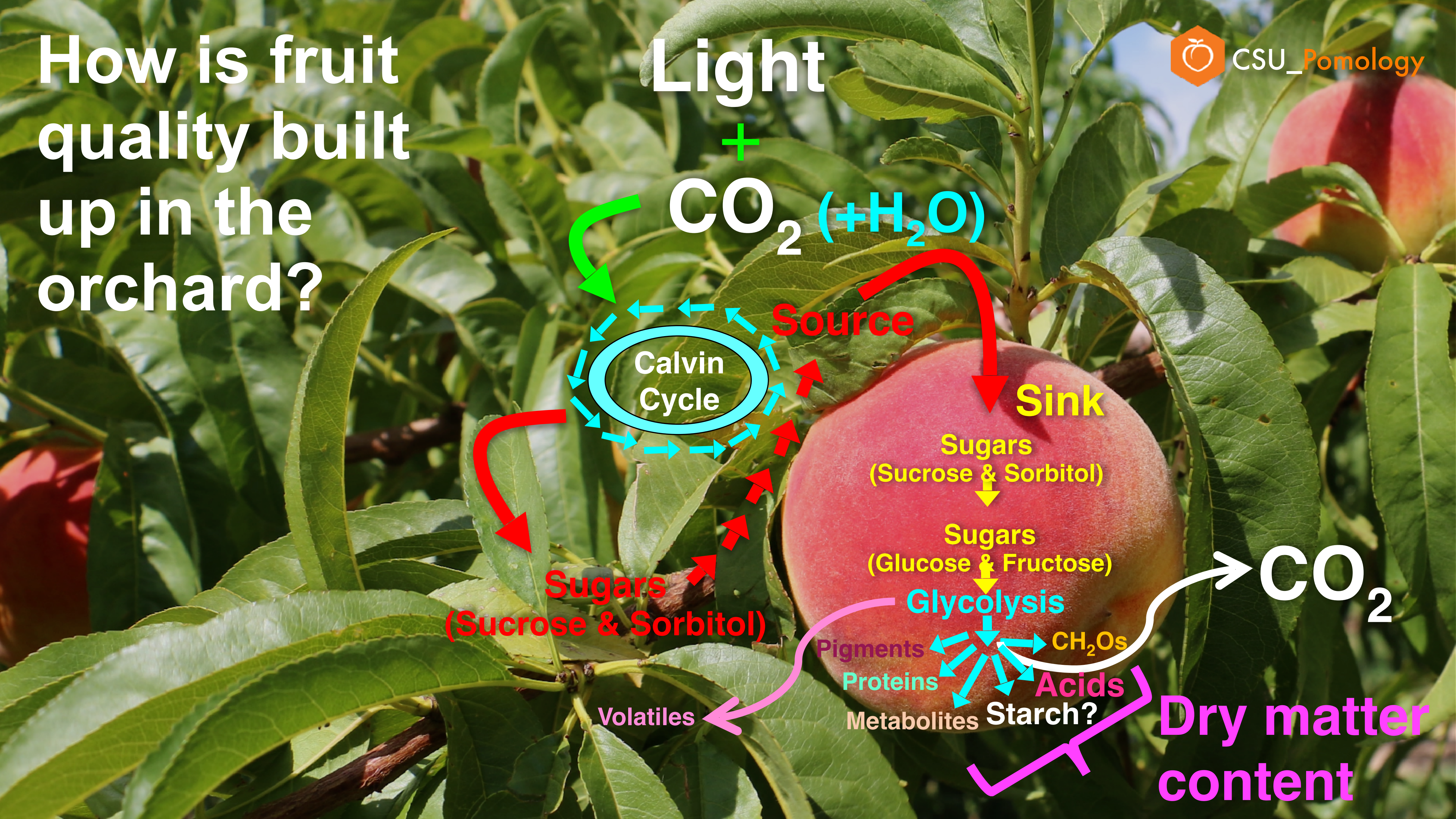
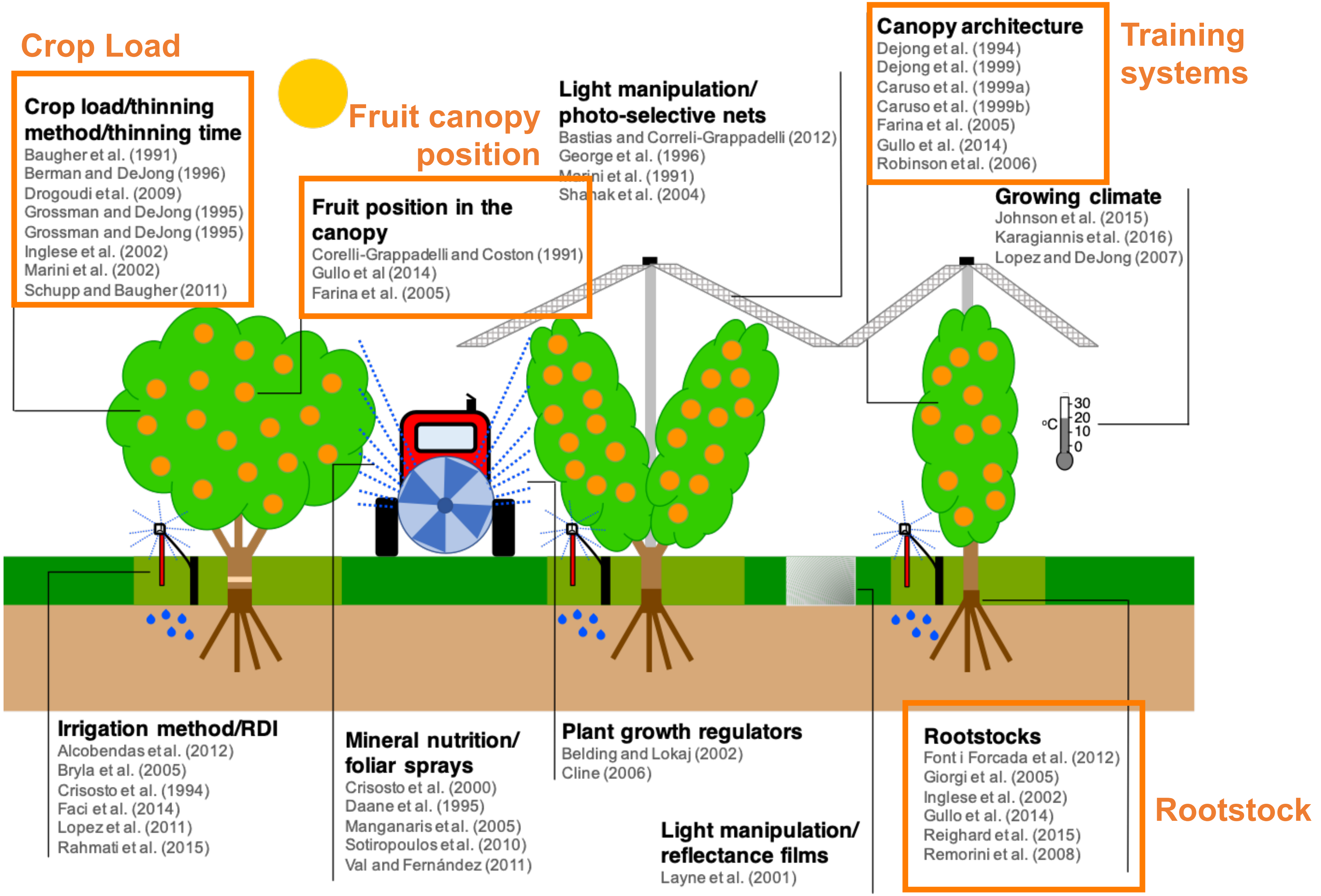

How is fruit quality built up in the orchard?
CSU_Pomology
Light
+
CO_2 (+H_2O)
Calvin Cycle
Source
Sink
Sugars (Sucrose & Sorbitol)
Sugars (Glucose & Fructose)
Glycolysis
Sugars (Sucrose & Sorbitol)
CO_2
Pigments
CH_2Os
Proteins
Acids
Metabolites
Starch?
Volatiles
Dry matter content

Pre-harvest factors affecting peach fruit quality



Reviewed by Minas et al., 2018. Scientia Horticulturae 235, 307–322

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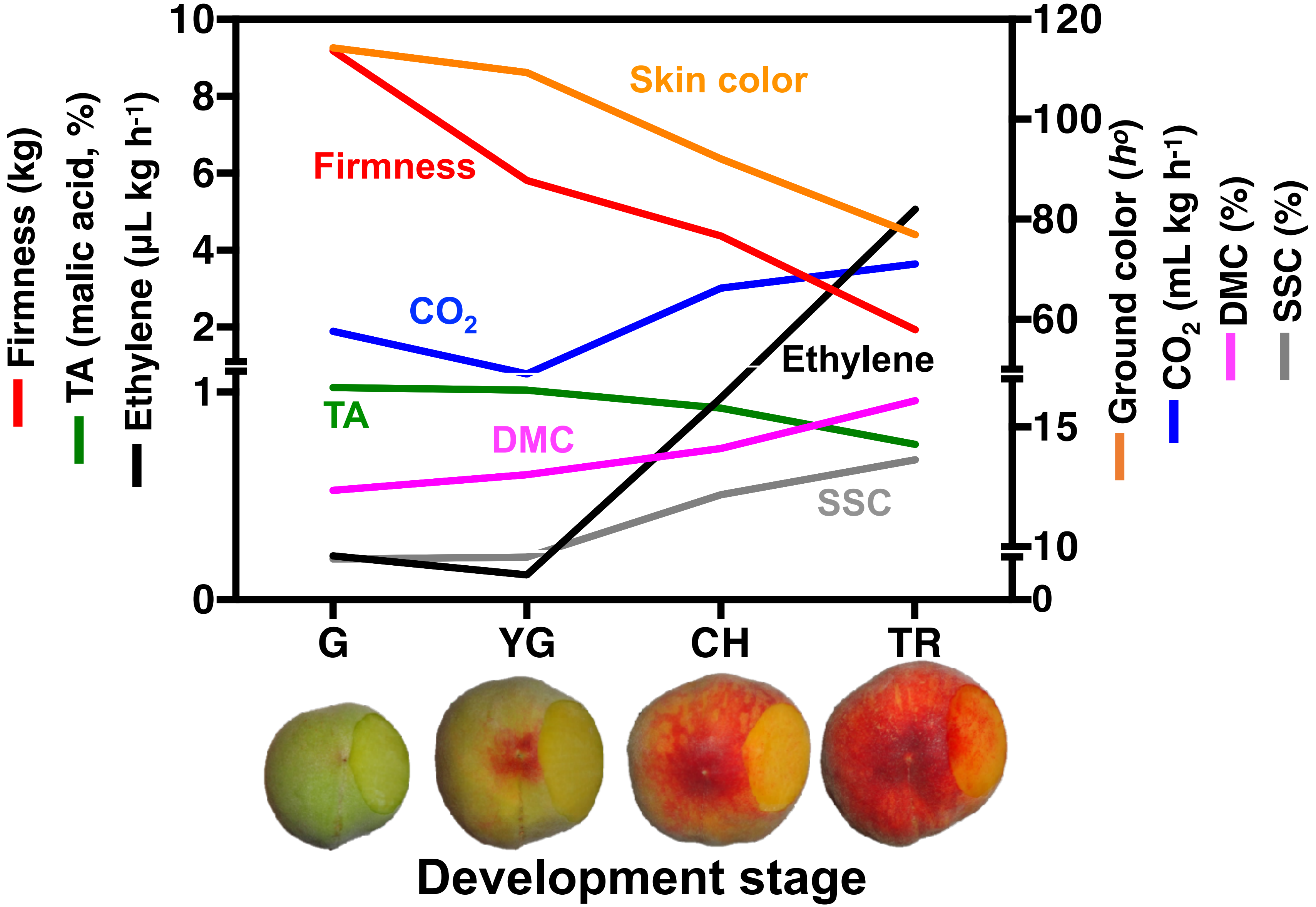
Quality changes during ‘June Gold’ peach fruit development & ripening on-tree



