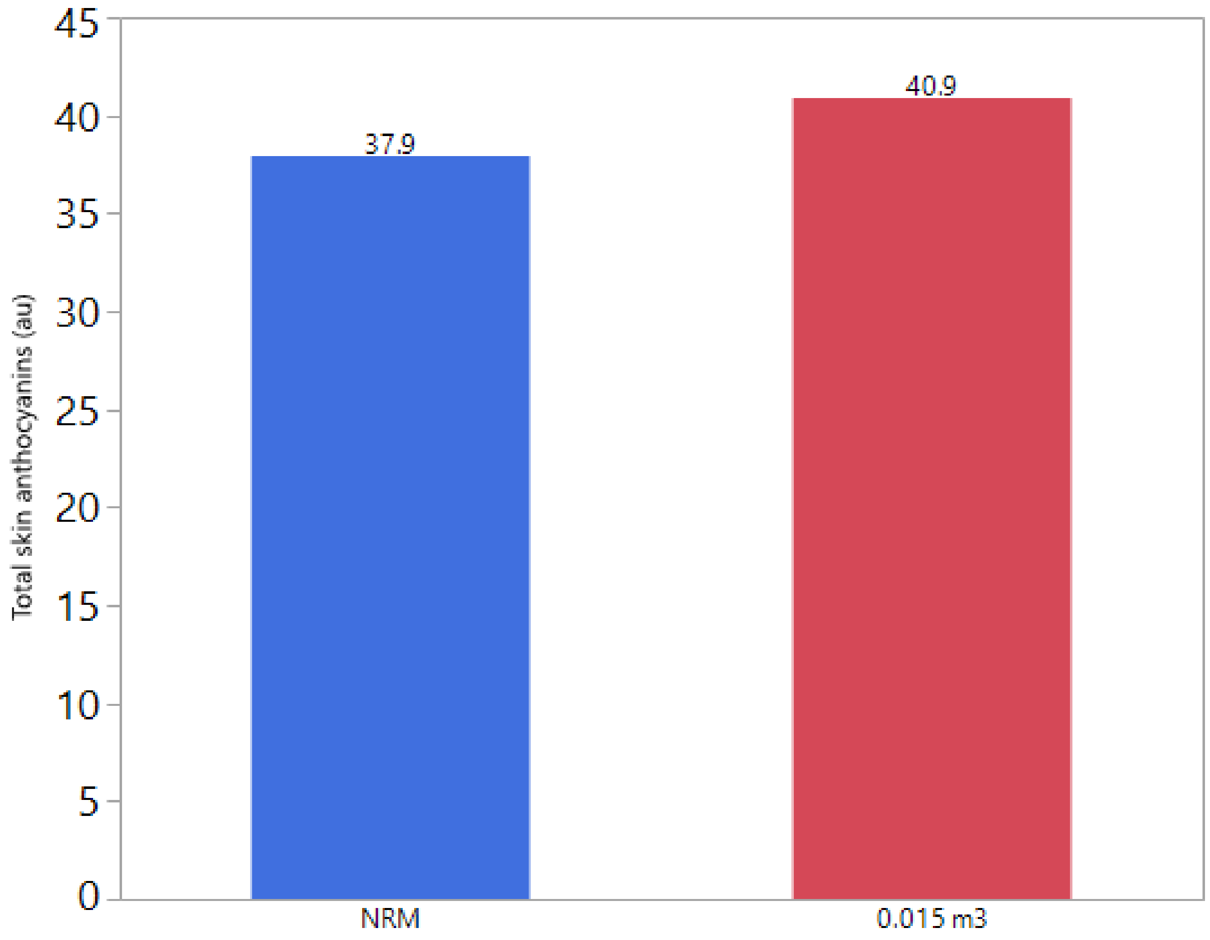
Treatment	Crop yield (t/acre)
Root restriction[a]	
0.015 m^3	2.56 b
NRM	3.98 a

- Crop yield reduction by 0.015 m^3
  - *Reduced* berry weight
  - *Reduced* berry number per cluster
  - *Reduced* cluster weight
  - Similar cluster number per vine

36% reduction in crop yield due to 0.015 m^3

0.015 m^3 volume root restriction vs. NRM

	2010		
	Brix	pH	TA
0.015 m^3	24.5 b	3.41	5.35
NRM	25.5 a	3.44	5.43
	2011		
	Brix	pH	TA
0.015 m^3	20.9	3.37 b	5.13 b
NRM	21.4	3.44 a	5.81 a



