Evaluating Cultural Practices for Recovery from Cold Damage in Grapevines

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Outline

- Cold hardiness classes of grapevines
- Overview of freeze damage in Ohio
- Goal and objectives
- Study 1 : Cane quality for trunk renewal and recovery
- Study 2 : Training systems for trunk renewal and recovery
- Conclusions and recommendations

Genetic potential of the genotype (variety)

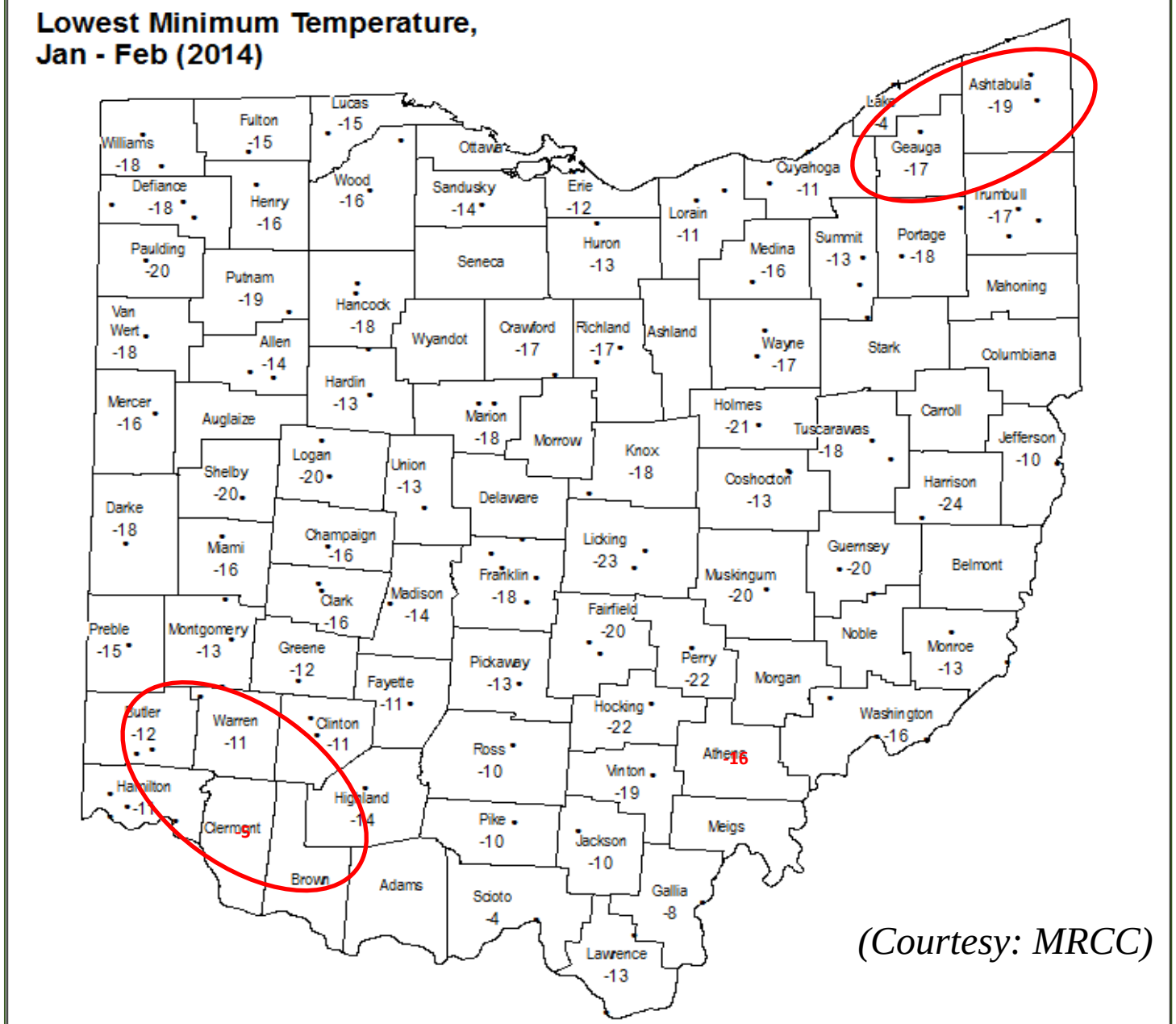
2014 Polar Vortex: -4°F to -24 °F

Cold Hardiness of Grape Genotypes

Cold hardiness class	Range of critical temp (LT50)	Species	Examples of varieties
Very tender	5 to -5	Most *V. vinifera*	Merlot, Semillon, Syrah, Sauv. Blanc
Tender	0 to -8	*V. vinifera*	Chardonnay, Cab Sauv, Gewurztraminer, Pinot gris, Pinot noir
Moderately tender	-5 to -10	Some *V. vinifera*, some hybrids	Riesling, Cab. Franc, Lemberger,Chambourcin
Moderately hardy	-10 to -15	Most hybrids	Chardonel, Traminette, Norton, Seyval
Hardy	-15 to -20	Most *V. labrusca*	Catawba, Concord, Delaware
Very hardy	-20 to -30	Some hybrids	Frontenac, Foch, LaCrescent

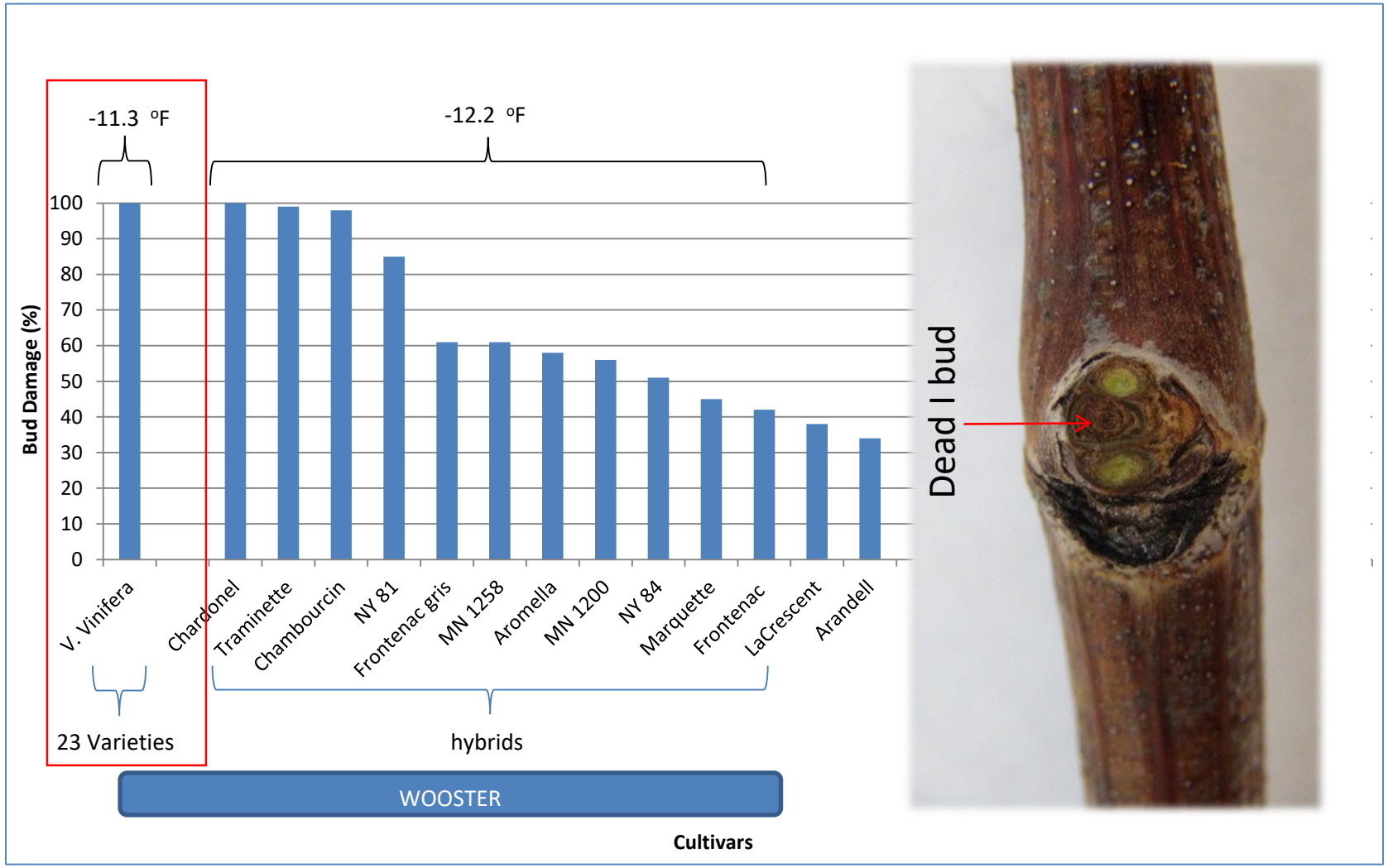
(Zabadal et al. 2007)

2014 Polar Vortex: -20°C (-4F) to -31°C (-24F)



(Courtesy: MRCC)

Primary Bud Damage During 2014 Polar Vortex



Winter Damage in Ohio after 2014 Polar Vortex

American: 30% Hybrid: 60% Vinifera: 97%

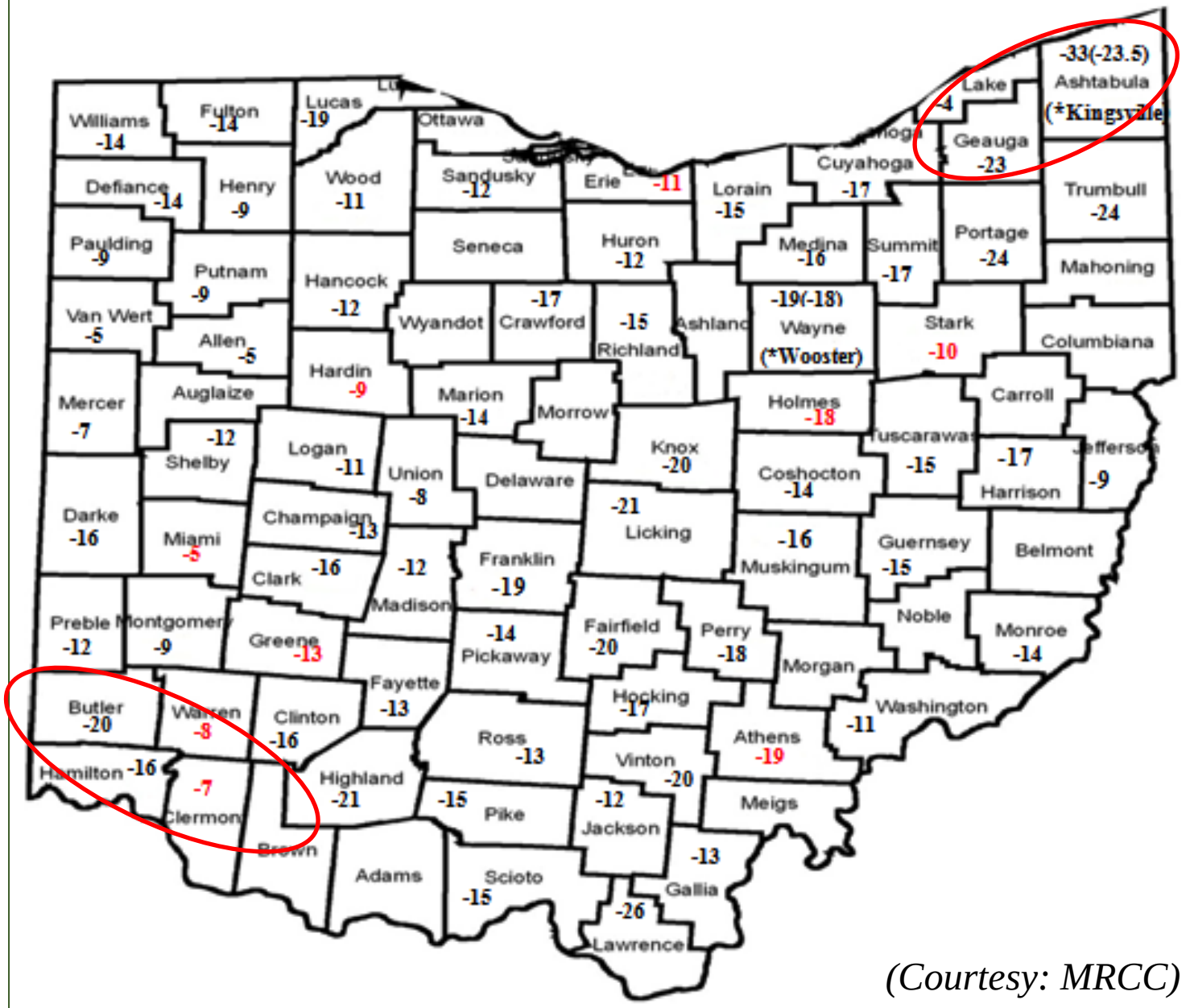
$12 Million crop loss

(Dami & Lewis 2014)

Vine die-back in 2014: How to rehabilitate?