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Fruit quality and maturity assessment methods are destructive and labor intensive

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Flesh Firmness (FF)
'maturity' &
'shipment/storage potential'

Soluble Solids Concentration (SSC)
'sweetness'

Dry Matter Content (DMC)
'sweetness' &
'consumer acceptance'

Development of non-destructive technologies to estimate internal fruit quality

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Handheld non-destructive sensors to estimate internal fruit quality and maturity in the field

✓ **Analysis of larger fruit volumes to understand the effect of pre-harvest factors**

F-750 Produce Quality Meter
Near-Infrared Spectroscopy (NIR)

DA-meter
Vis/NIR

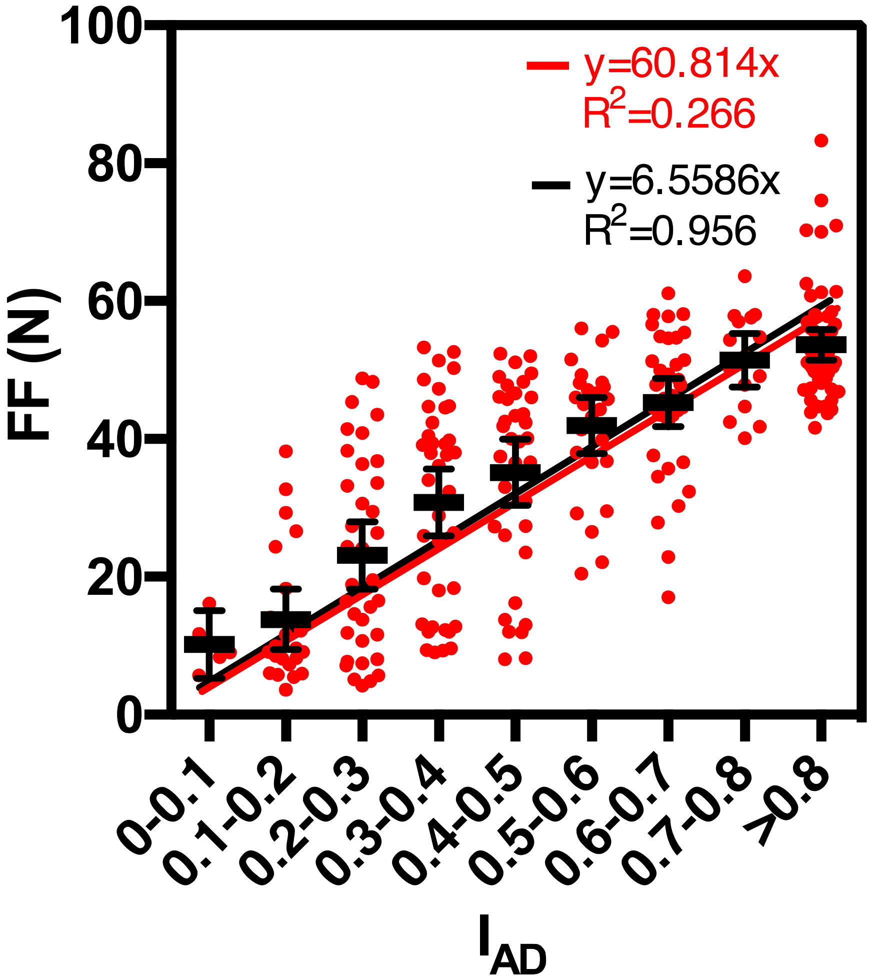
- "Open" type instrument (on-site calibration)
- **DMC and SSC at 729-935 nm**
- Three online measurements at the same time (2 displayed)

- **Costa et al., 2009**
- "Closed" type instrument (calibrated at the factory)
- **Index of Absorbance Difference (I_{AD})**
- **$I_{AD}=A_{670nm}-A_{720nm}$ (chlorophyll content)**
- **Fruit physiological maturity**

I_{AD} correlates with FF in 'Sierra Rich' peach only when I_{AD} values are plotted in clusters

(but describes physiological maturity better)

FF



I_{AD}

(Minas et al., 2021)

Accurate non-destructive prediction of peach fruit internal quality and physiological maturity with a single scan using Vis-NIRS

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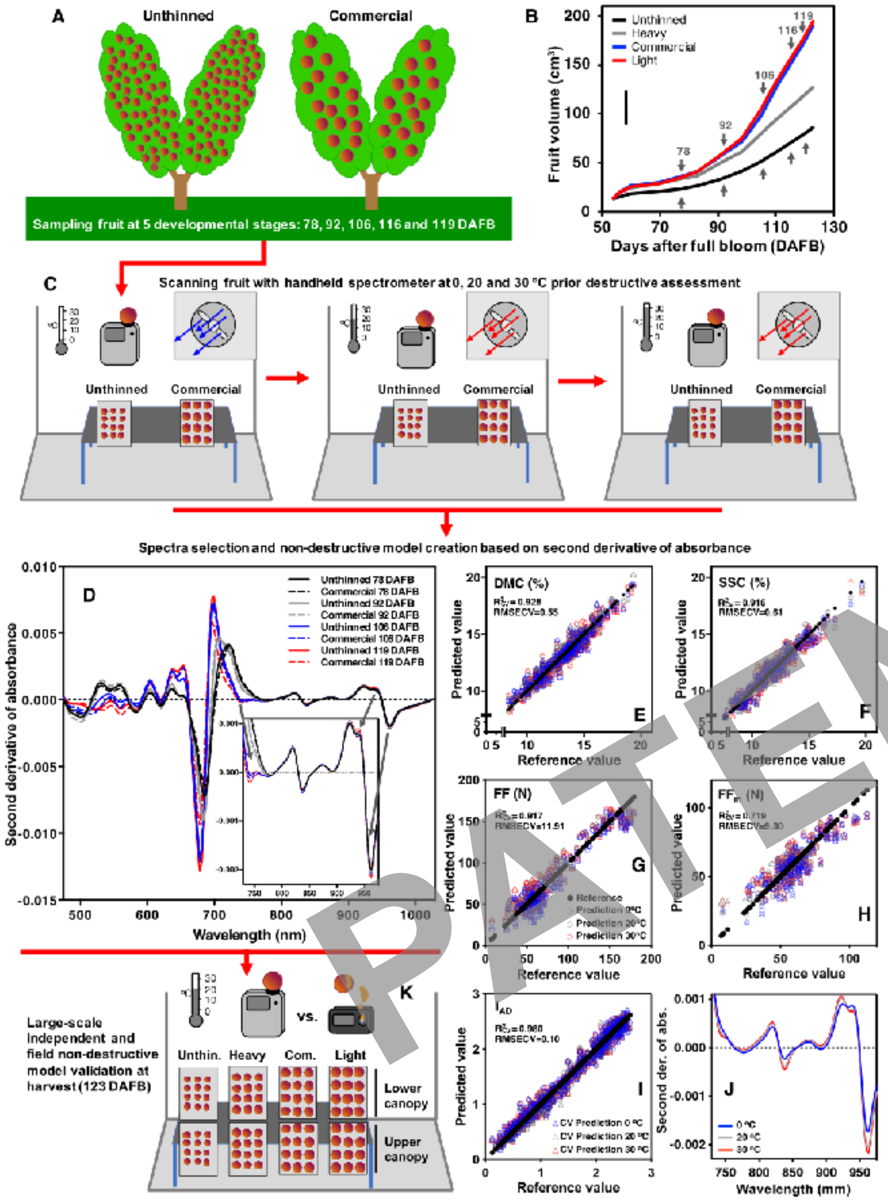
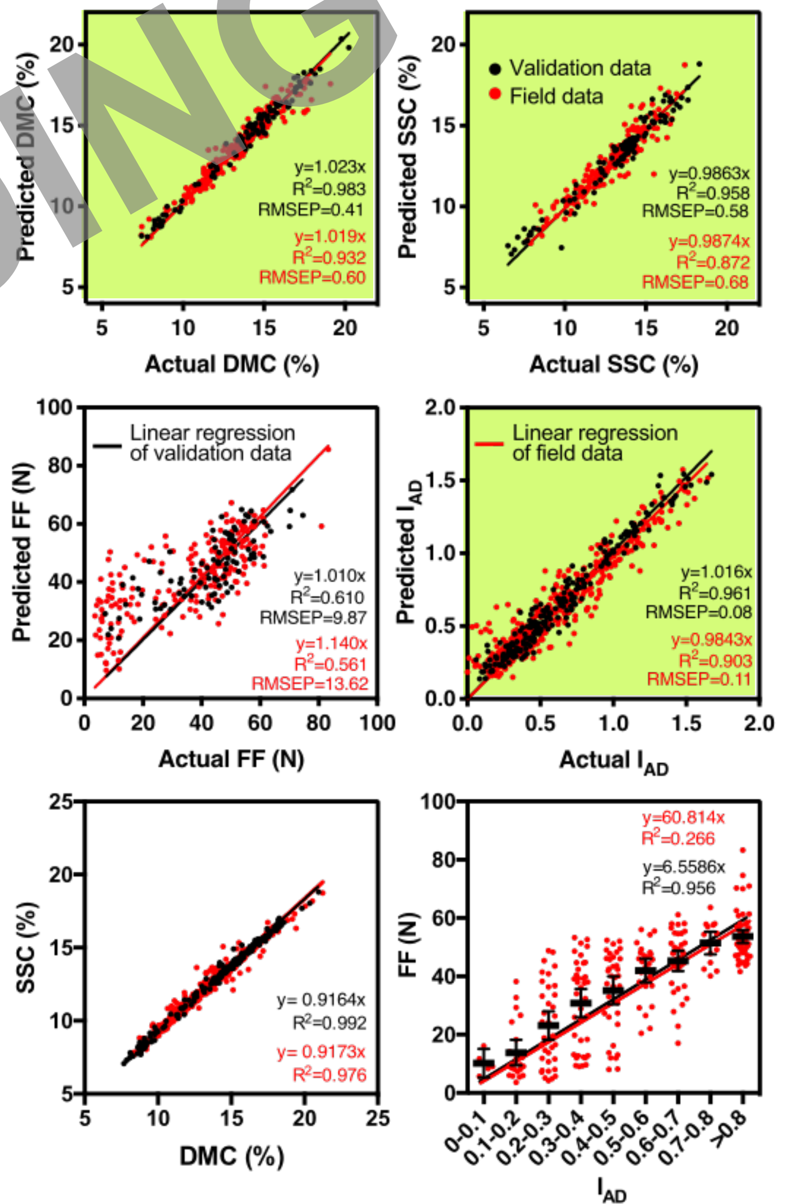


- Novel Vis-NIRS calibration protocol resulted in accurate regression models of peach quality and maturity
- DMC, SSC and I_{AD} can be predicted with a single scan to assess the true orchard impact on peach quality
- A novel concept device can assess peach quality and maturity during fruit growth, development and at harvest in the field and during postharvest
- This calibration protocol and concept device can enhance NIRS utilization across tree fruit supply chain

Minas et al, 2021. Accurate non-destructive prediction of peach fruit internal quality and physiological maturity with a single scan using near infrared spectroscopy. Food Chemistry 335, 127626.