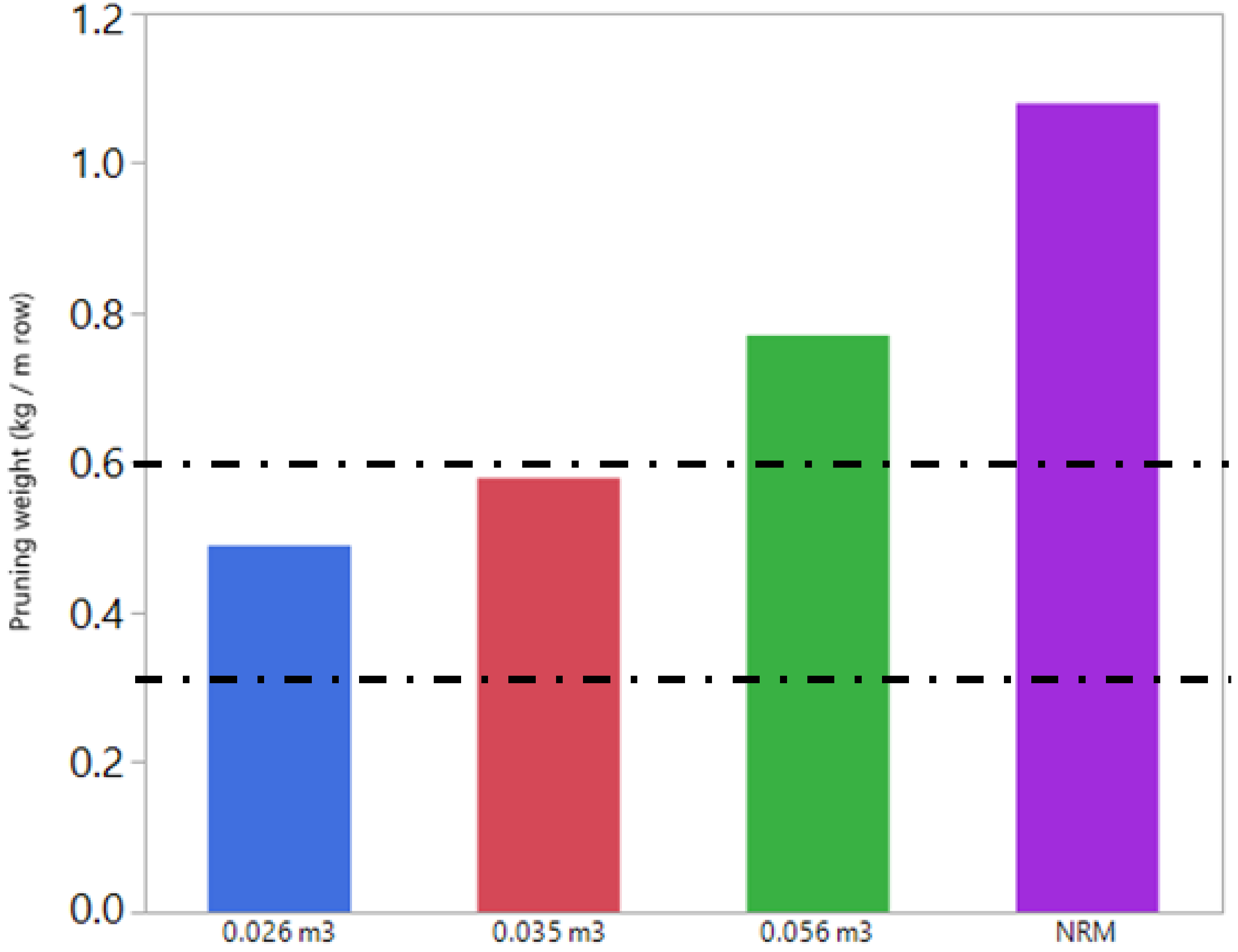
Multi-volume (0.026, 0.035, 0.058 m^3) root restriction vs. NRM

- Immediately thought that 0.015 m^3 was maybe “too much” growth regulation…
- …let’s try larger volumes…
- 0.026 m^3
- 0.035 m^3
- 0.058 m^3

Multi-volume (0.026, 0.035, 0.058 m^3) root restriction vs. NRM

- Pruning weight

- 0.026 and 0.035 m^3
  - "in the zone"



Multi-volume (0.026, 0.035, 0.058 m^3) root restriction vs. NRM

Treatment	Crop yield (t/acre)
Root restriction[a]	
0.026 m^3	5.23
0.035 m^3	5.96
0.058 m^3	5.18
NRM	5.50

Multi-volume (0.026, 0.035, 0.058 m^3) root restriction vs. NRM

Table 29. Treatment effects on soluble solids (°Brix), pH, and titratable acidity (g/L) in 2015-2016.