Issue: lack of research-based information on optimum vine recovery

2015 Min Temp : -20°C (-5F) to -36°C (-33F)



(Courtesy: MRCC)

Back to Back Winter Injury

Goal

Provide research-based information on how to mitigate freezing damage

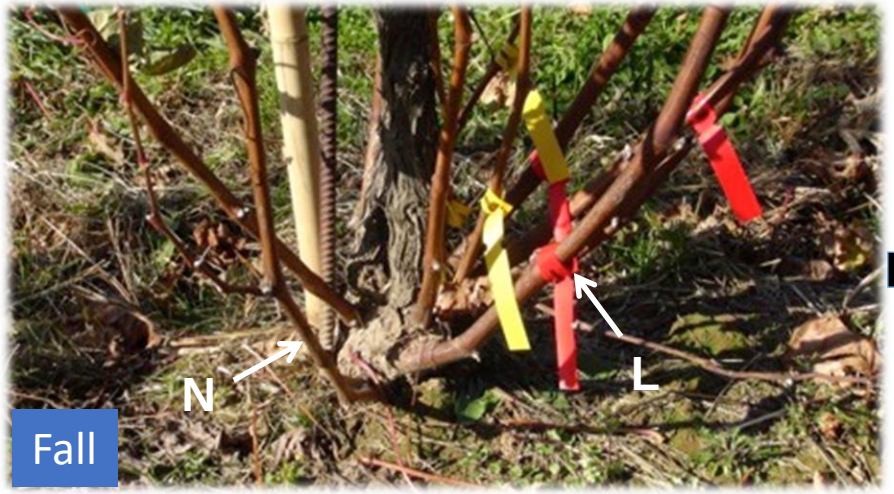
Objectives

1) Evaluate the impact of **cane morphology** on freezing tolerance (FT) of bud and vascular tissues in relation to carbohydrate concentrations and anatomical structures of cold sensitive cultivars.

2) Evaluate several **training systems** for trunk renewal including cost, growth, yield, and fruit quality in three important cold sensitive cultivars in Ohio.

Determine best cane size, and training system to use following severe cold damage in cold tender cultivars.

Study 1: Cane morphology ‘Cabernet franc’



Normal	Pencil	Large
7-9 mm	8 mm	>12 mm

What is a “Bull Cane”?

Characteristics of “bull” shoot/cane

- Rapid and vigorous growth
- Long internodes (5-6 inches)
- Large diameter (>1/2inch)
- Flattened shape
- Poorly fruitful

‘Cabernet Franc’ Bull cane

(E-Extension; Todaro & Dami, 2017)

Vegetative growth characteristics

Shoot length (summer)

Lateral length (summer)

Pruning weight (winter)

Internode diameter (summer)

Leaf area (Fall)

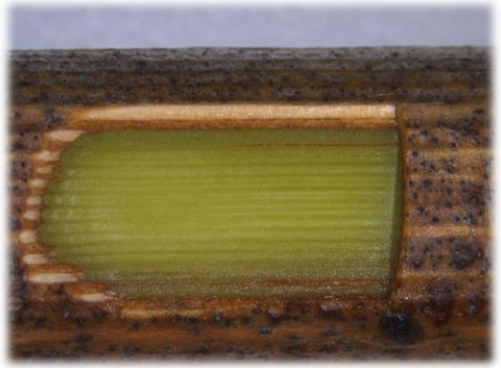
Freezing Tolerance

Bud & Cane Tissue Assessment

Live Buds

Dead I bud

Live Phloem

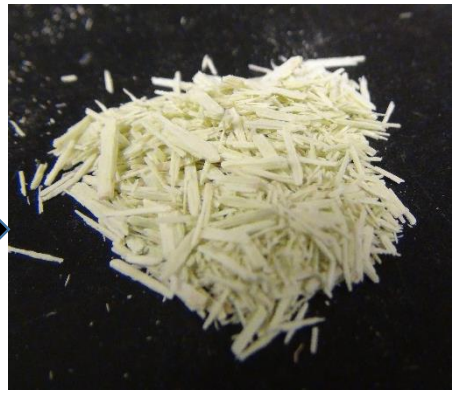


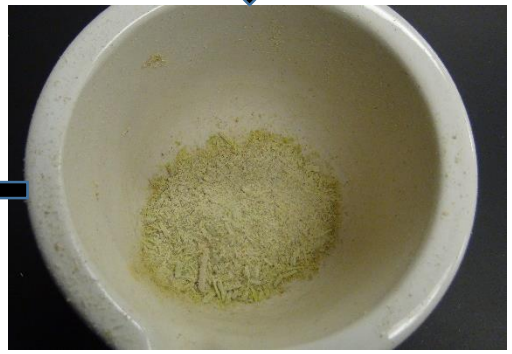
Phloem Injury

Determine LT50 = Lethal temperature to 50% of tissues

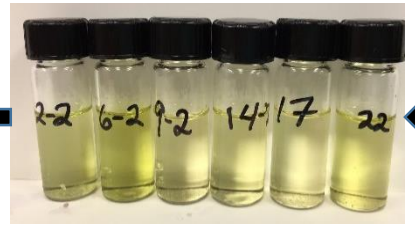
Carbohydrate analysis

Cryo-mill





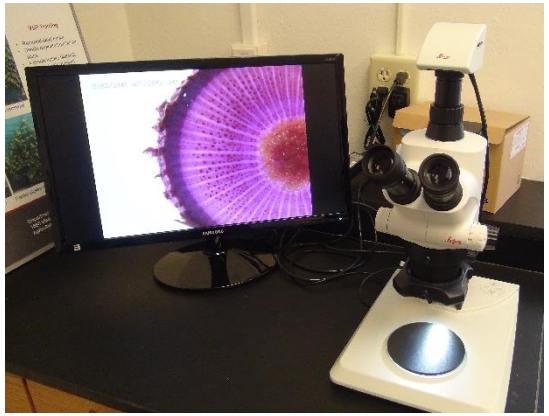
Freeze drier



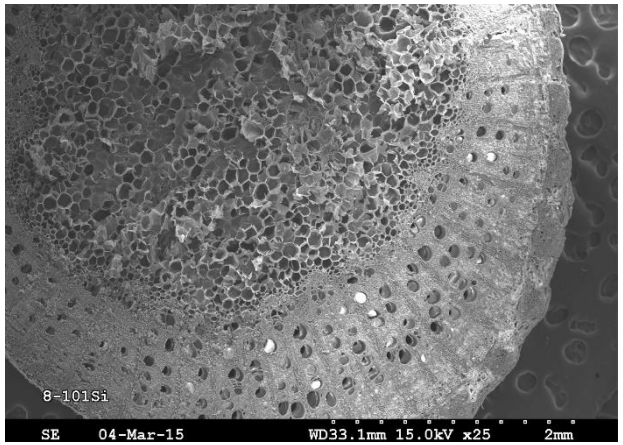
C.E. machine

Anatomy

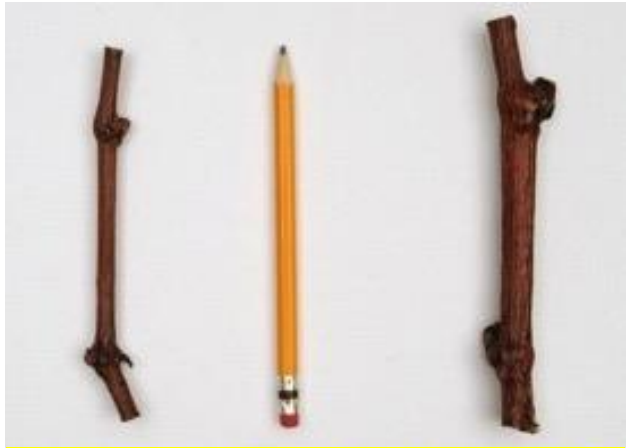
Light microscopy



Electron microscopy



Results: Vegetative growth characteristics



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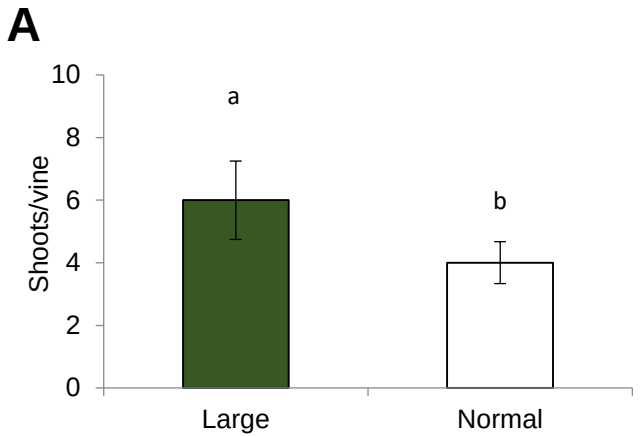
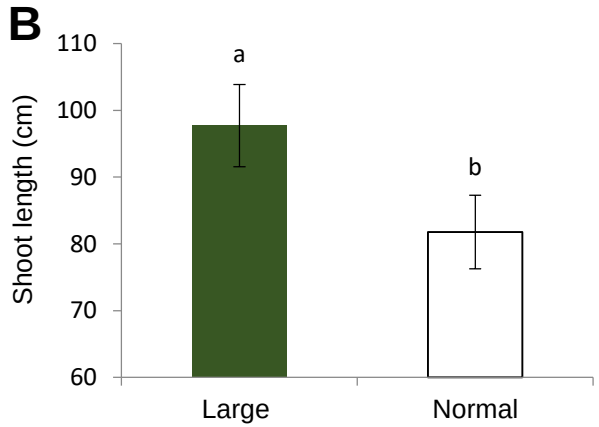
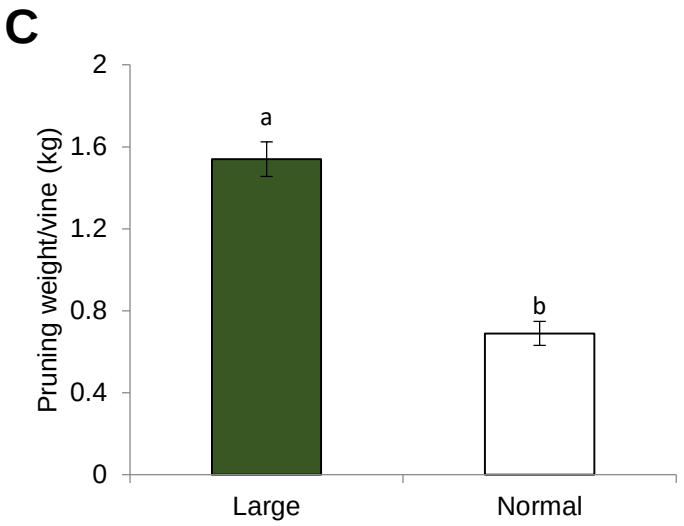
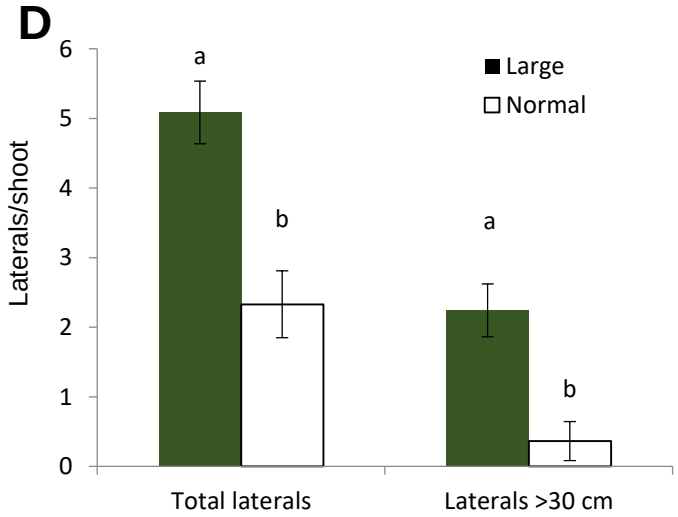