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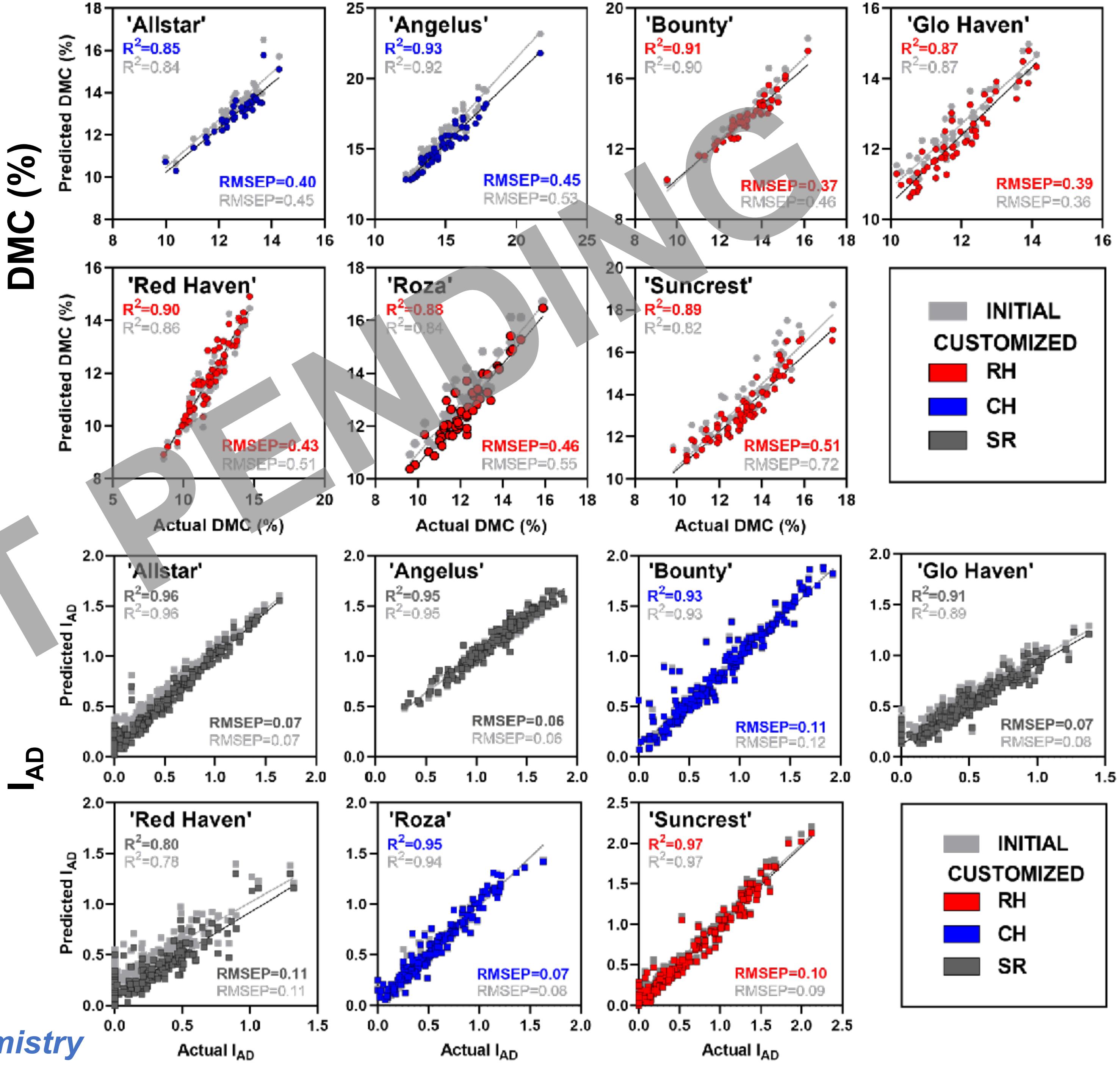
Technology Readiness Level: 5

Proof of concept-real world demonstration stage



Developed models of the concept device are showing strong performance with multiple peach cultivars

Anthony et al, 2022. *Submitted in Food Chemistry*

Cultivar Evaluation: 13 Cultivars of variable harvest date assessed for quality at three ripeness stages in 2021

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‘Redhaven’


‘Galaxy’*


‘Newhaven’


‘Starfire’


‘Glohaven’


‘PF-19’


‘Suncrest’


‘Glowingstar’


‘Blushingstar’*


‘PF-23’


‘PF-24C’


‘Angelus’


‘O’Henry’

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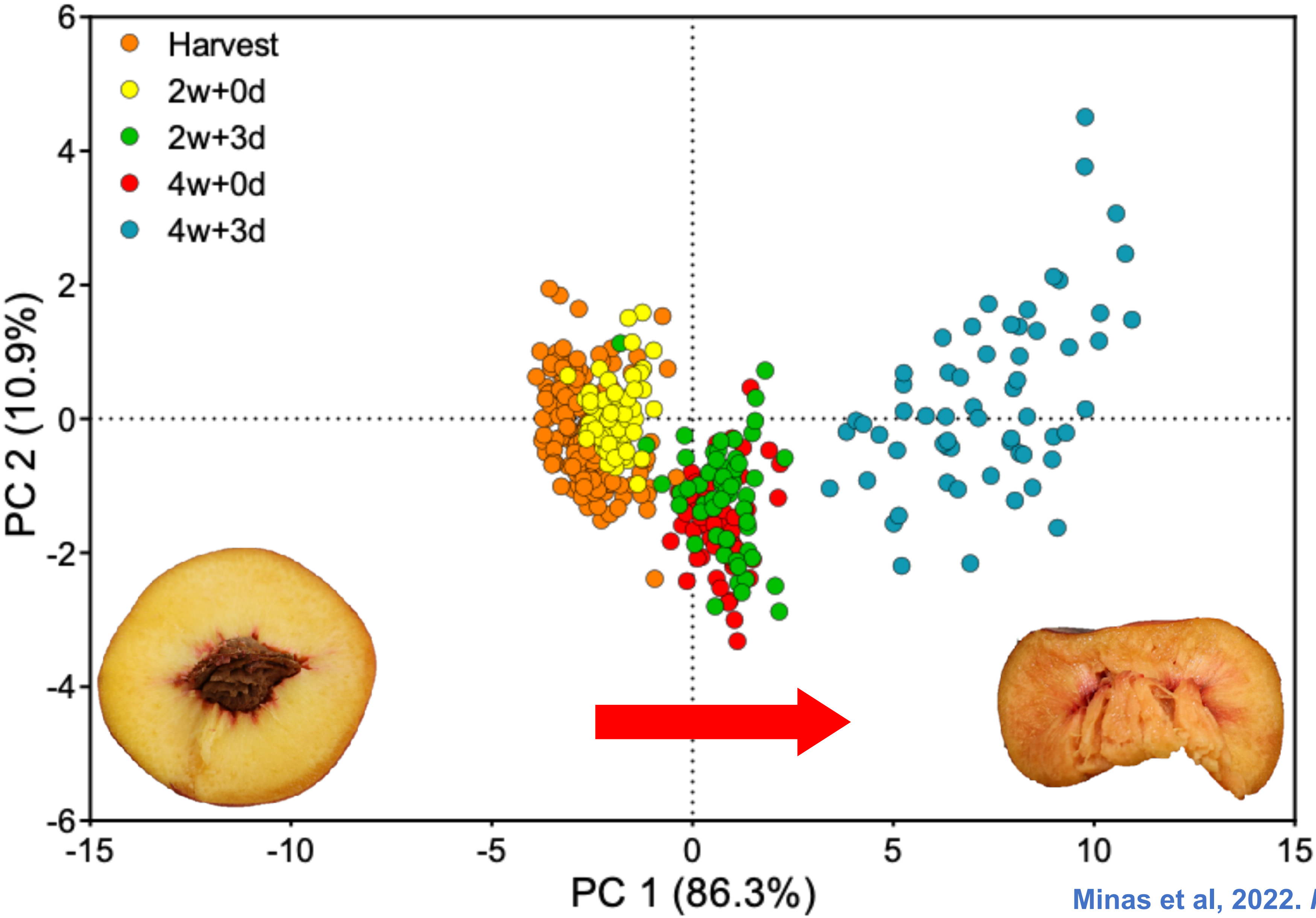
Jake Pott

Pott et al, 2022. *In preparation*

*white flesh

Use of NIR spectral data to predict chilling injury (CI) symptoms development that damage consumer quality



Minas et al, 2022. *In preparation*

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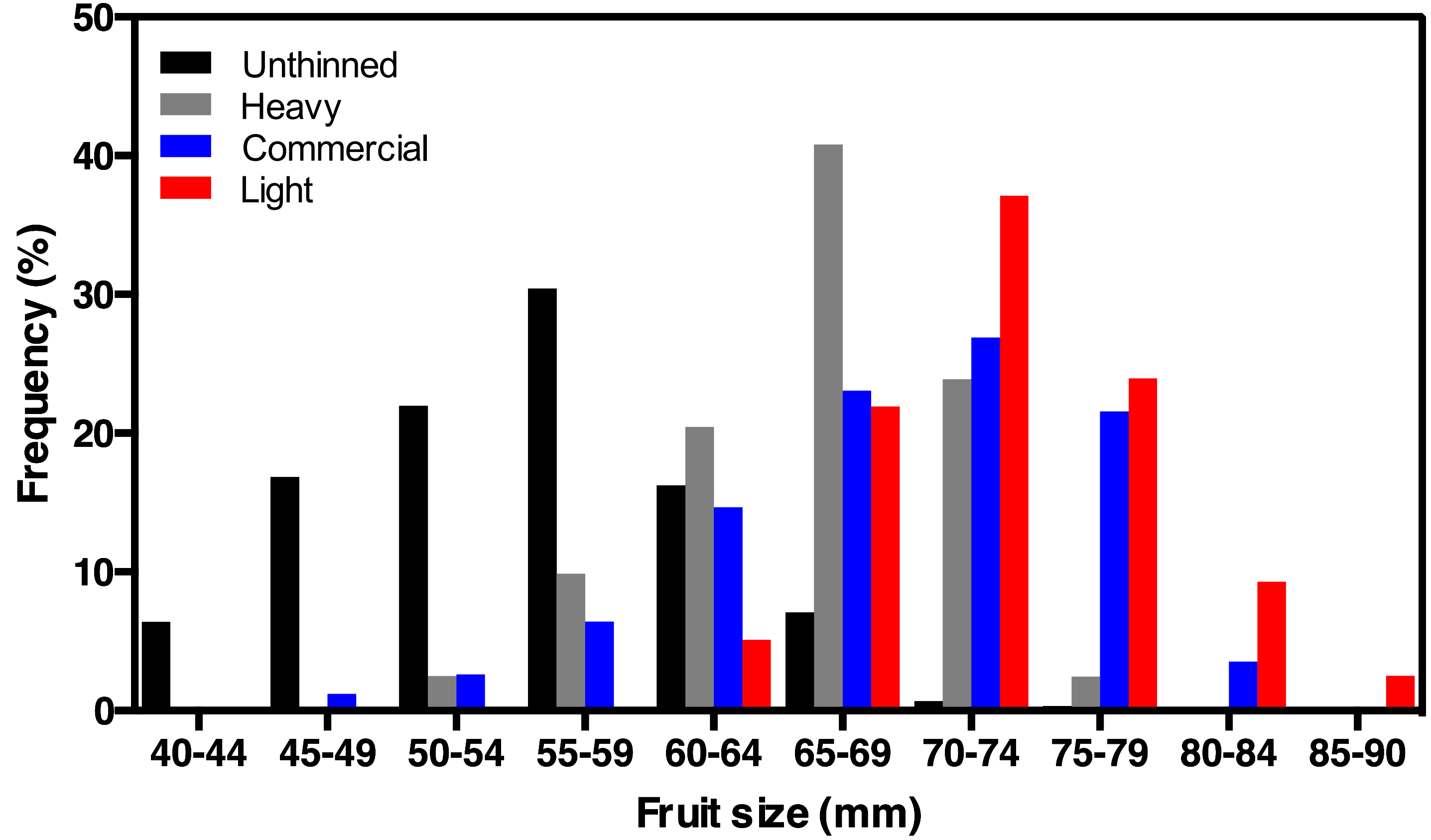
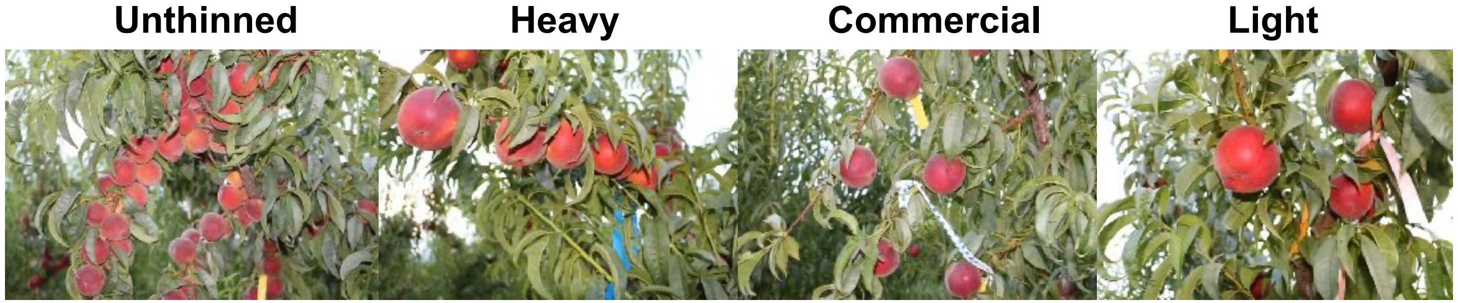
Effect of crop load on ‘Sierra Rich’ peach fruit size at harvest