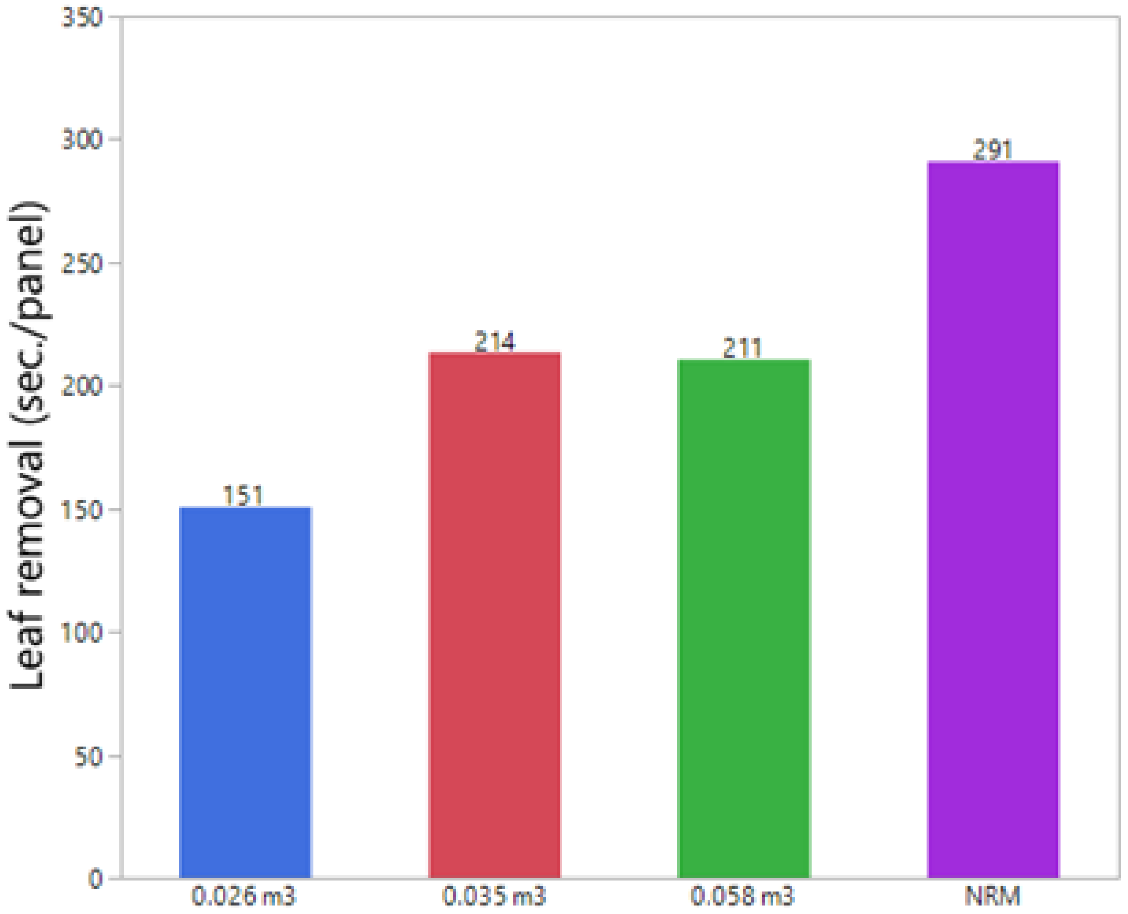
	Soluble Solids (°Brix)		pH		Titratable Acidity (g/L)	
Treatment[ab]	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
0.026 m^3	23.10 a	22.15 a	3.27 b	3.61 a	6.88 b	5.35 b
0.035 m^3	22.80 a	21.73 a	3.26 b	3.59 a	7.67 a	5.57 b
0.058 m^3	23.08 a	22.28 a	3.29 b	3.61 a	7.65 a	5.91 ab
NRM	22.18 a	20.35 b	3.34 a	3.56 a	8.12 a	6.82 a
Significance[c]	NS	0.0010	0.0041	NS	0.0025	0.0138