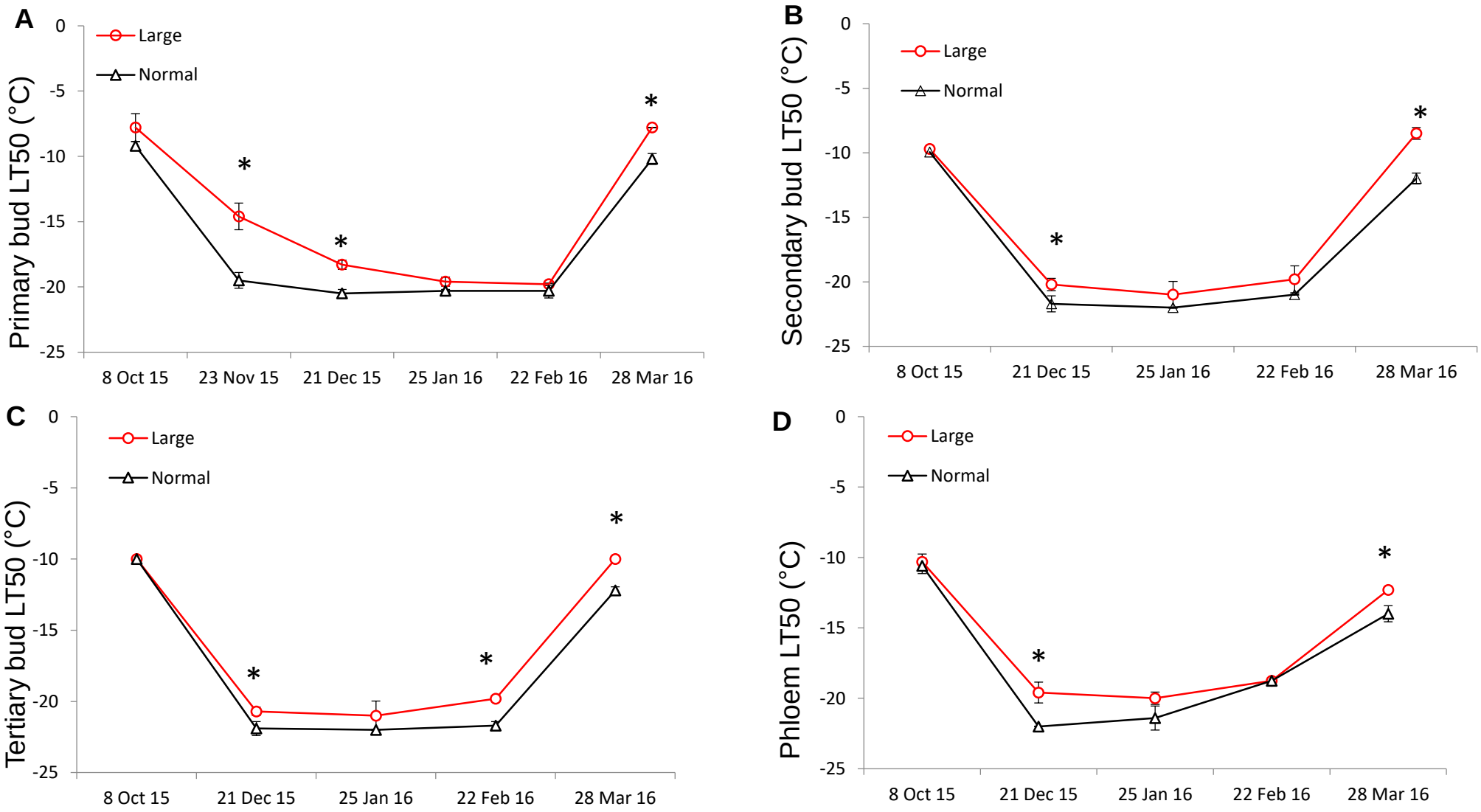






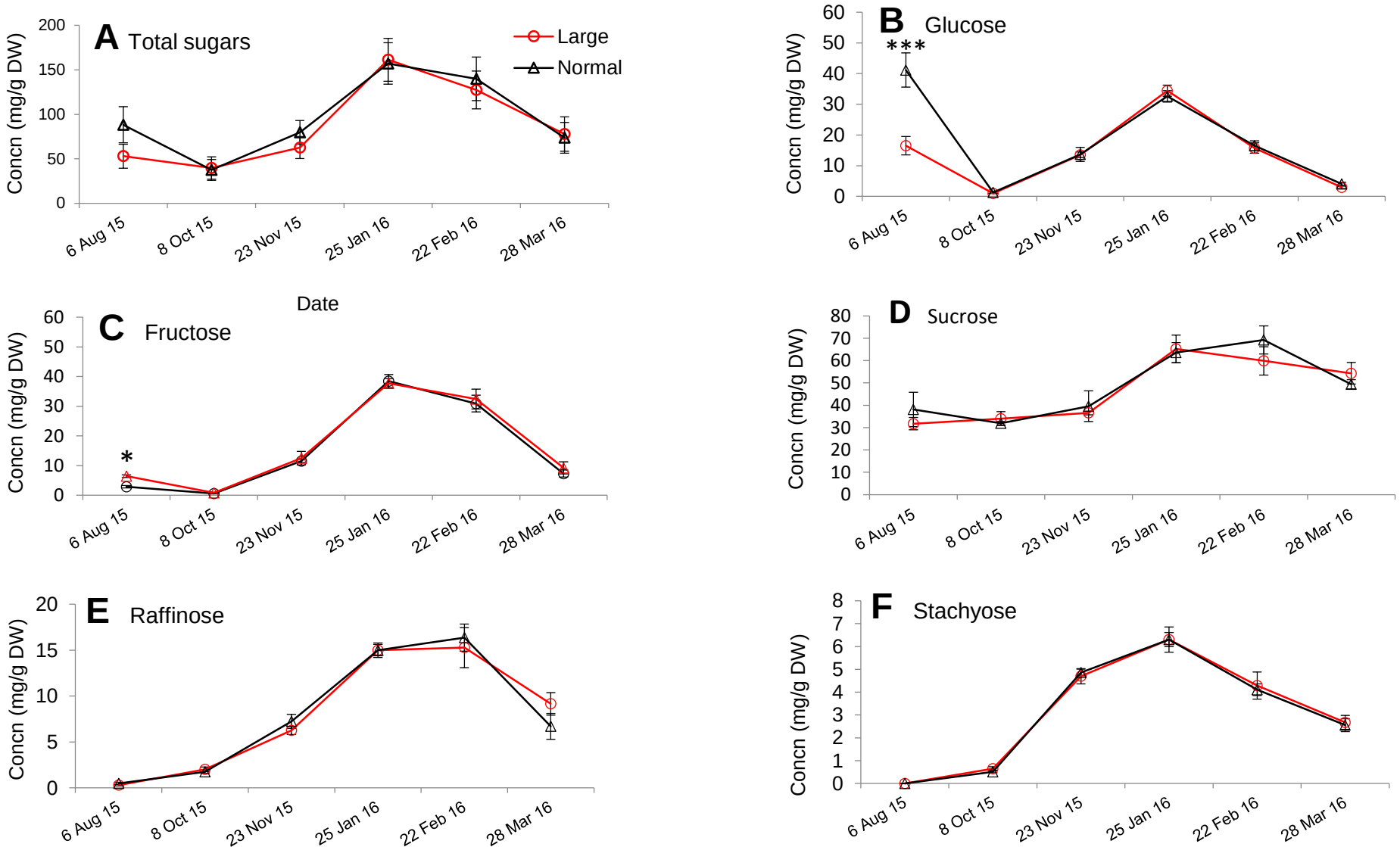
(Todaro and Dami, 2017)

Freezing tolerance



(Todaro and Dami, 2017)

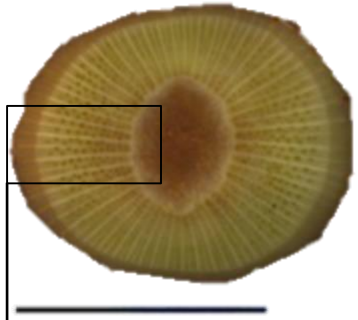
Carbohydrates



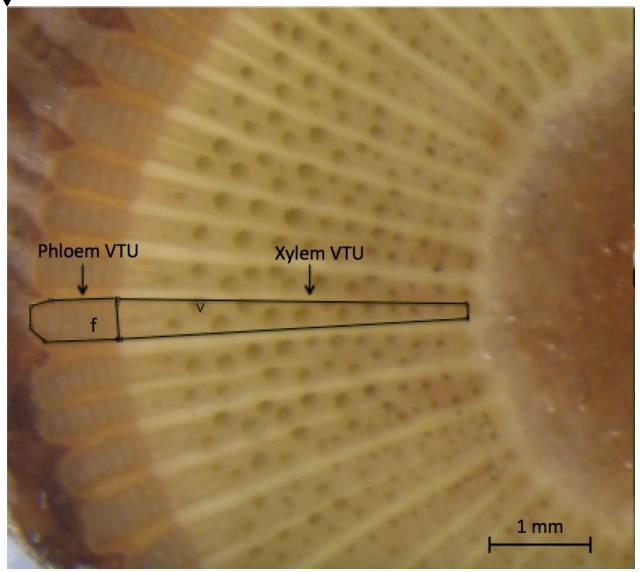
(Todaro and Dami, 2017)

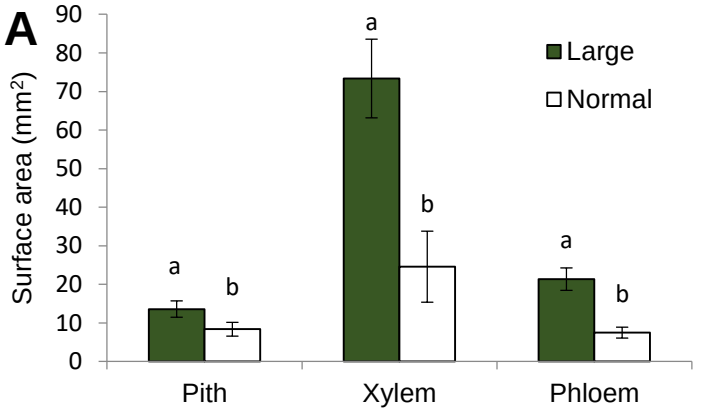
Anatomy

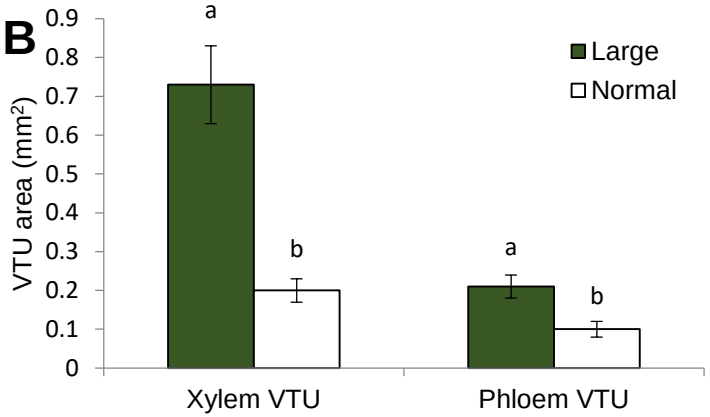
Large cane (14mm Diam)

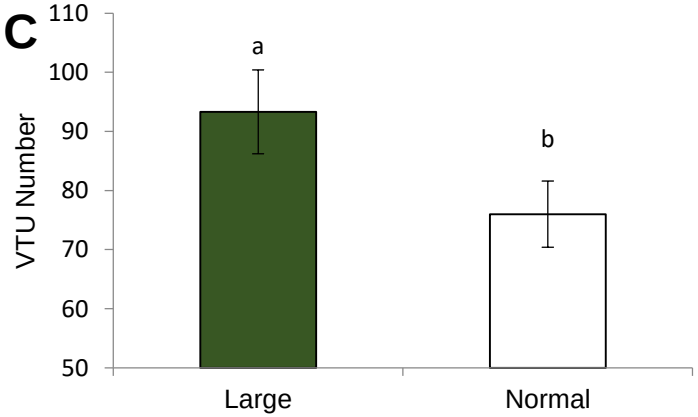


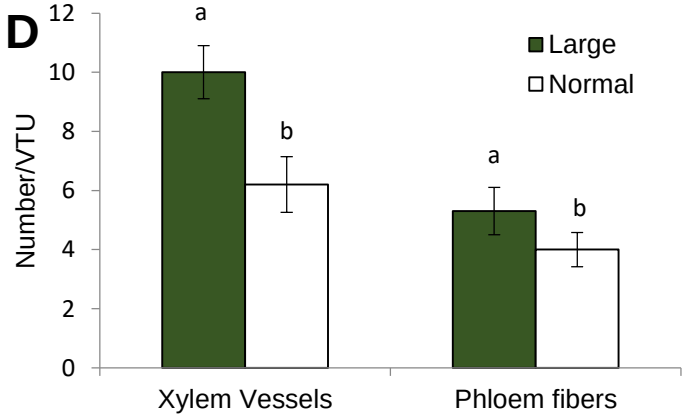
Normal cane (7mm Diam)











(Todaro and Dami, 2017)