(Minas et al., 2021)

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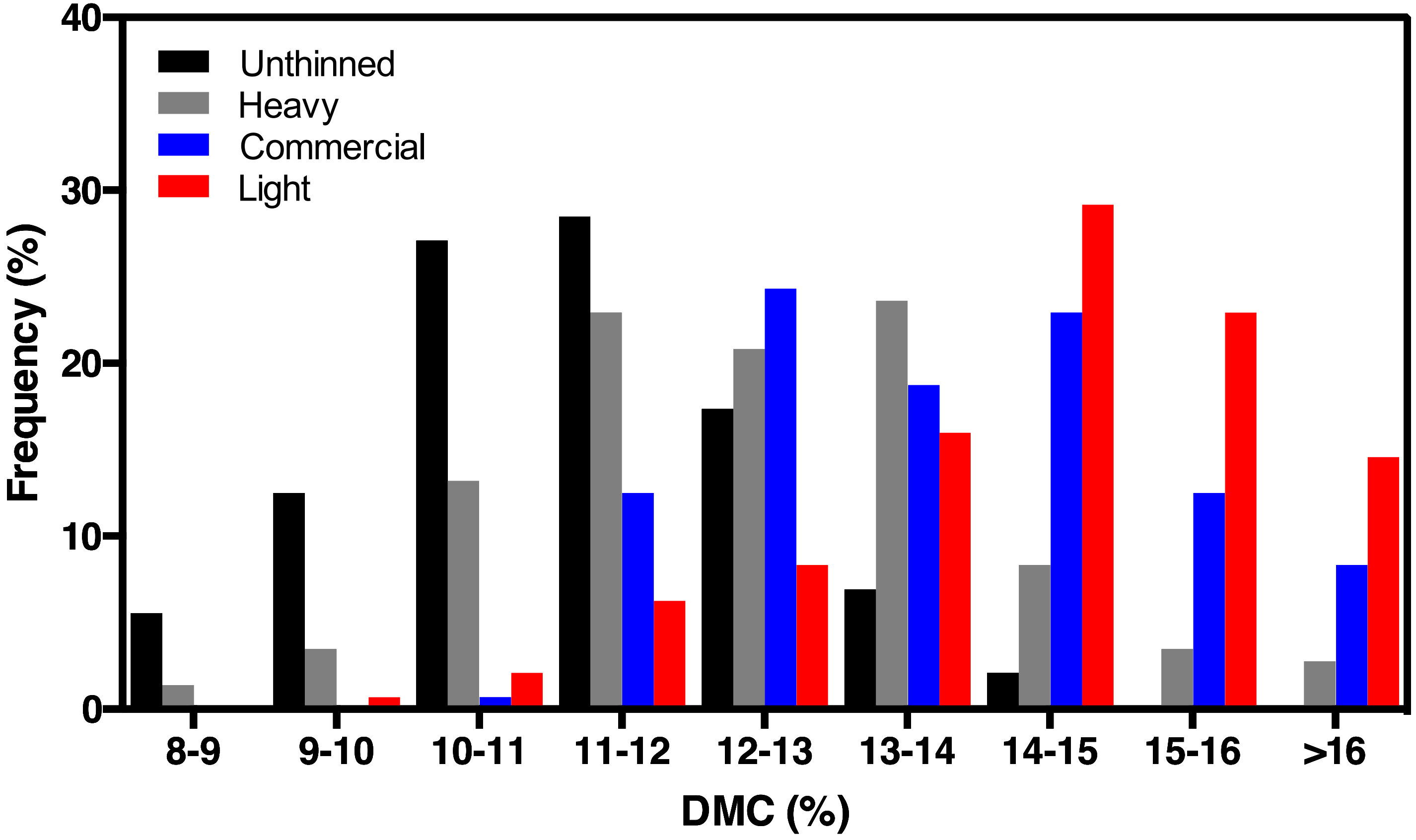
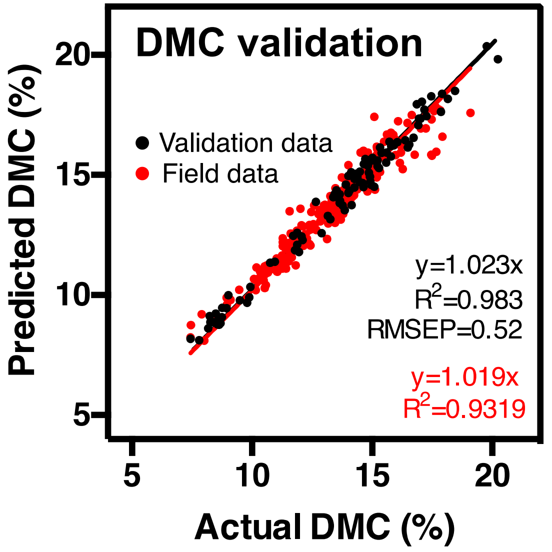
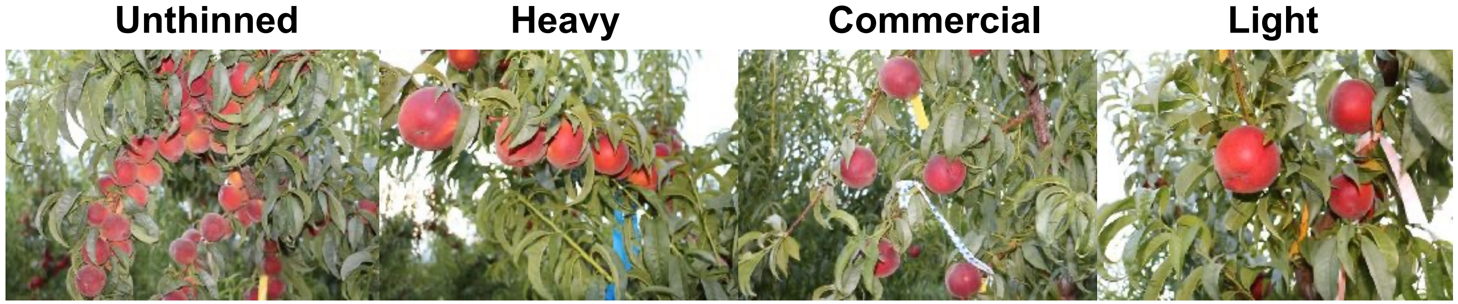
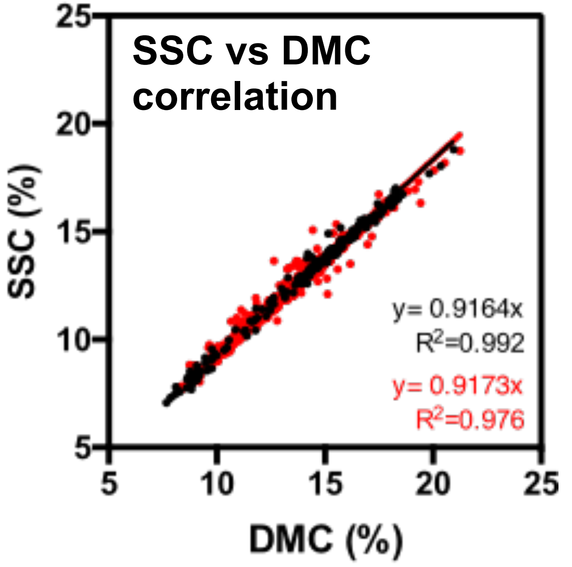
Effect of crop load on ‘Sierra Rich’ peach DMC at harvest as predicted by NIR



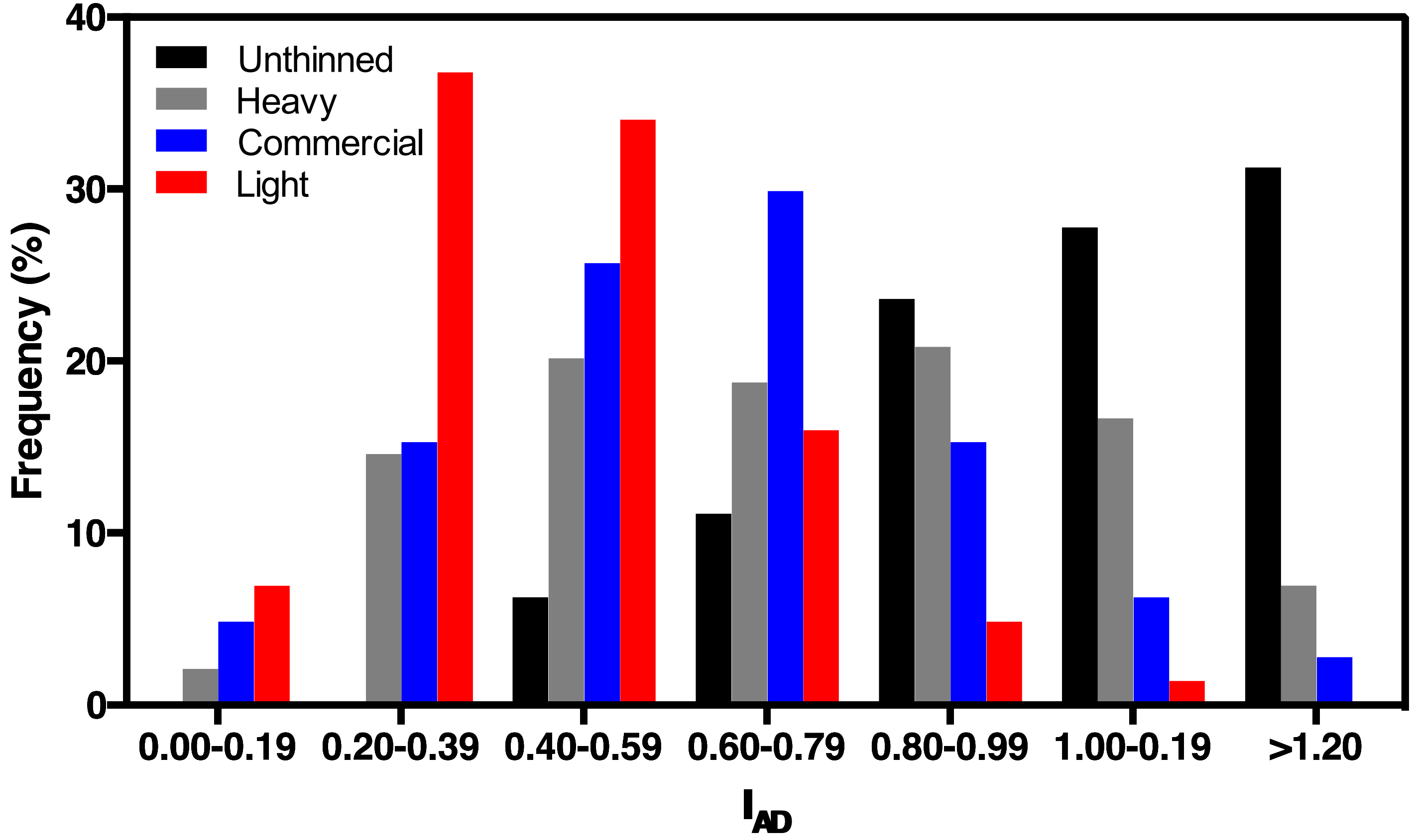






(Minas et al., 2021)