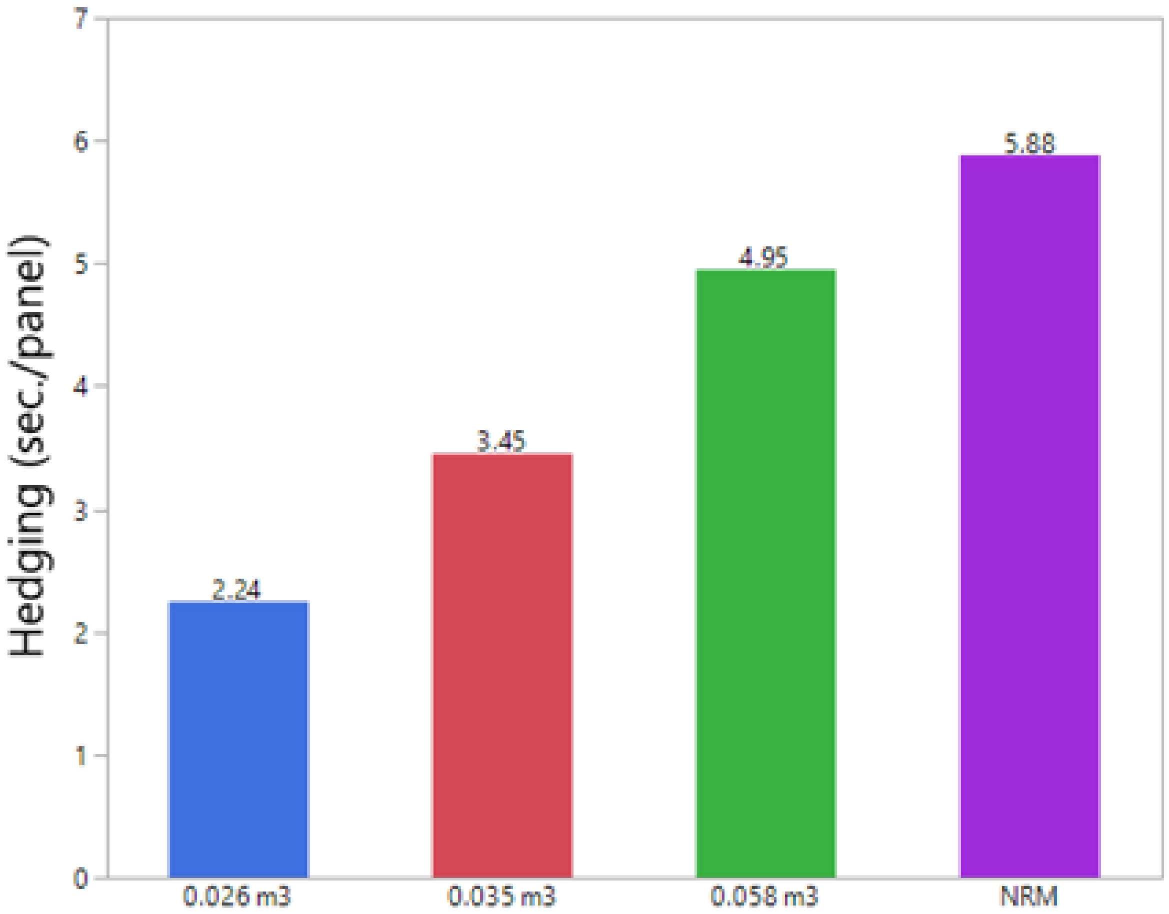
Multi-volume (0.026, 0.035, 0.058 m^3) root restriction vs. NRM

	Anthocyanin concentration (mg/g)		Absorbance at 280 nm	
Treatment[ab]	2015	2016	2015	2016
0.026 m^3	1.25 a	1.30 a	1.60 a	1.68 a
0.035 m^3	1.10 ab	1.04 ab	1.46 a	1.50 ab
0.058 m^3	1.05 ab	1.04 ab	1.45 a	1.56 a
NRM	0.96 b	0.84 b	1.32 a	1.24 b
Significance[c]	0.0155	0.0045	NS	0.0106