Summary of Findings

Vegetative growth

Large canes
- longer, wider and heavier shoots
- longer and more laterals

Anatomy

Large canes
- Larger and more numerous vascular structures

Freezing tolerance

Large canes
- Less cold hardy buds
- Less cold hardy phloem

Than Normal canes

Recommendations:
- Remove large “bull” canes
- Retrain vines using normal sized canes (7-9 mm)

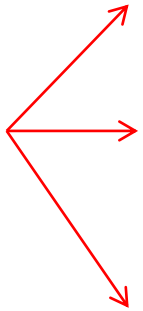
Study 2: Training Systems for Trunk Renewal

Hypotheses

Training system impacts vine recovery to pre-damage crop production

Objectives

Training systems



1) Determine work hours required to implement
2) Evaluate vine growth, yield components, and fruit quality
3) Determine quality of renewed trunks

Data collection

1) **Vegetative growth characteristics**
   - Bud and shoot counts
   - Retraining time
   - VSP conversion time
   - Leaf area

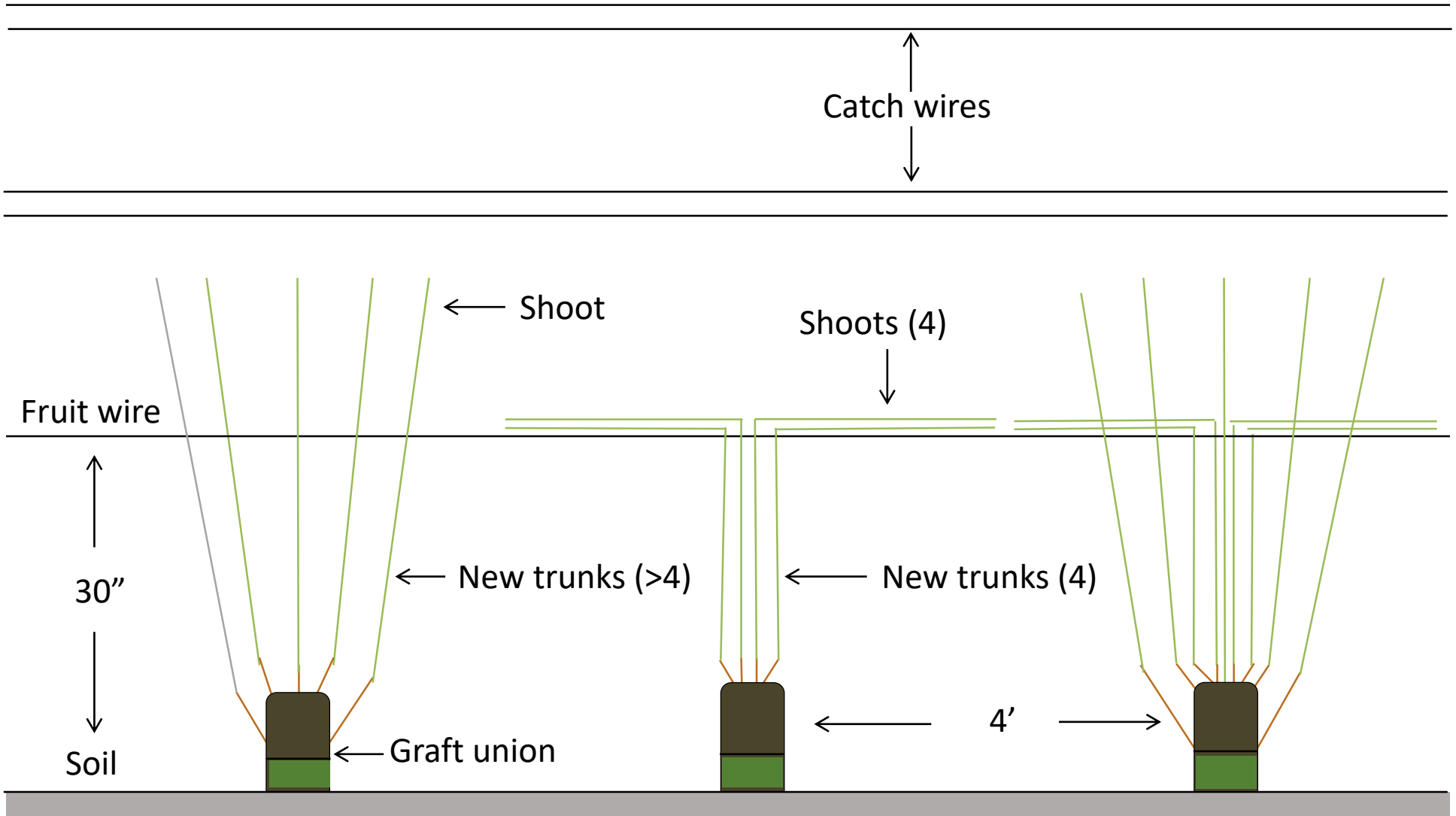
2) **Yield components**
   - Cluster number
   - Crop wt.

3) **Fruit composition**
   - Total soluble solids (Brix)
   - pH
   - Titratable acidity

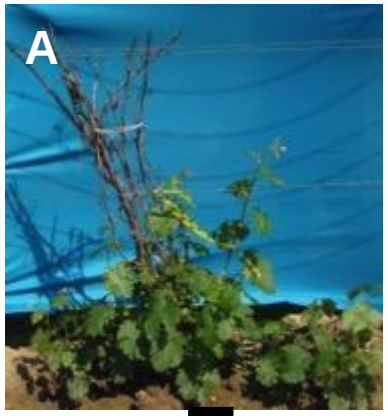
4) **Trunk quality**
   - Diameter
   - Crown gall incidence

Year 1: 2015

A. Fan **B. Bilateral training (VSP)** **C. Fan-VSP**



‘Cabernet franc’

	Fan	VSP	Fan-VSP
4 June 2015			
10 June 2015 (Before)			
10 June 2015 (After)			