Effect of crop load on ‘Sierra Rich’ peach maturity at harvest assessed non-destructively with I_{AD} (DA-meter)



Light Commercial Heavy Unthinned

(Minas et al., 2021)

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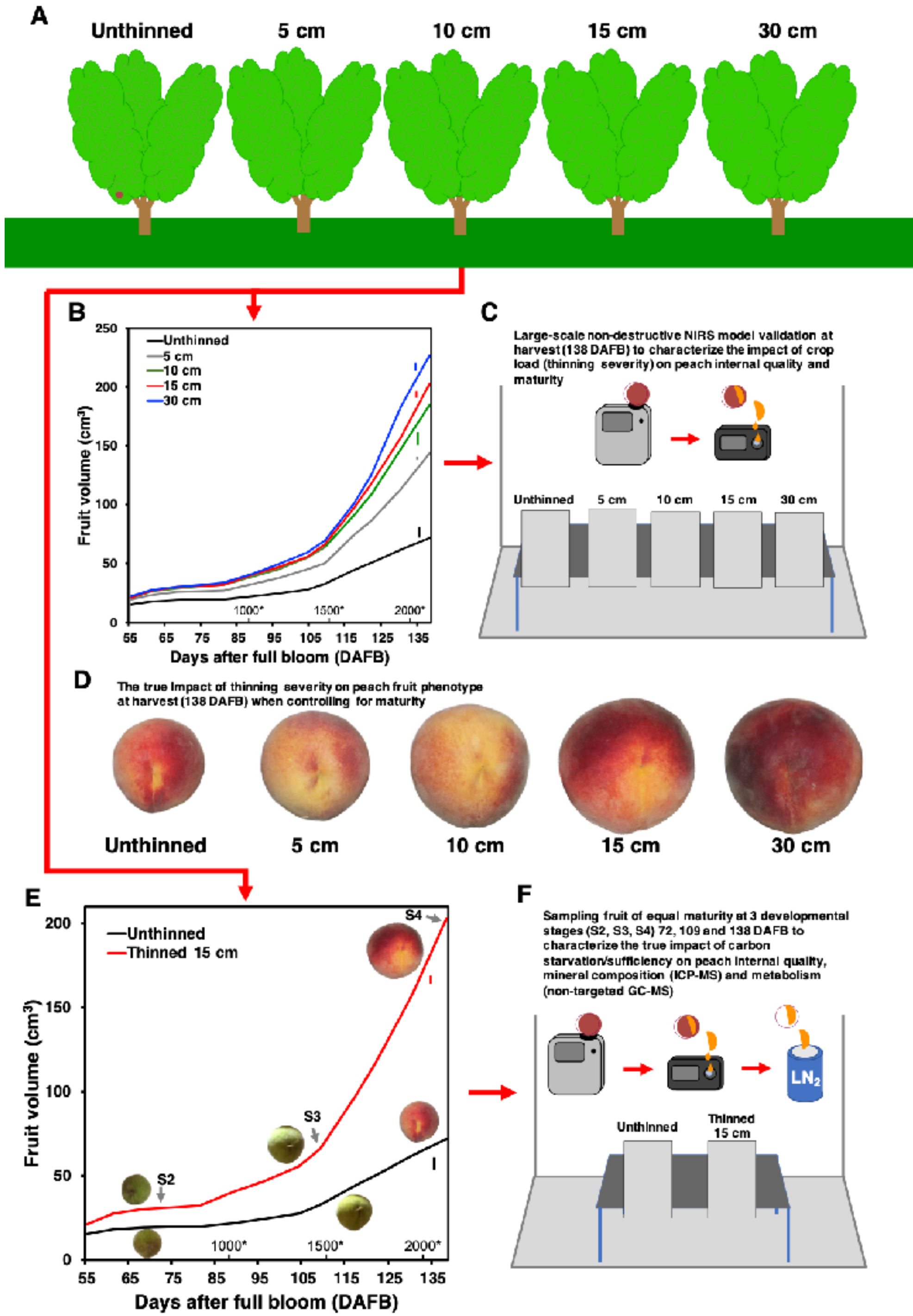
Effect of Thinning Severity and Carbon Competition on Peach Fruit Quality Development

(@ equal maturity)

- **Two distinct thinning severities** selected for in depth quality analysis and non-targeted metabolomic profiling:
  - Thinned (15 cm) – Carbon Sufficient
  - Unthinned – Carbon Starved
- At each dev. stage, **maturity was equal** between thinning treatments
- Fruit from the **thinned** (carbon sufficient) treatment **revealed superior fruit quality at harvest** (S4), when compared to the unthinned (carbon starvation) treatment



Anthony et al., (2020). Early metabolic priming under differing carbon sufficiency conditions influences peach fruit quality development. Plant Physiology and Biochemistry, DOI: 10.1016/j.plaphy.2020.11.004

Early metabolic priming under differing carbon sufficiency conditions influences peach fruit quality development

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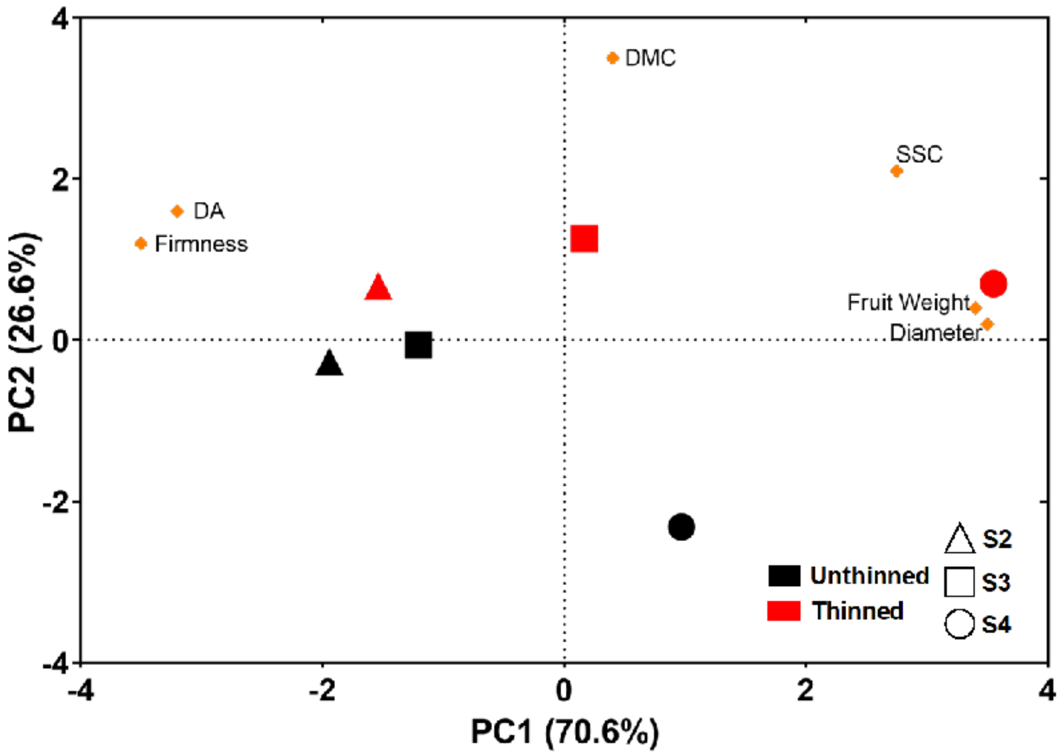
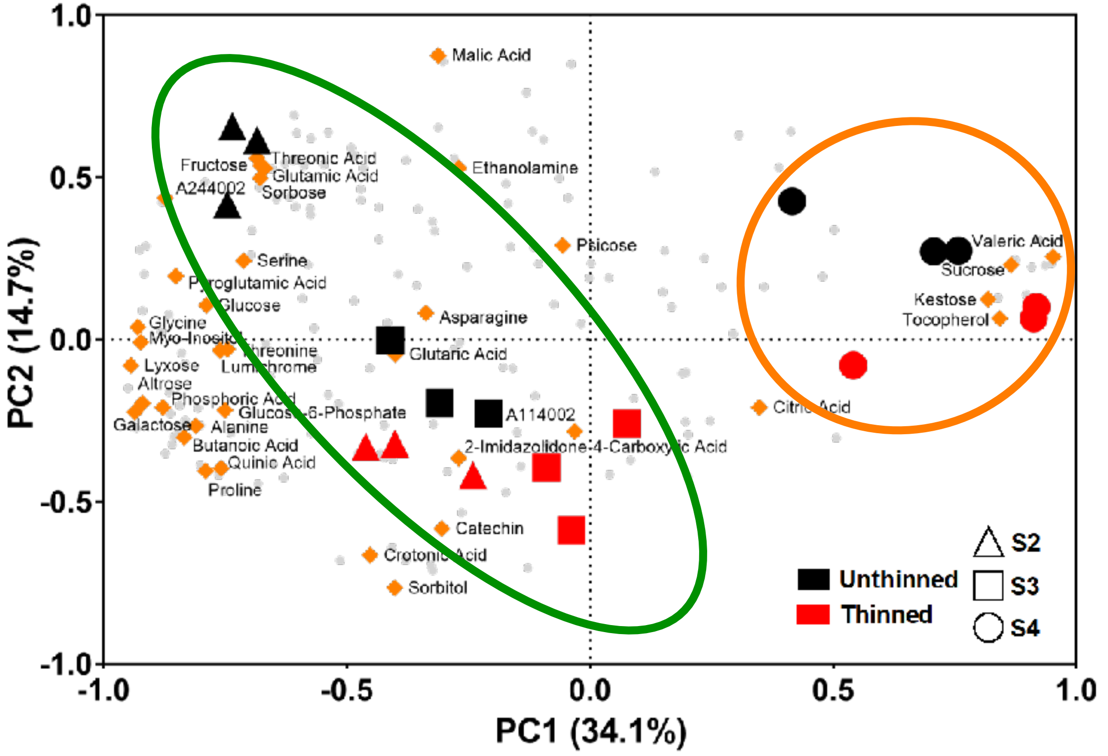
Fruit Quality



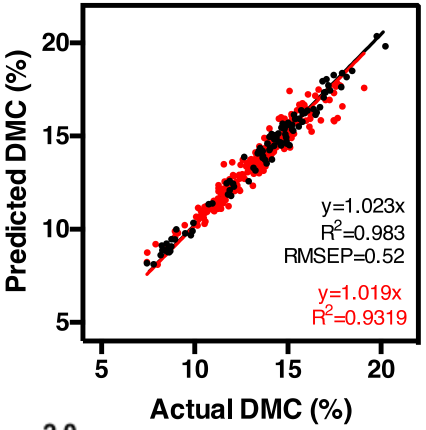
Metabolism

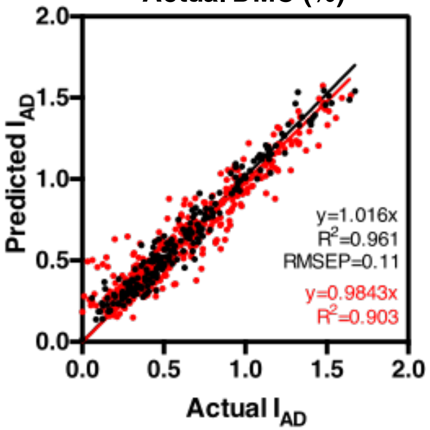


- Quality and **phenotypic differences were minimal at S2,** but vastly different at S4 (left)
- **Metabolic differences were vast at S2**, while profiles at S4 were similar (right)
- Many metabolites associated with the **primary metabolism shift according to development process**
- **Catechin** was **positively** related to **quality** parameters, DMC and SSC