DeAnna D'Atillio

Canopy management labor savings of 4.8-8.7 hours per acre

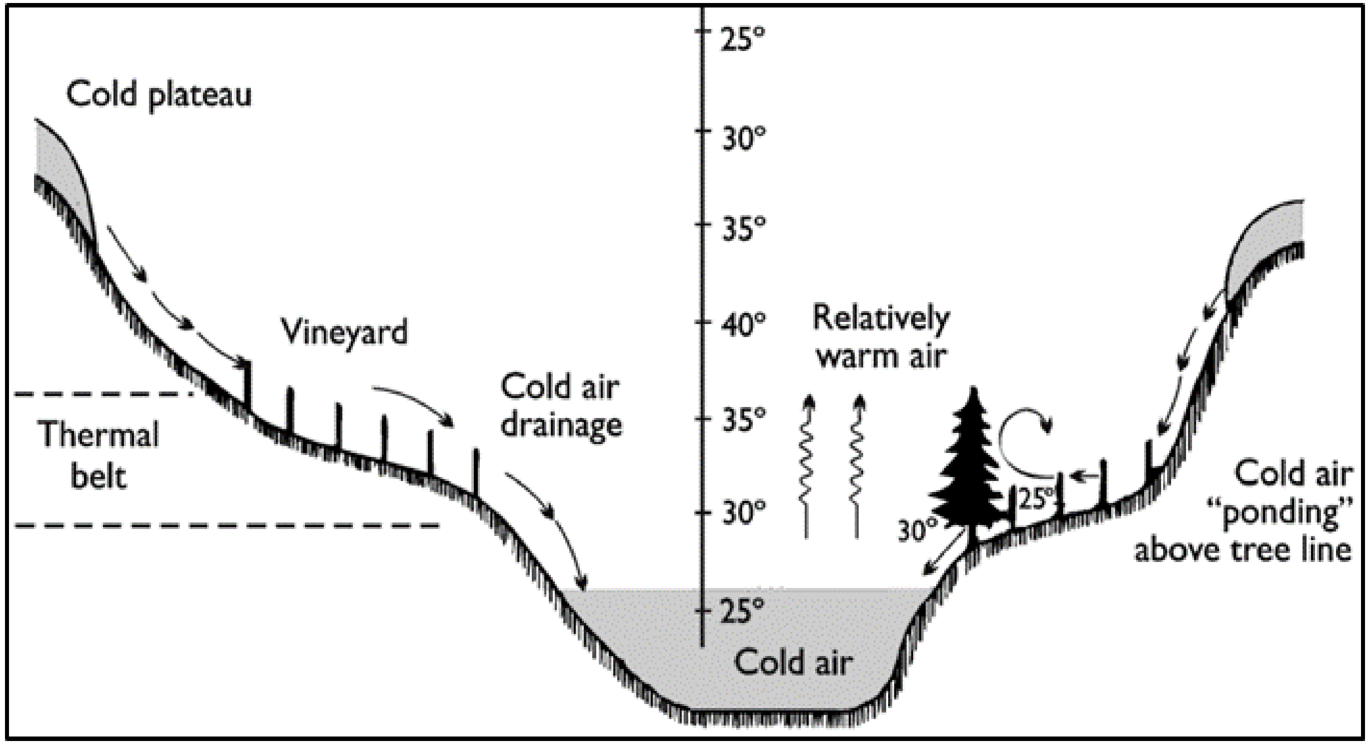




Overall take home

- Use proactive tools to "match" your site and production goals
  - High clay, high O.M., flat land

  VS.
  - Rocky, low O.M. sloped land
  - Think about vine spacing, trellis system, and cultivar.
- Cover crops may provide tandem vineyard benefits (soil health, reduced leaching and erosion)
  - Wait until *at least* year 2-3 to establish
  - Watch nitrogen levels
  - Choose species wisely (*F. rubra*)



Poling (2006)

Overall take home

- *Riparia* worked well
  - attenuated vegetative growth
  - increased crop yield; maintained wine quality potential

- If experimenting with root restriction:
  - Irrigation may be necessary in dry summers
  - Can “tame” canopy vigor
  - Choose volume wisely ($\geq 0.026\ m^3$)

  - 0.026 and 0.038 m^3 may be “best” in terms of growth regulation and crop yield maintenance

Vine size – fruit quality comment

Farming is a business – need quantity and quality; you can have both

Comment on vine size – crop yield - quality

Thanks very much

- Russ Moss

- Sierra Winegarner
- Bree Boskov
- Jason Tosch
- Gill Giese

- Tony Wolf
- Brycen Hill
- Tremain Hatch