Summer

29 July 2015

Fan

VSP

Fan-VSP

Fall Harvest

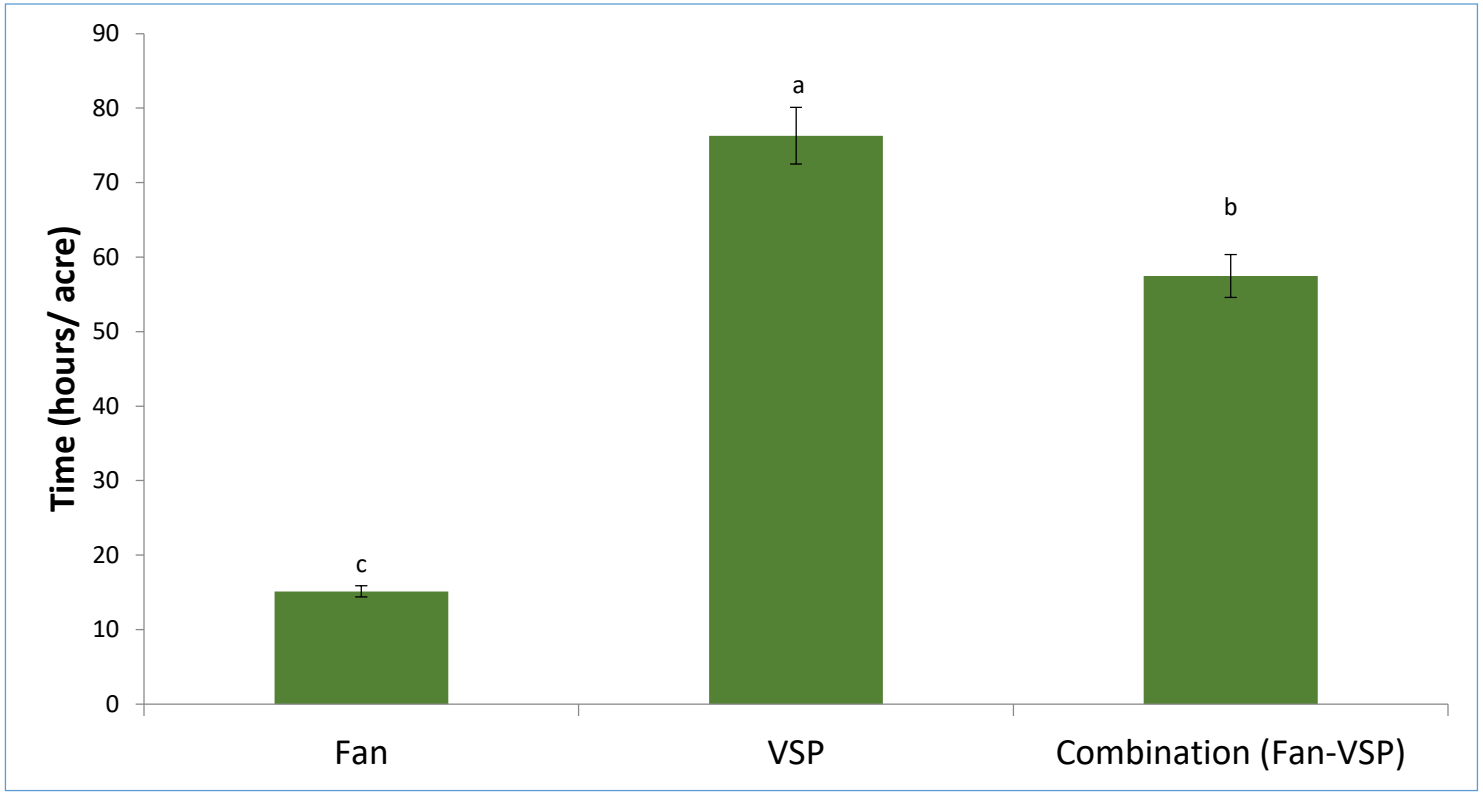
24 September 2015

Fan

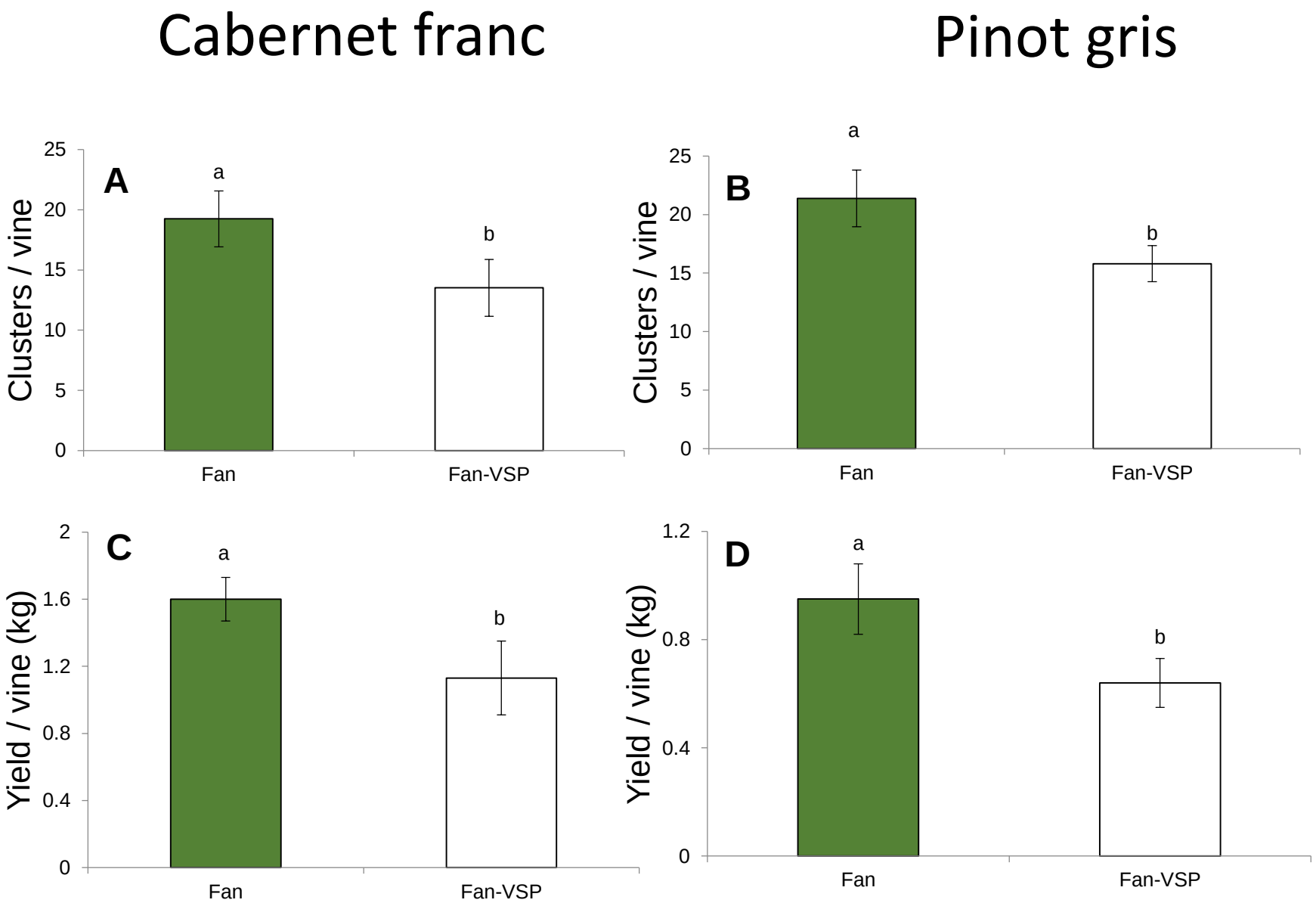
VSP

Fan-VSP

Initial retraining time in spring

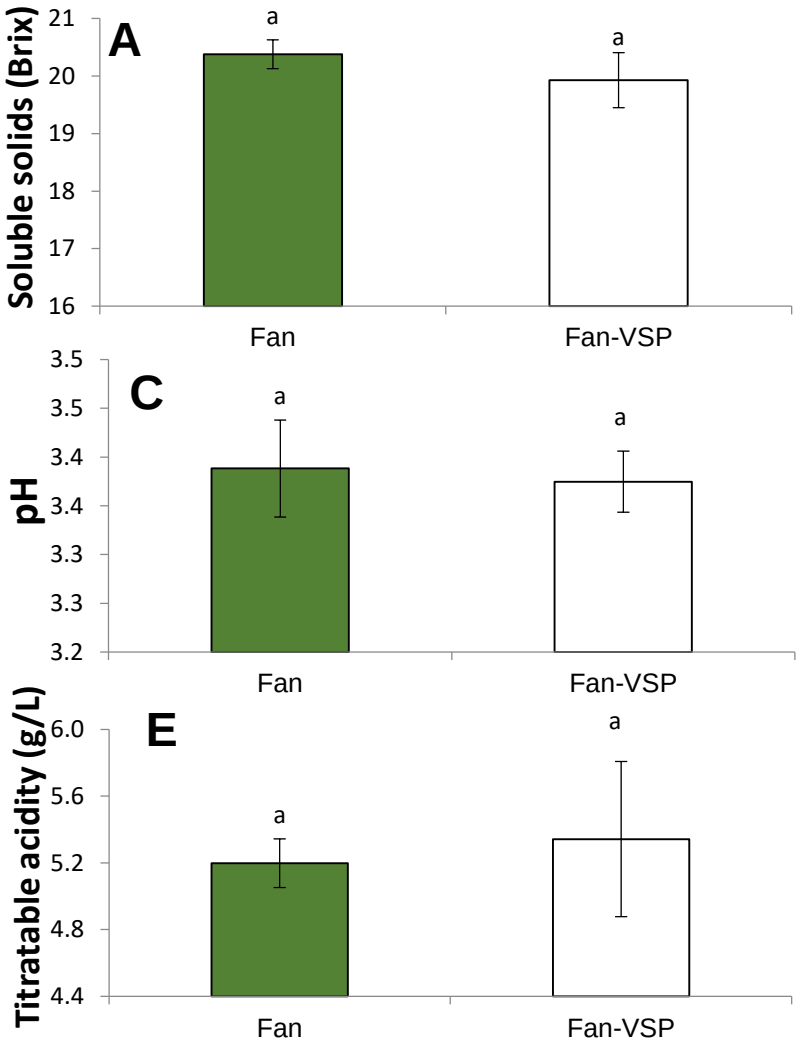


2015 Yield components

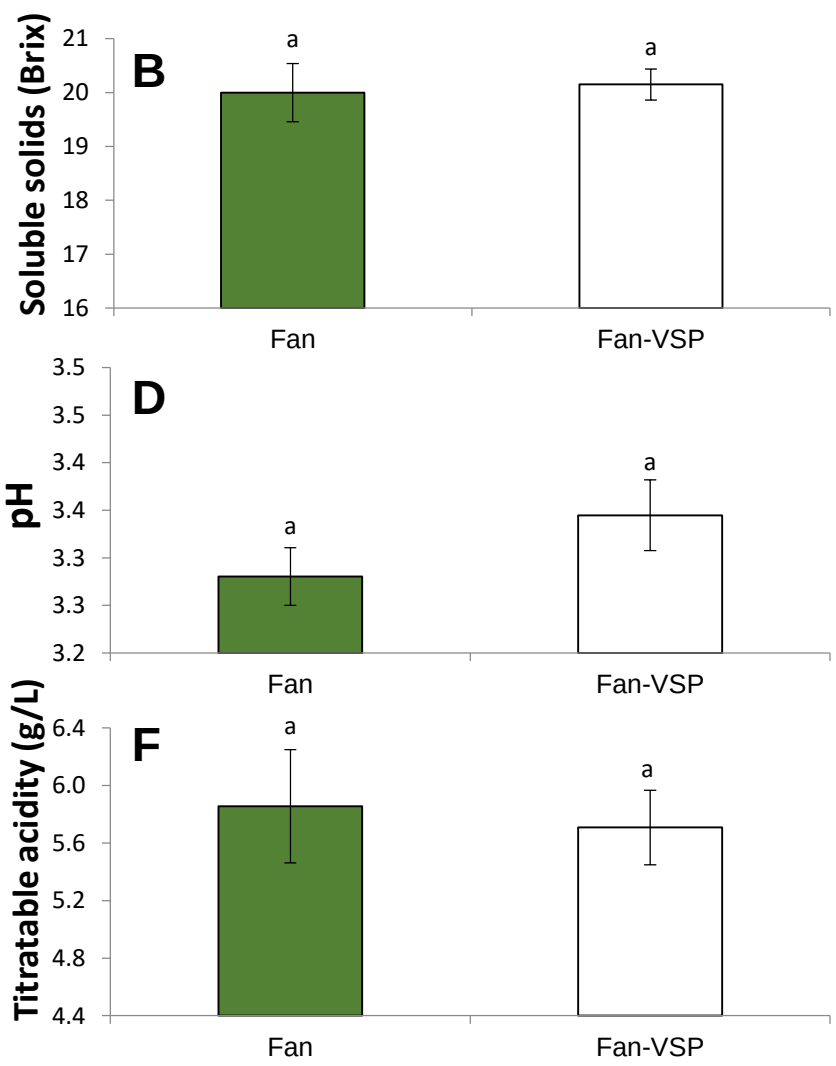


2015 Fruit composition

Cabernet franc



Pinot gris



Late fall (2015)

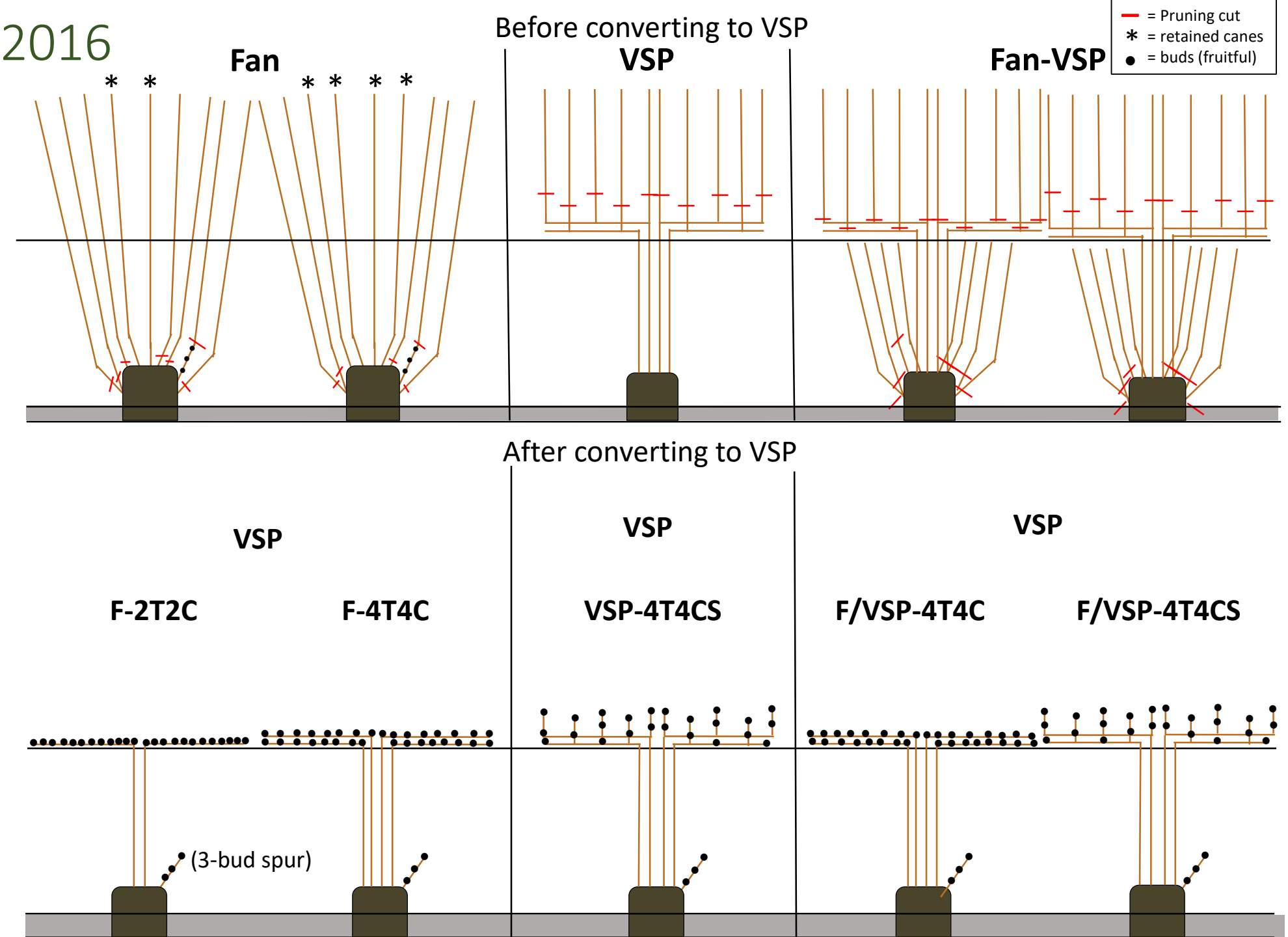
12 December

Fan training

VSP

Combination (Fan-VSP)

Year 2: 2016


= Pruning cut
= retained canes
= buds (fruitful)
Before converting to VSP
Fan
VSP
Fan-VSP
After converting to VSP
VSP
VSP
VSP
F-2T2C
F-4T4C
VSP-4T4CS
F/VSP-4T4C
F/VSP-4T4CS
(3-bud spur)

Before VSP conversion (yr 1: 2015)

After conversion to VSP (yr 2: 2016)