(Anthony et al., 2020)

Effect of fruit position in the canopy on 'Sierra Rich' peach internal quality at harvest
(@ equal maturity)

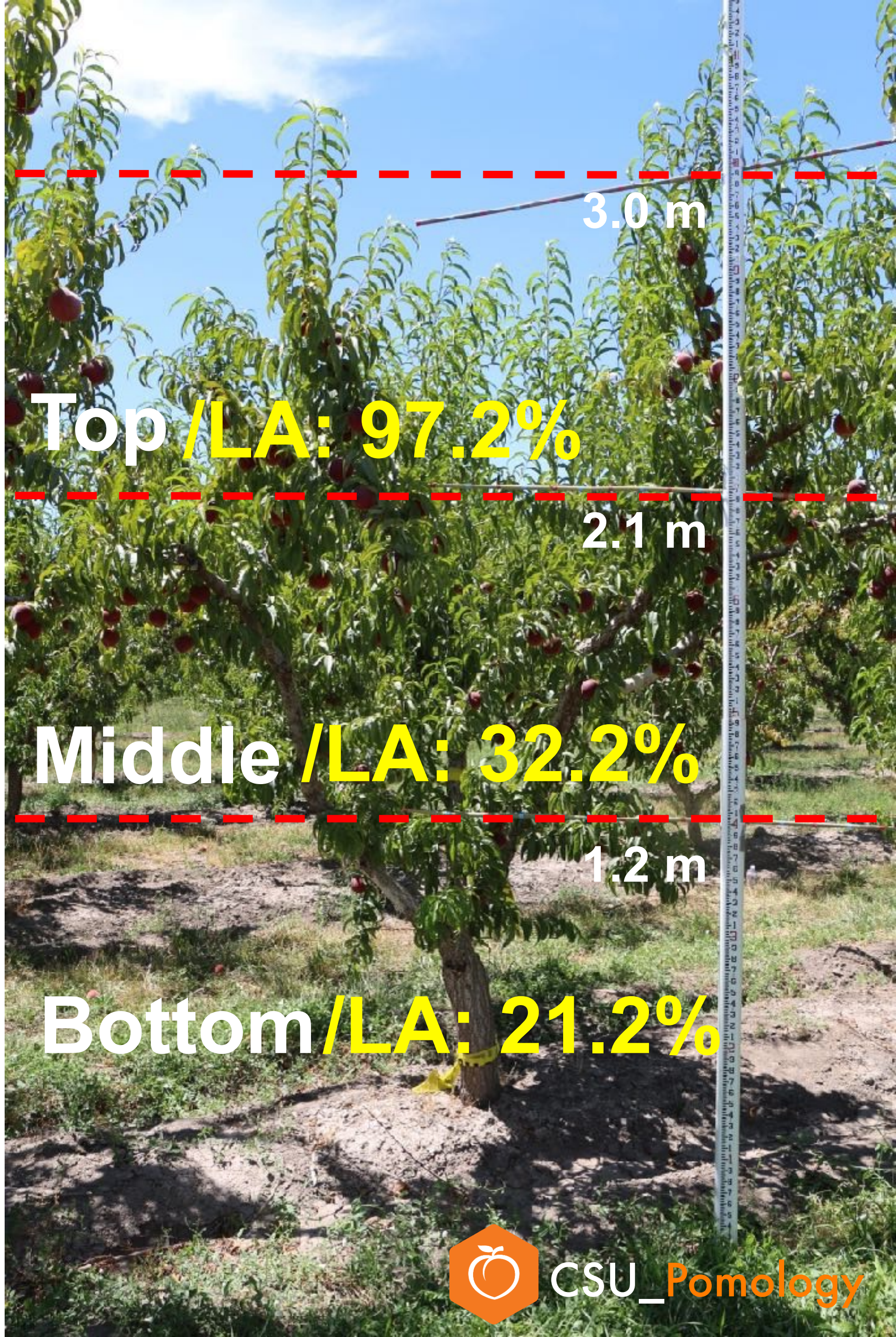




I_{AD}: 0.69
DMC (%):13.1

I_{AD}: 0.71
DMC (%):12.2

I_{AD}: 0.71
DMC (%):12.4

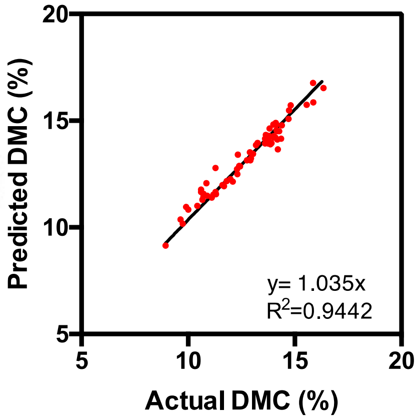


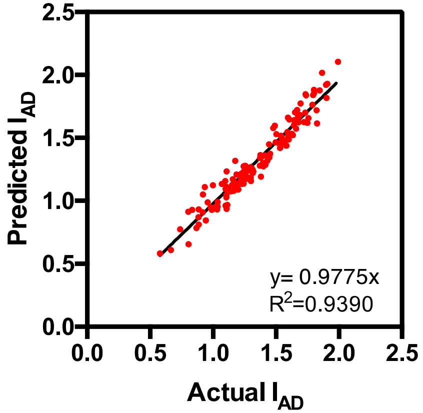
- **No significant differences** across canopy positions
- **Low vigor** = uniform light

Anthony et al., 2021. *Environmental & Experimental Botany*

*LA= Light Availability

Effect of fruit position in the canopy on 'Cresthaven' peach internal quality at harvest *(@ equal maturity)*

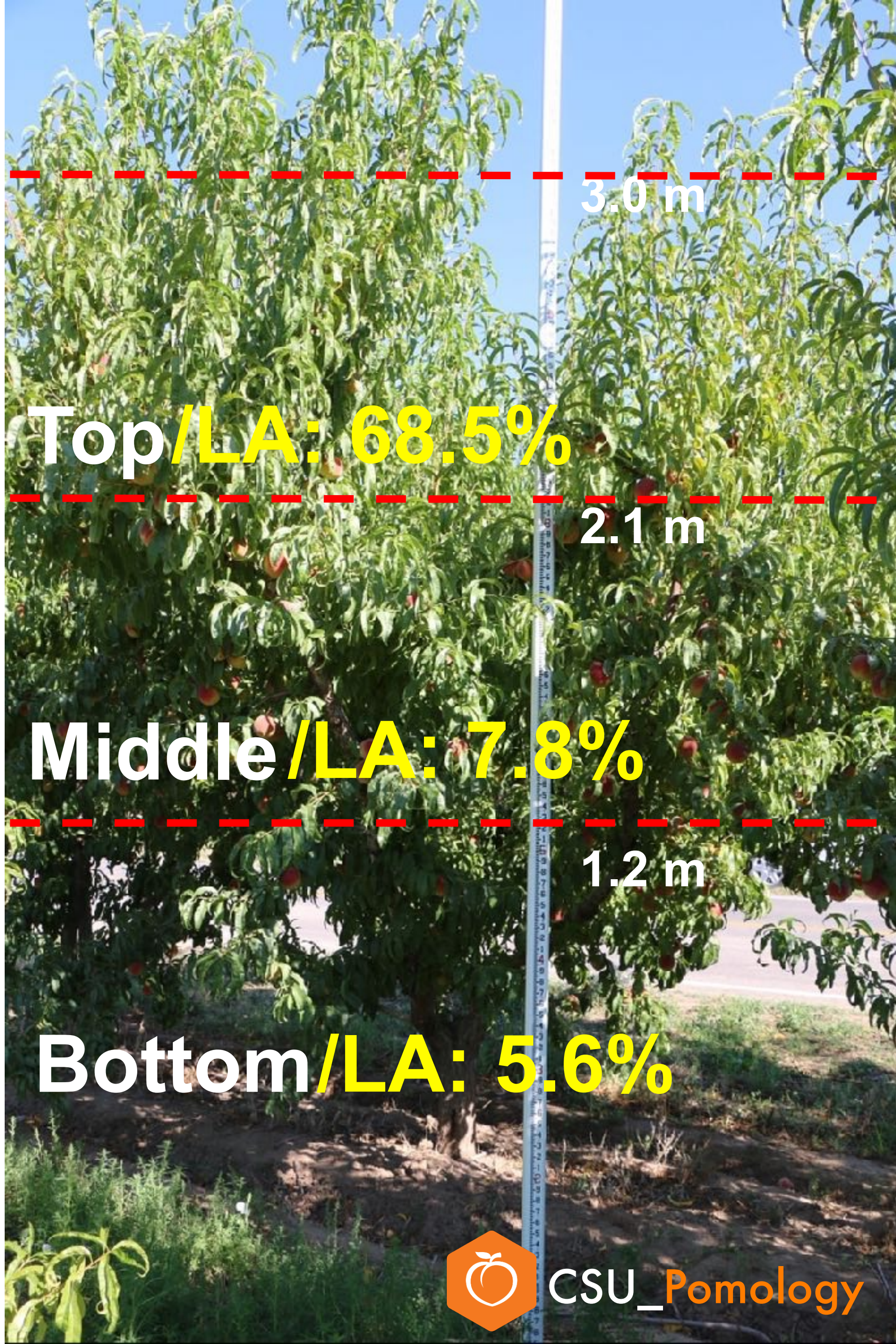




I_{AD}: 1.05
DMC (%):13.0* a

I_{AD}: 1.07
DMC (%):11.7* b

I_{AD}: 1.08
DMC (%):10.9* c



- ***Significant differences** across canopy positions
- **High vigor** = non-uniform light

*LA= Light Availability

Anthony et al., 2021. *Environmental & Experimental Botany*

Impact of cultivar x canopy position on peach mesocarp and exocarp primary metabolism (GC-MS) at harvest

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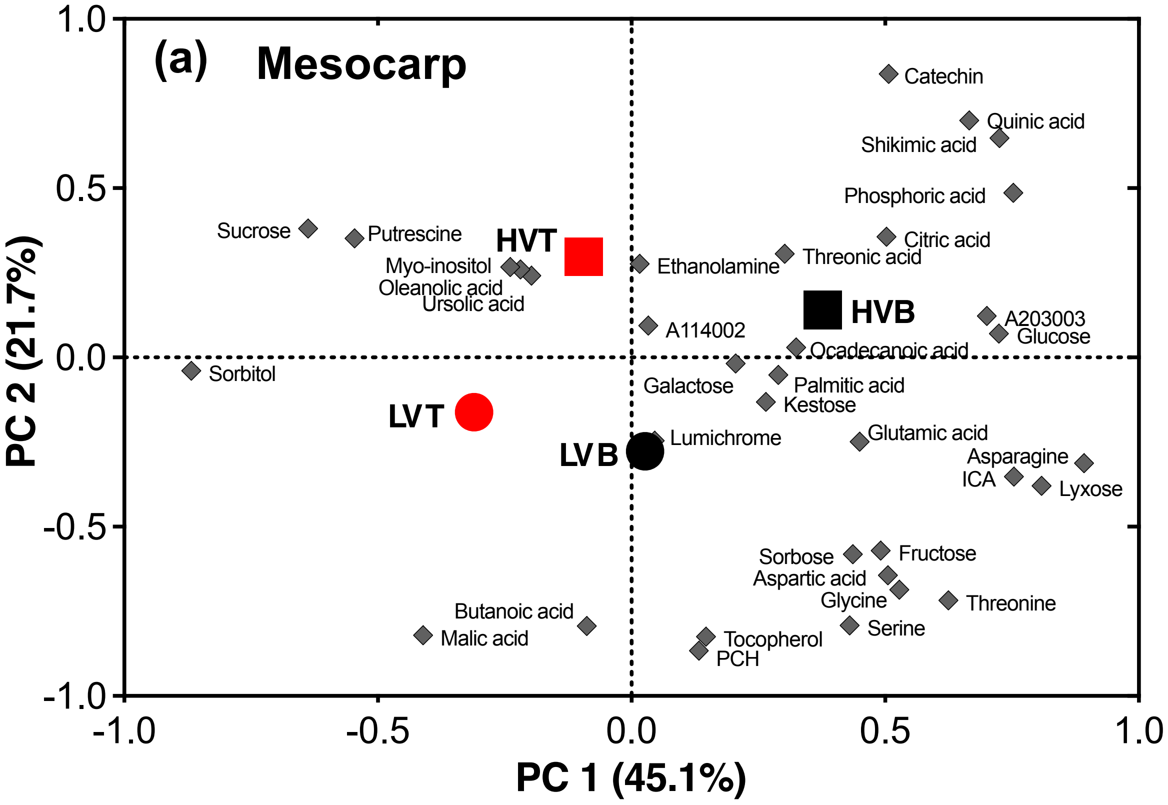
35 annotated metabolites across all samples

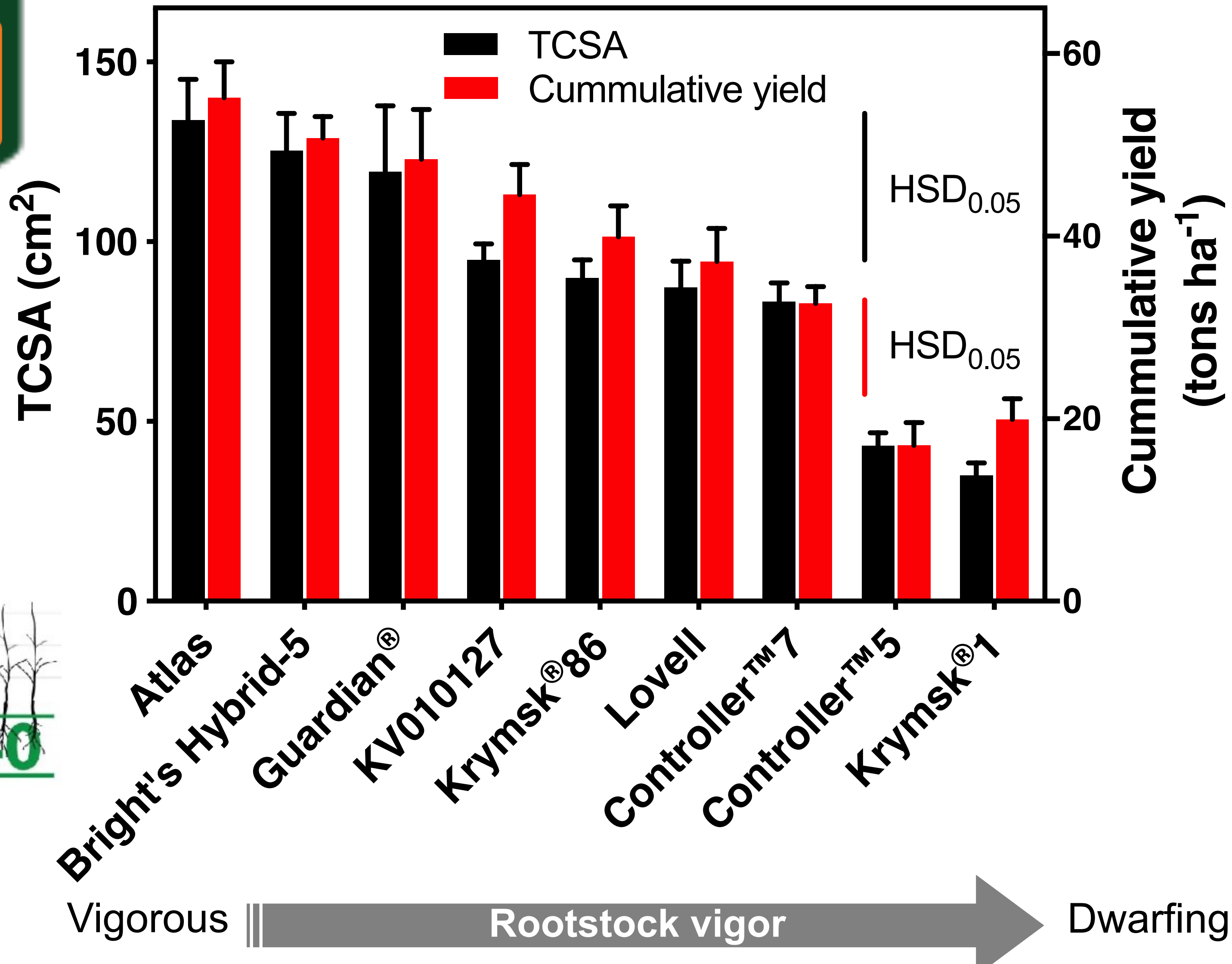


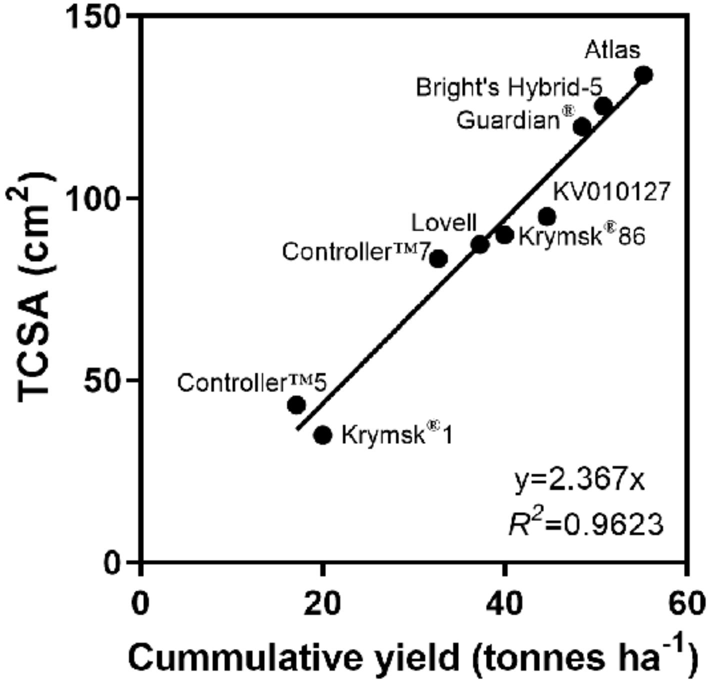
- **Minimal/similar variation** across positions in each cultivar (vigor context) in mesocarp
- **Mesocarp less affected by environment**, due to protection from exocarp and is heavily regulated by development (i.e., maturity)
- **Exocarp metabolite profiles more distinct in HV**, due to less uniform light conditions

Anthony et al., 2021. *Environmental & Experimental Botany*

X INTERNATIONAL PEACH SYMPOSIUM

Effect of rootstock on ‘Redhaven’ tree size and cumulative yield (2009-2017)





2009 NC-140 ‘Red Haven’ Peach Rootstock Trial

Minas et al., 2021. *In preparation*

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Influence of rootstocks on peach fruit internal quality

Rootstocks influence 'Redhaven' peach productivity and dry matter content (DMC) - 2016-18 (@ al maturity & crop load)

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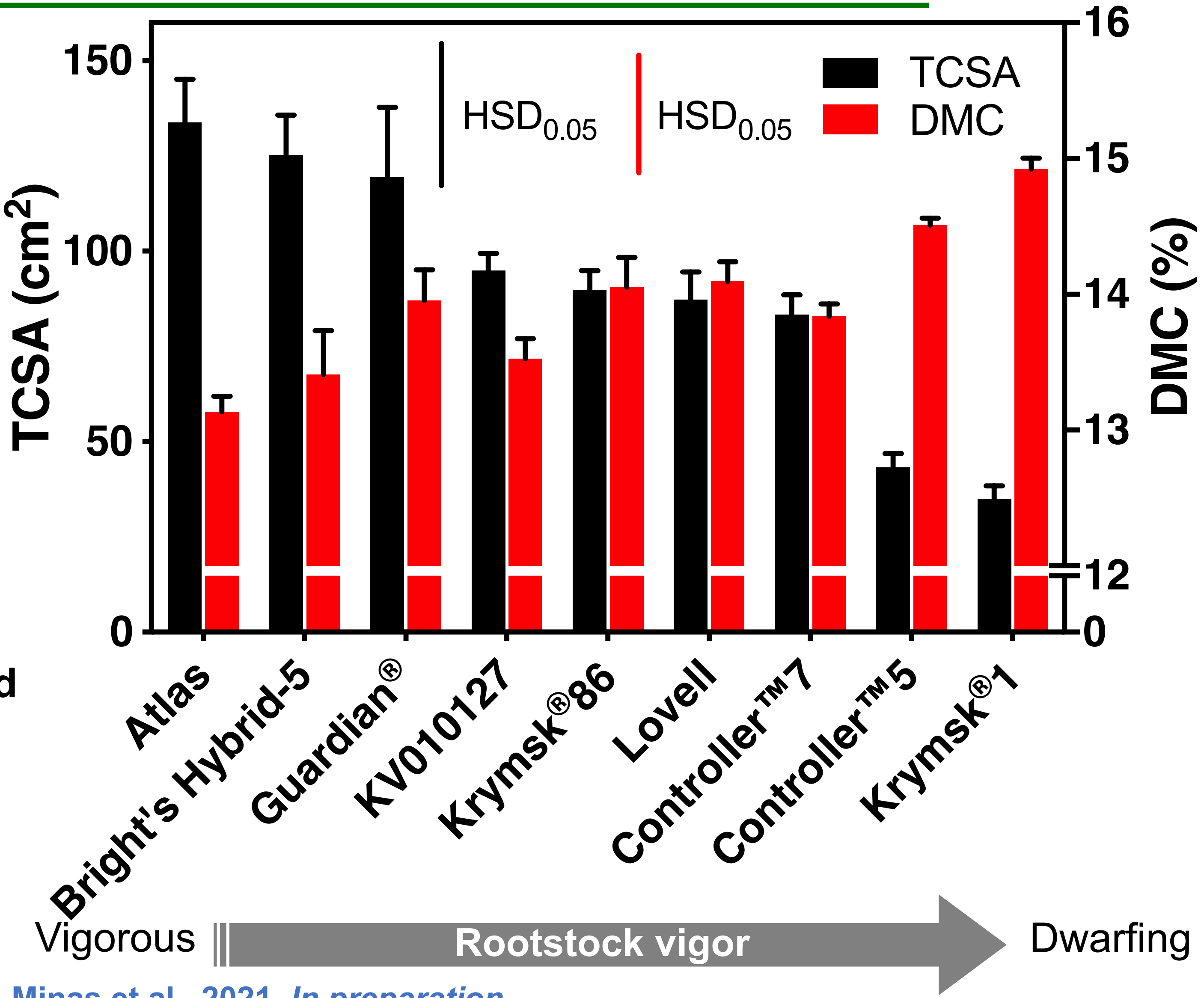
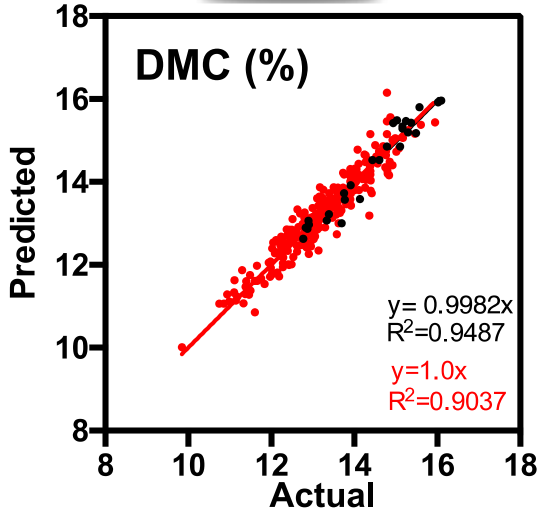
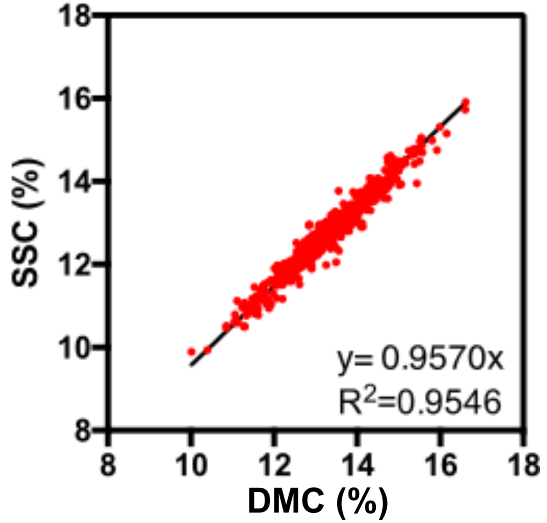