Pre-bud break

3-6” shoot growth

Harvest

Leaf fall

Fan

F-2T2C

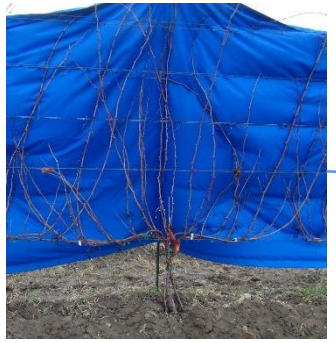
F-4T4C

F/VSP

F/VSP-4T4C

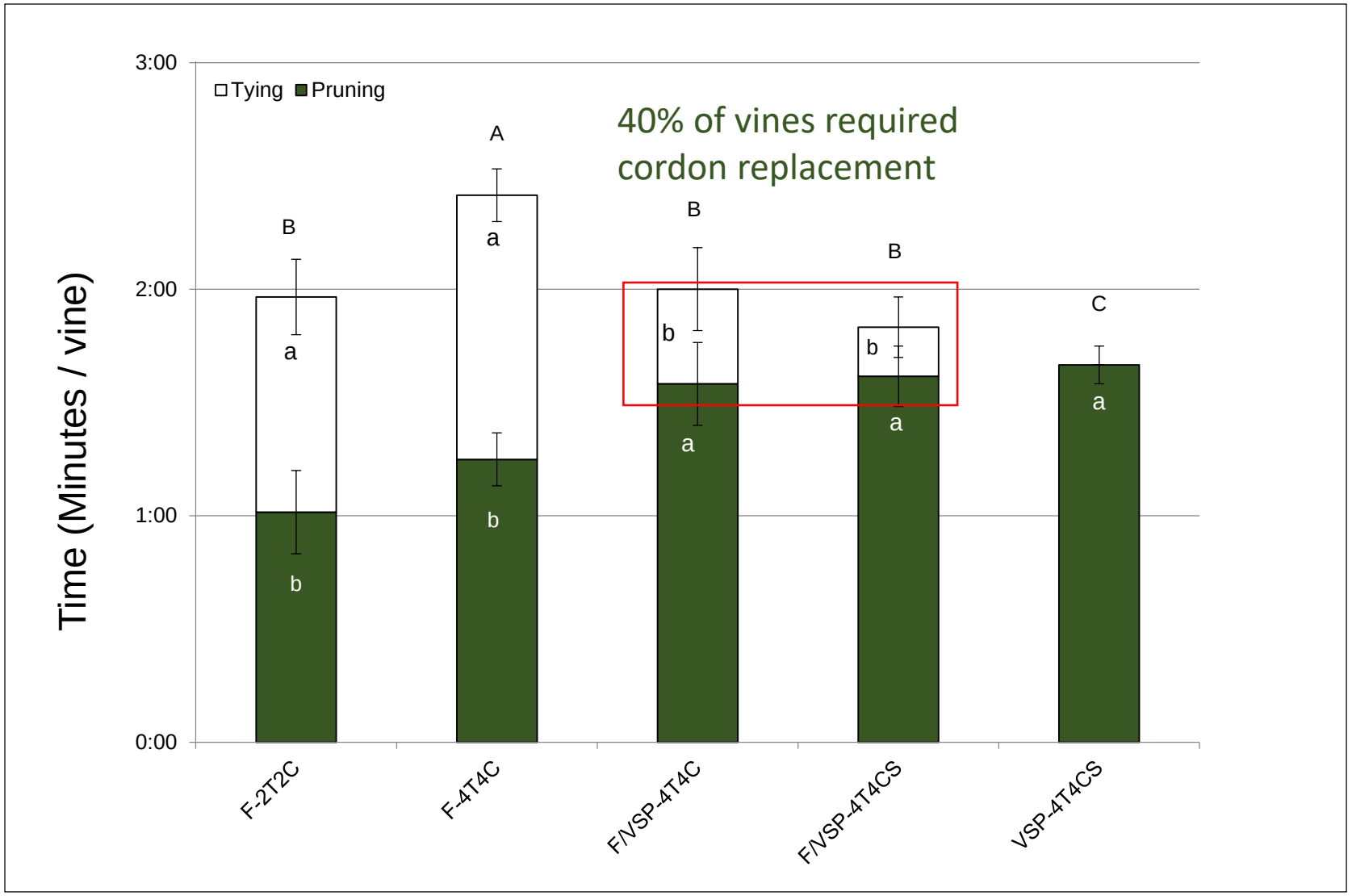
F/VSP-4T4CS

VSP

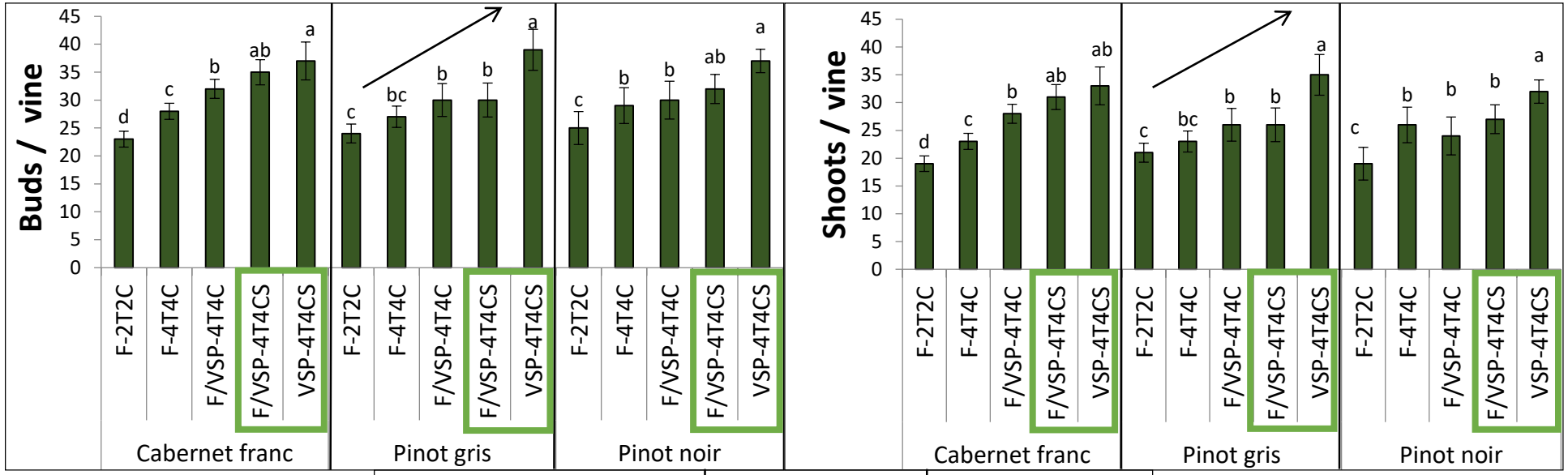


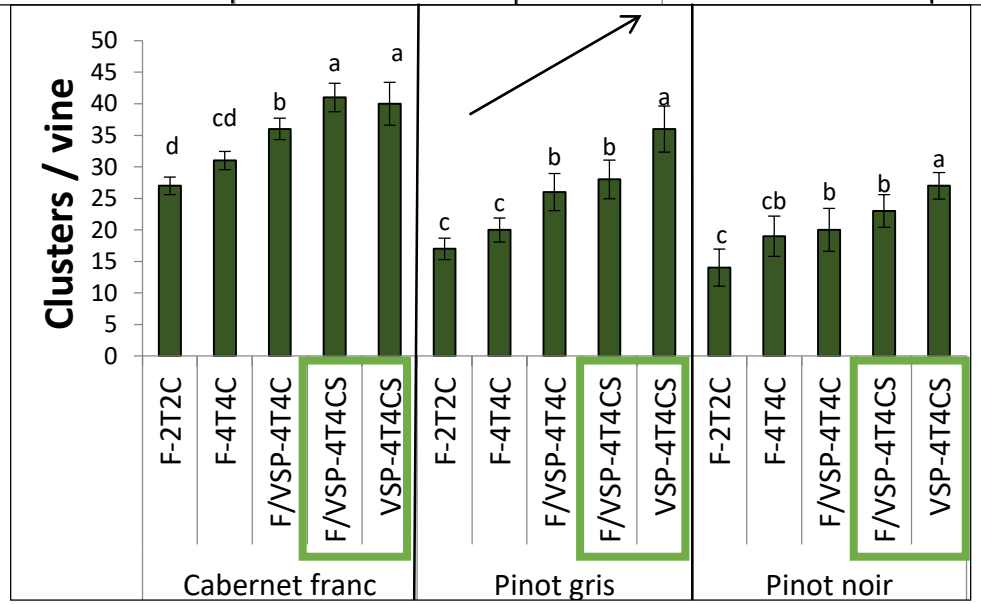
VSP-4T4CS

Results: Labor



Vegetative characteristics

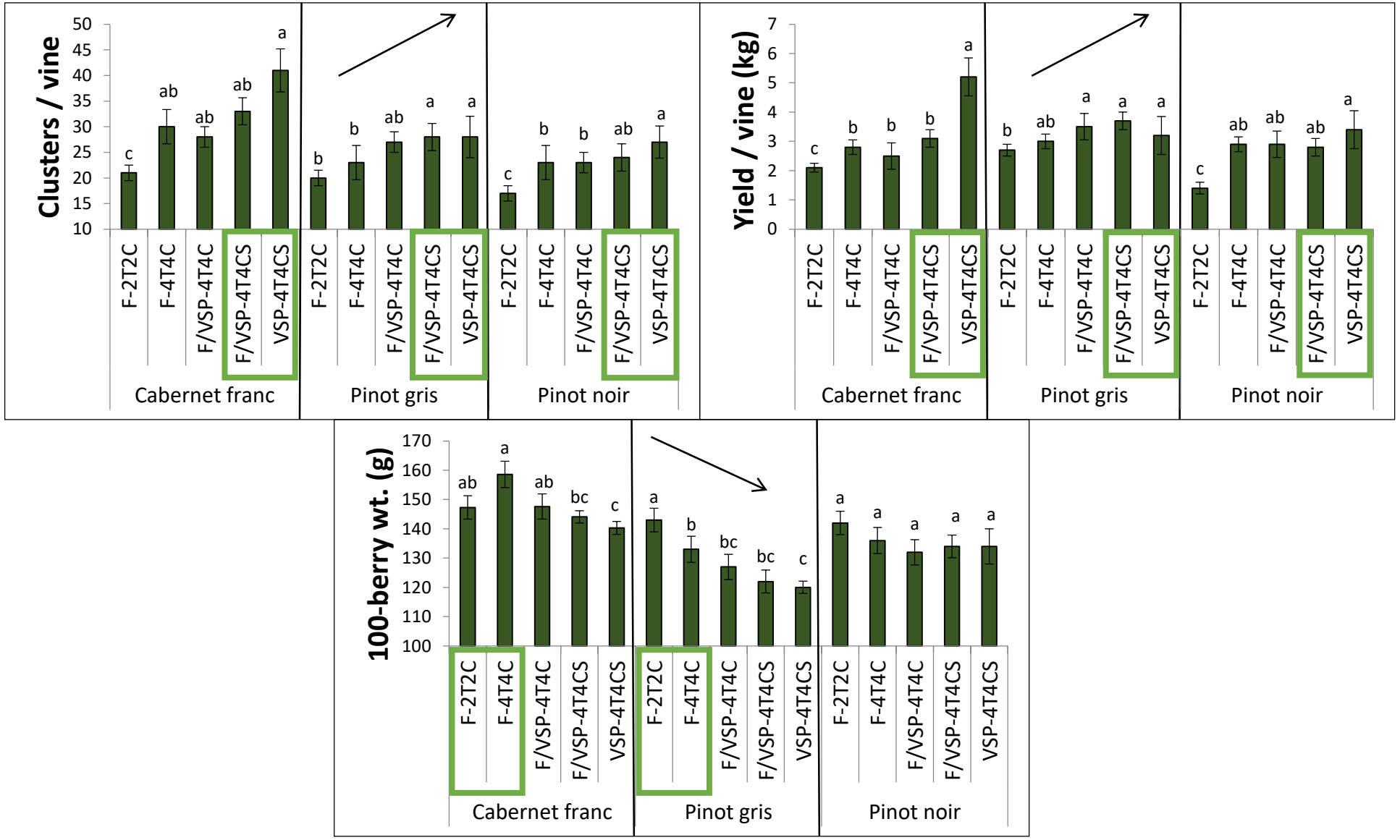




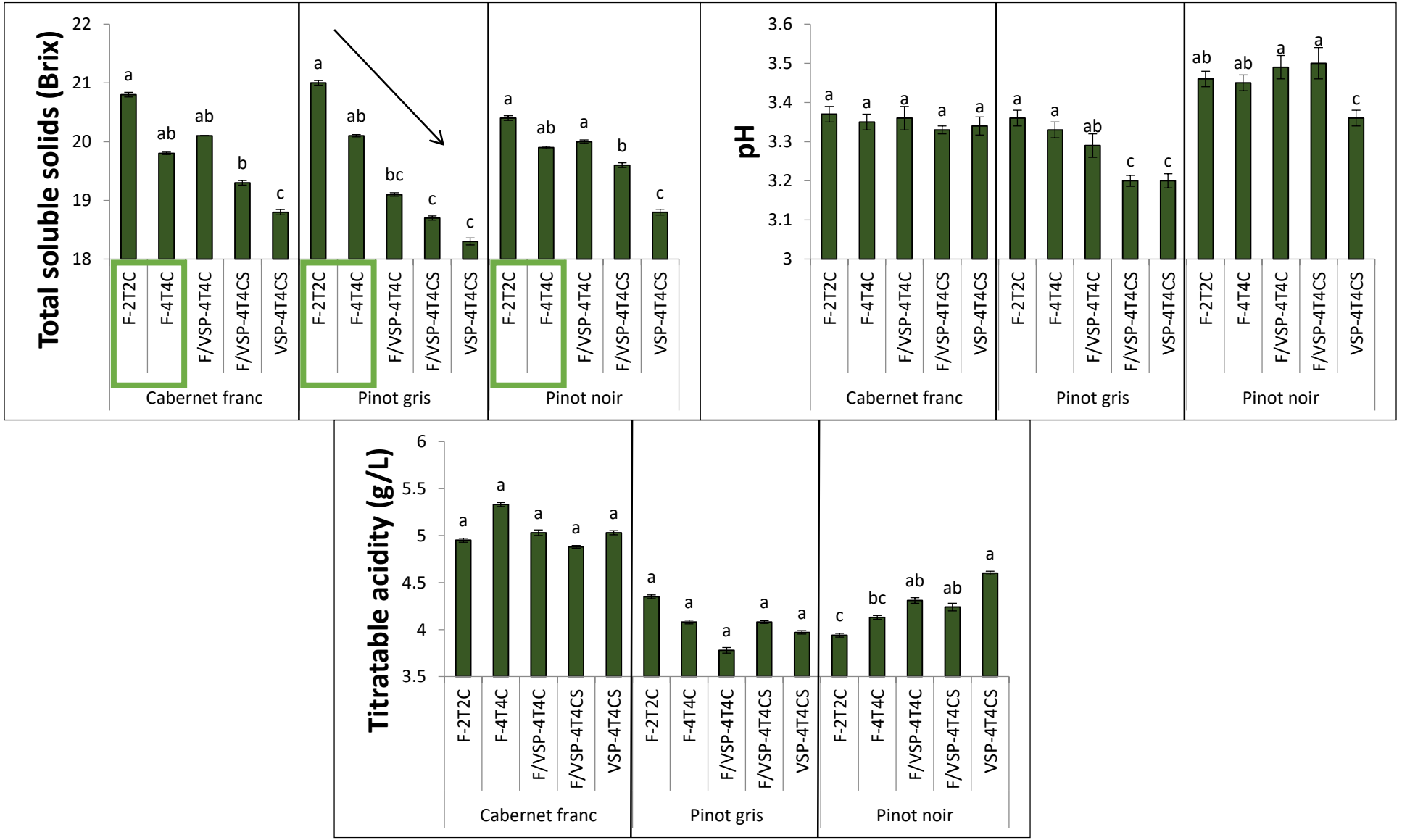
SPOILER ALERT!!!!

SPOILER ALERT!!!!

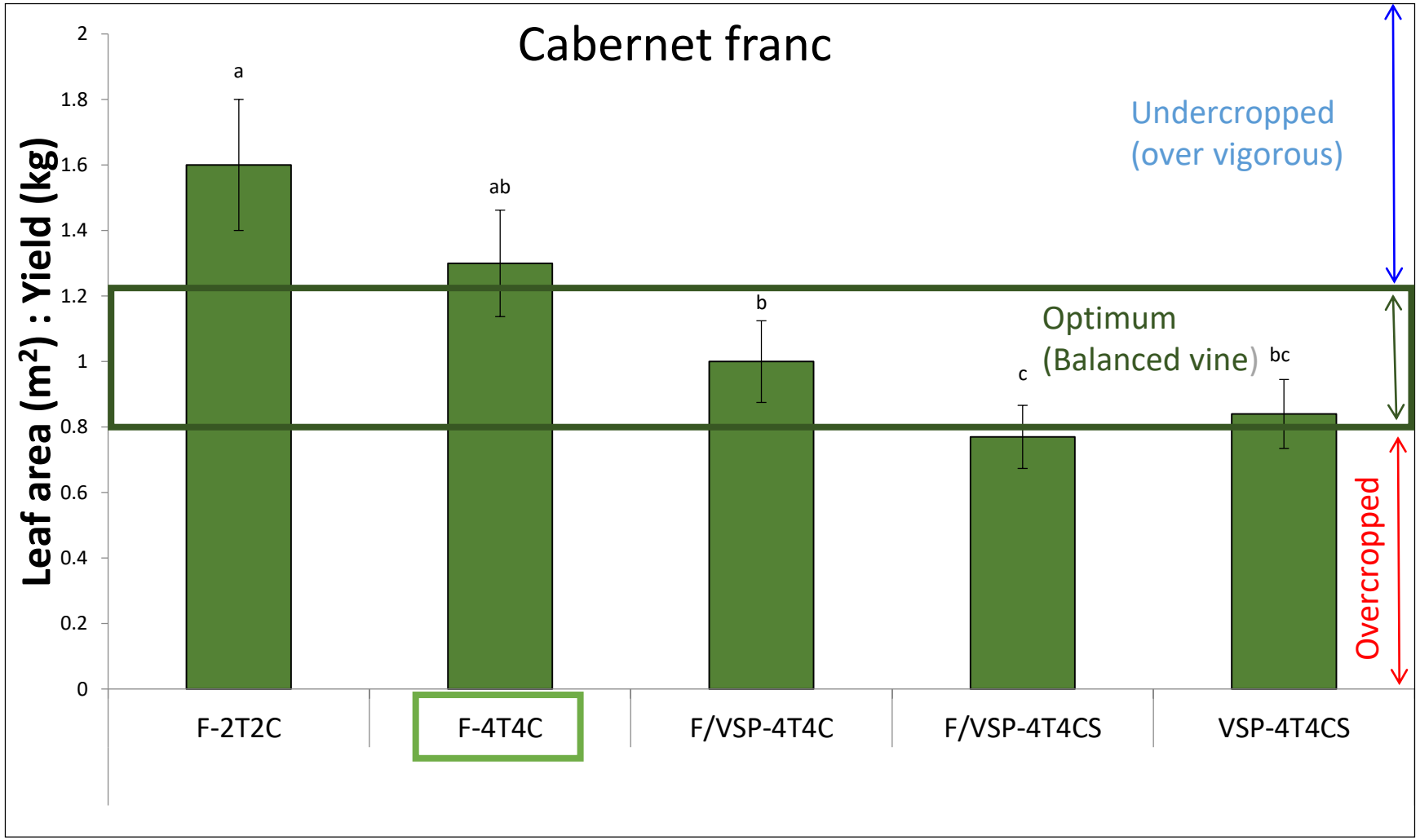
Yield components



Fruit composition

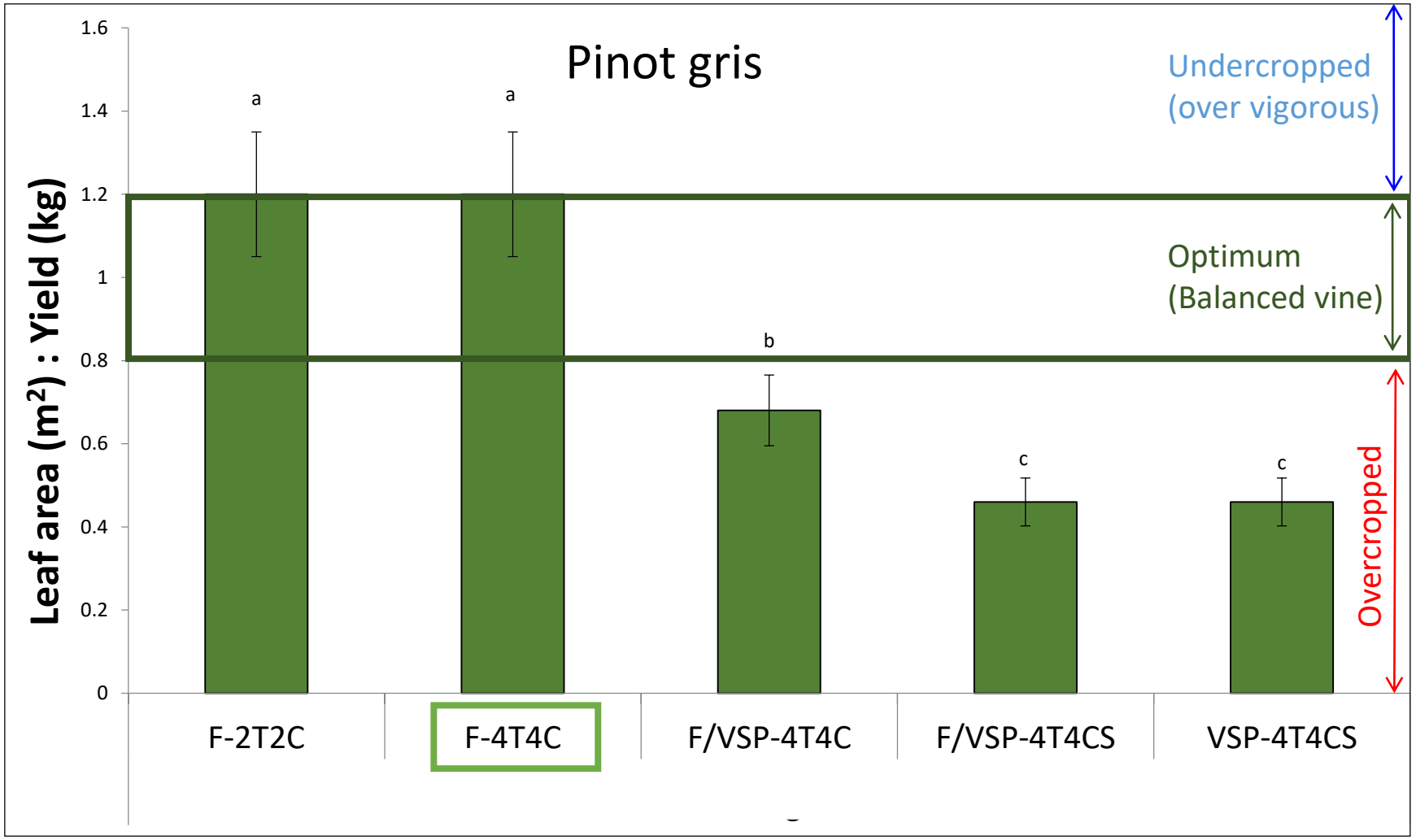


Leaf area : Yield ratio

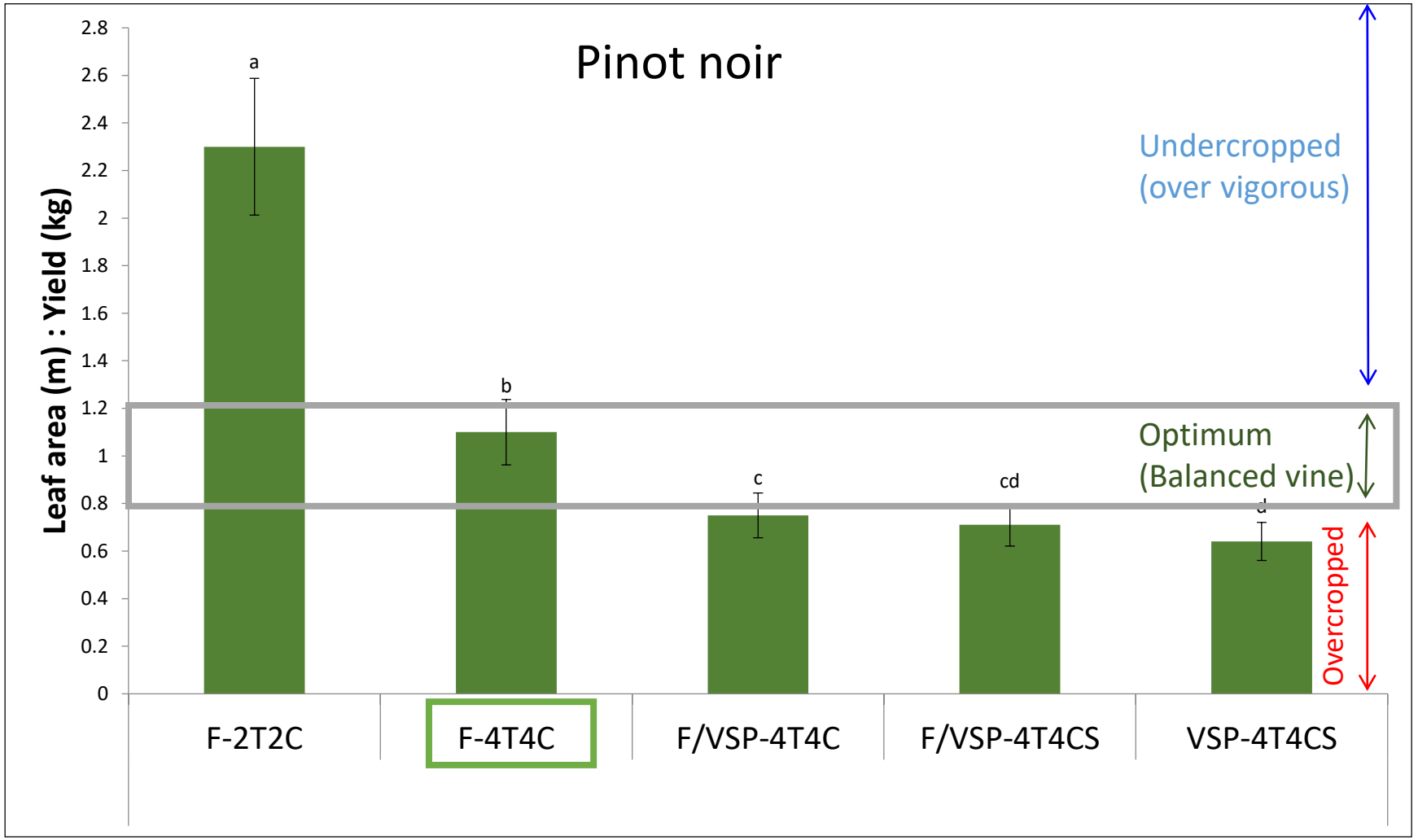


(Kliewer and Dokoozlian, 2005)

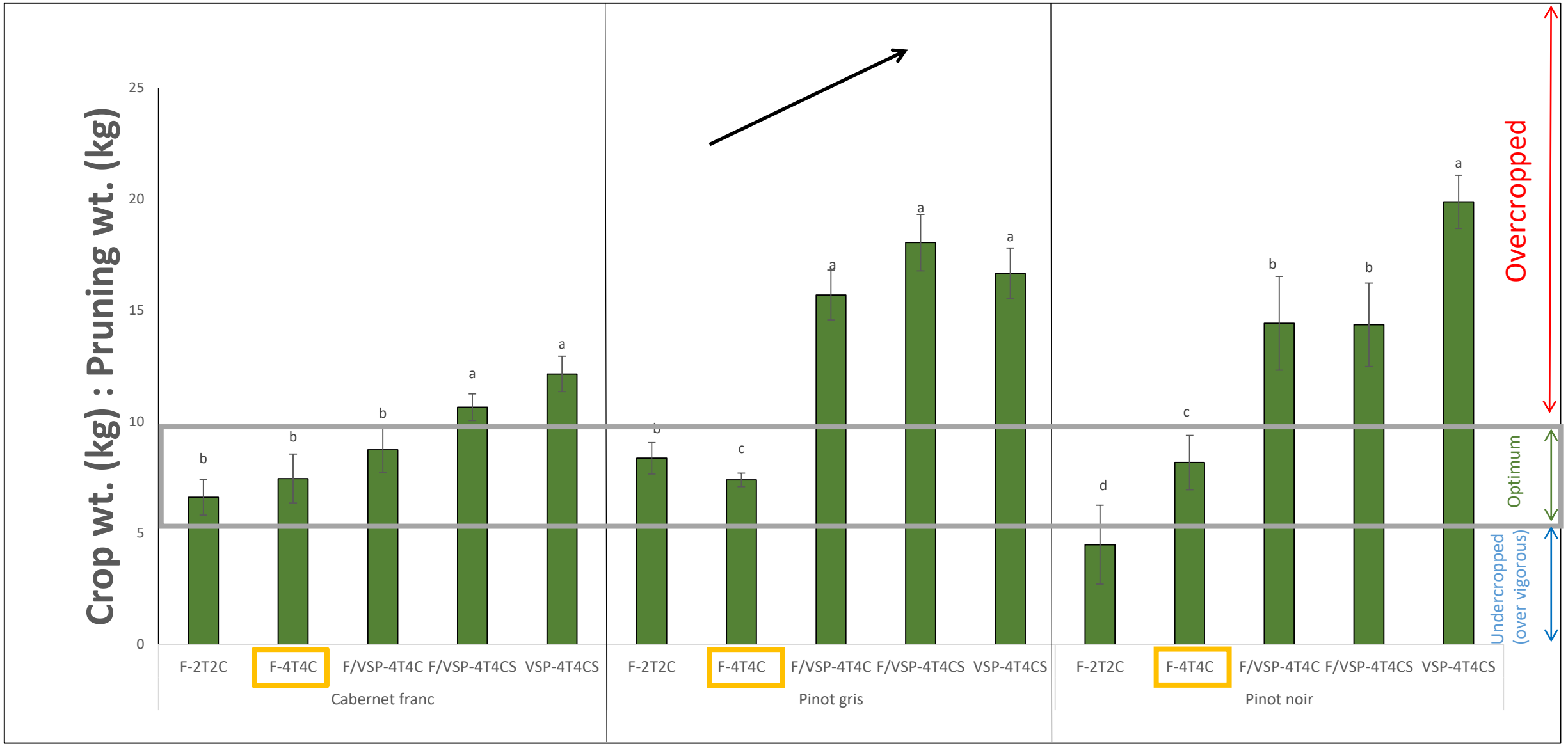
Leaf area : Yield ratio



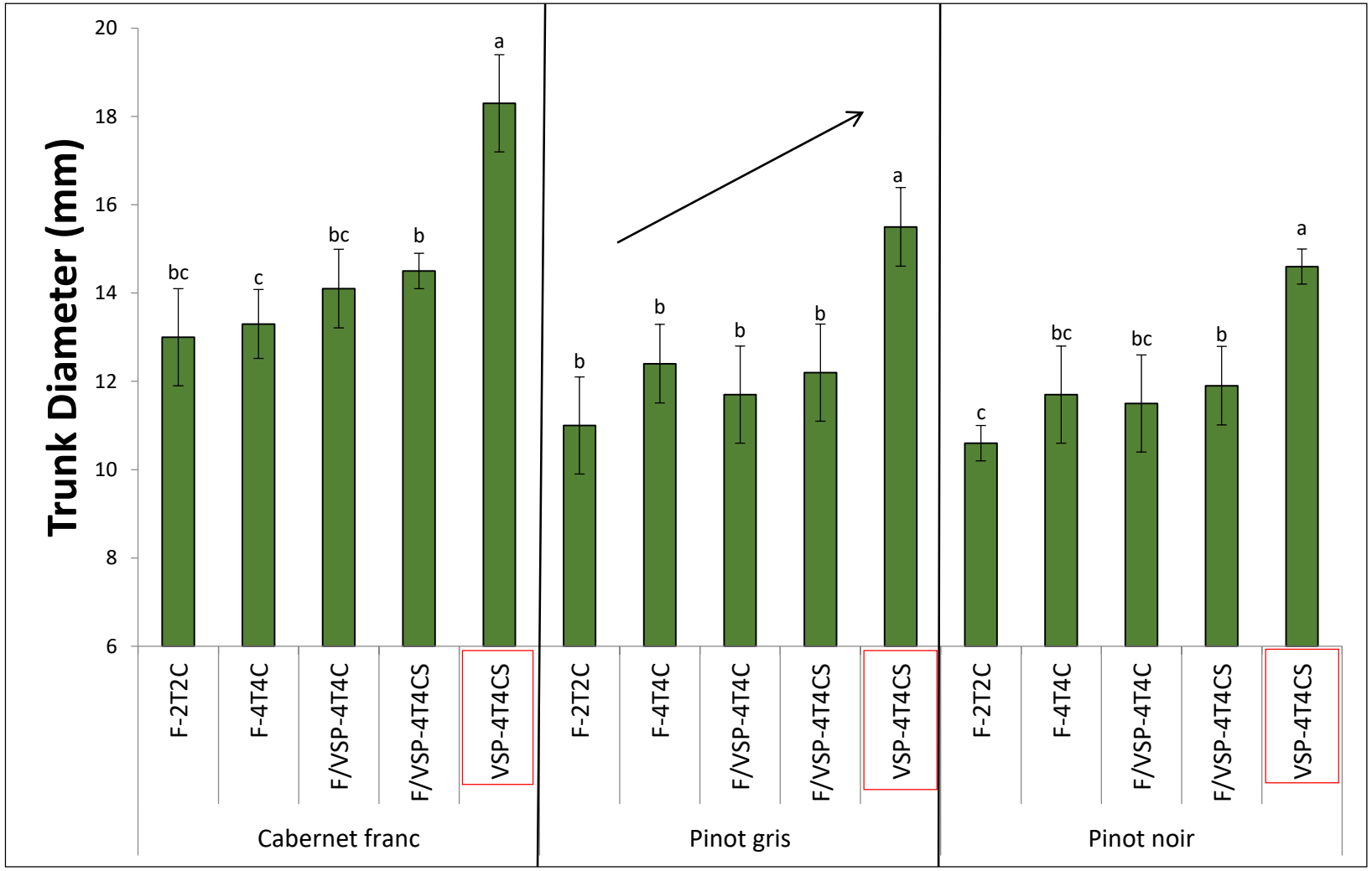
Leaf area : Yield ratio



Yield : Pruning weight ratio (Crop Load)



Trunk (2-year old) quality :



Summary

Vine balance

Var.	Year 1	Year 2	Retraining (hrs/acre)	Yield (T/A)	TSS (Brix)	Leaf area: yield (m^2)/kg	Yield : pruning wt. (kg /kg)	Trunk diameter (mm)
Cabernet franc	Fan	F-2T2C	55c	4.6c	20.6a	1.2a	6.6b	13.0c
		F-4T4C	69bc	5.5b	20.2a	1.1ab	7.4b	13.3c
	Fan-VSP	F/VSP-4T4C	91a	4.7c	20.0ab	1.0b	8.7b	14.1b
		F/VSP-4T4CS	91a	5.3b	19.6b	0.90b	10.7a	14.5b
	VSP	VSP-4T4CS	99a	6.3a	18.8c	1.3a	12.1a	18.3a
Pinot gris	Fan	F-2T2C	70c	4.5b	20.5a	1.2a	8.4b	11.0c
		F-4T4C	71c	4.8ab	20.1a	1.2a	7.4b	12.4b
	Fan-VSP	F/VSP-4T4C	86b	5.1a	19.7ab	1ab	15.7a	11.7bc
		F/VSP-4T4CS	93ab	5.3a	19.5b	0.85b	18.0a	12.2bc
	VSP	VSP-4T4CS	103a	3.9c	18.3c	0.80b	16.7a	15.5a

Conclusions

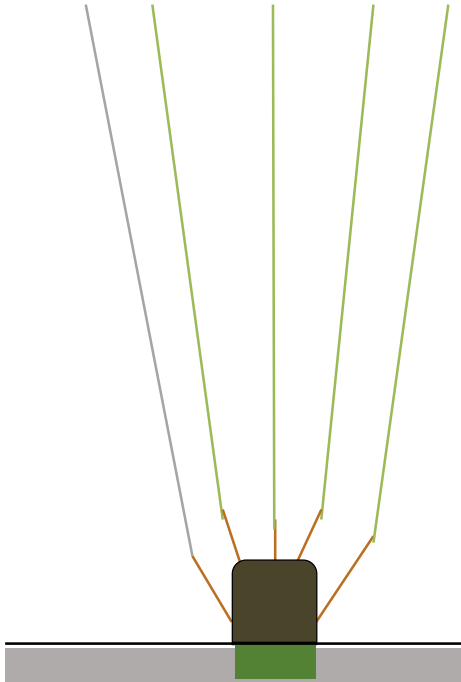
- Medium cane size is optimum with increased freezing tolerance.
- Training systems with high bud number have increased shoot number and yield but delayed fruit ripening.
- Fan/VSP training is not recommended!
- Optimum training system / pruning : Fan-4T4C

Practical application to growers

Year 1: Retain all shoots using fan system.

Year 2: When pruning, select normal cane [(7-9mm diameter) optimum for trunk renewal] and train using 4 trunks and 4 canes.

FAN



F-4T4C

Acknowledgments

Advising mentors and experts

Dr. Dami

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Dr. Blakeslee

Dr. Channon

Anatomy

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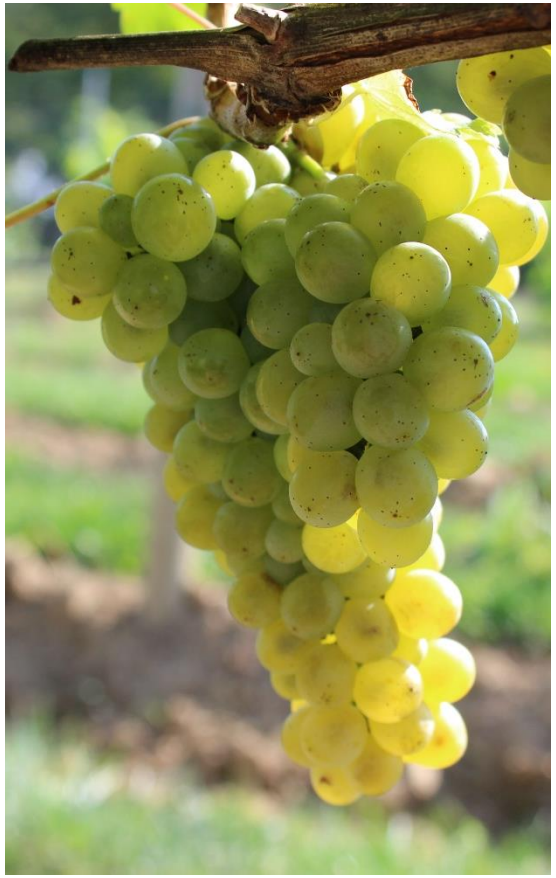
Diane Kinney, Emily Romain
Tori Massaro, Bailey Miller
Yvonne Woodworth, Andrew Kirk

Ohio Grape Industries Program

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Dept. of Horticulture & Crop Science

Thank you for your time



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MSU Extension would like your feedback!

Please visit
https://tinyurl.com/msufruitsurvey
to fill out the **Fruit Team Survey!**

The survey will close on
Dec 12th 5:00 PM EST.

Download a QR Code reader app and scan this code to access the survey.