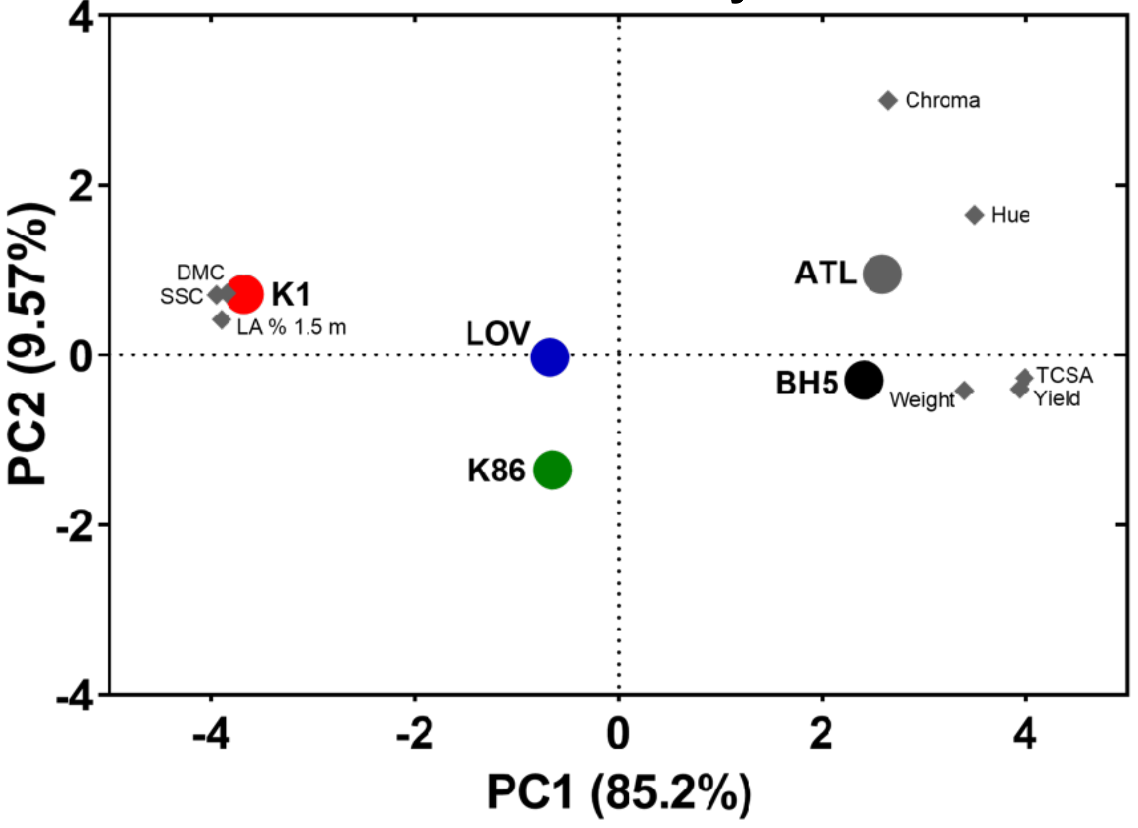


2009 NC-140 'Red Haven' Peach Rootstock Trial

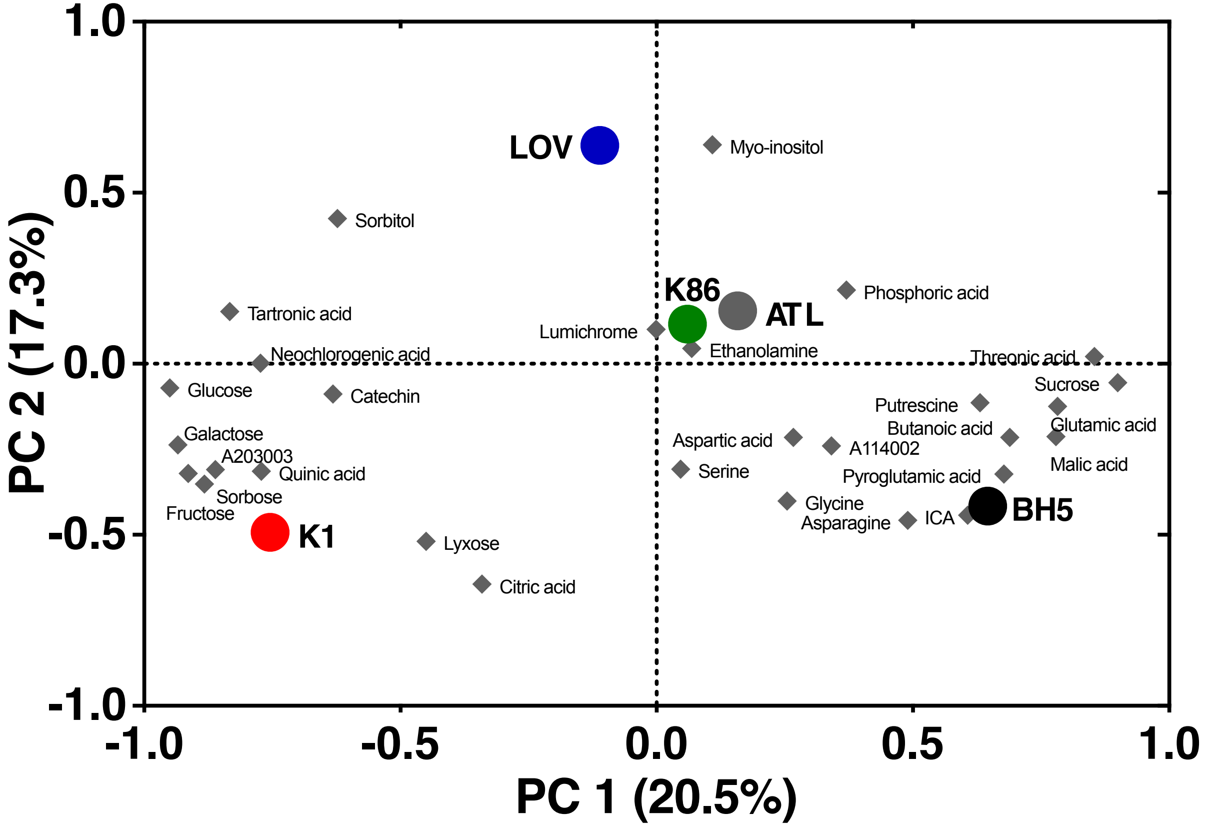
Minas et al., 2021. *In preparation*

Rootstock vigor and light availability highly correlated with internal fruit quality and caused swifts to primary metabolites (GC-MS)

Fruit Quality



Metabolism



Dwarfing — **Rootstock vigor** → Vigorous

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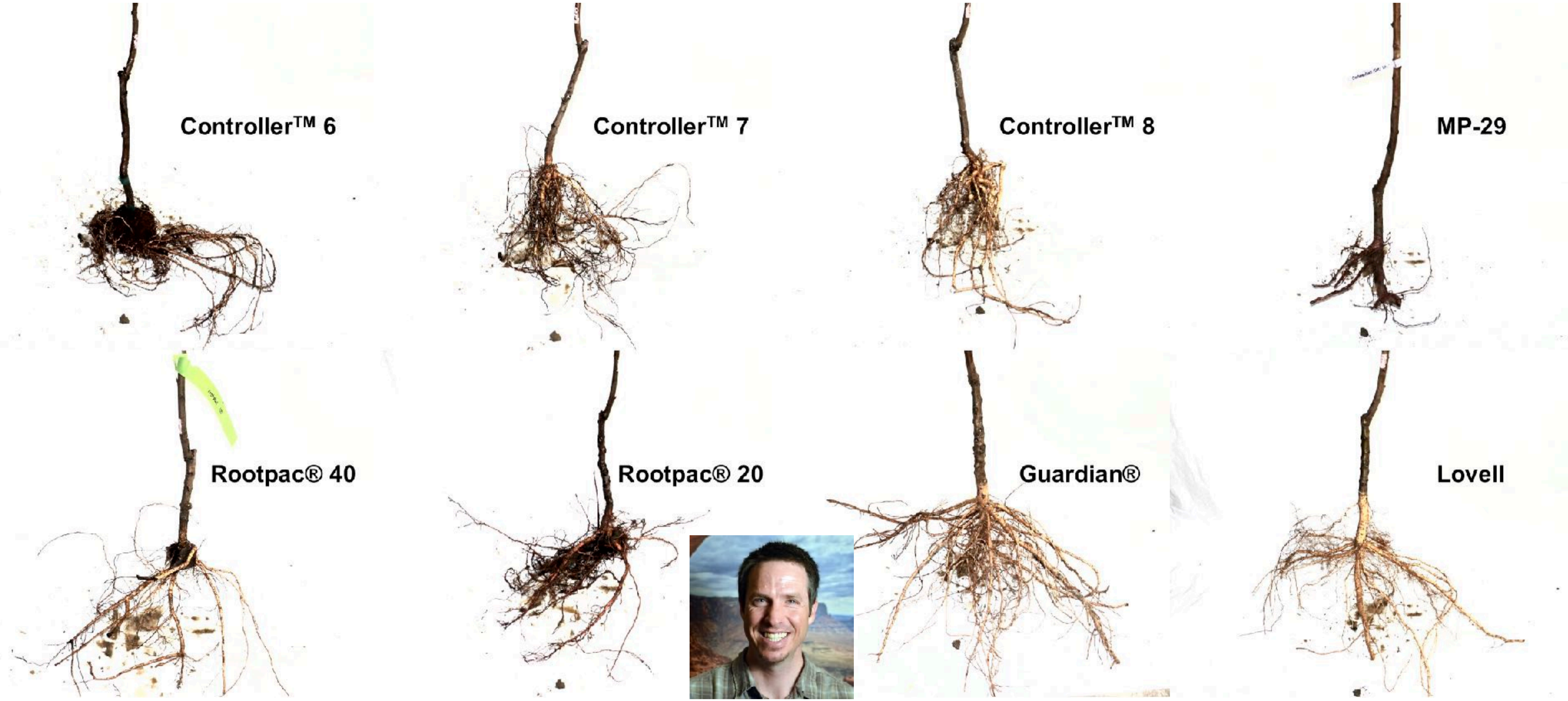
Pieper et al., 2021. *In preparation*

The 2017 NC-140 Cresthaven Semi-Dwarf Peach Rootstock Trial



Jeff Pieper

NC-140

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Today @ 2:30 PM – CSU Showcase

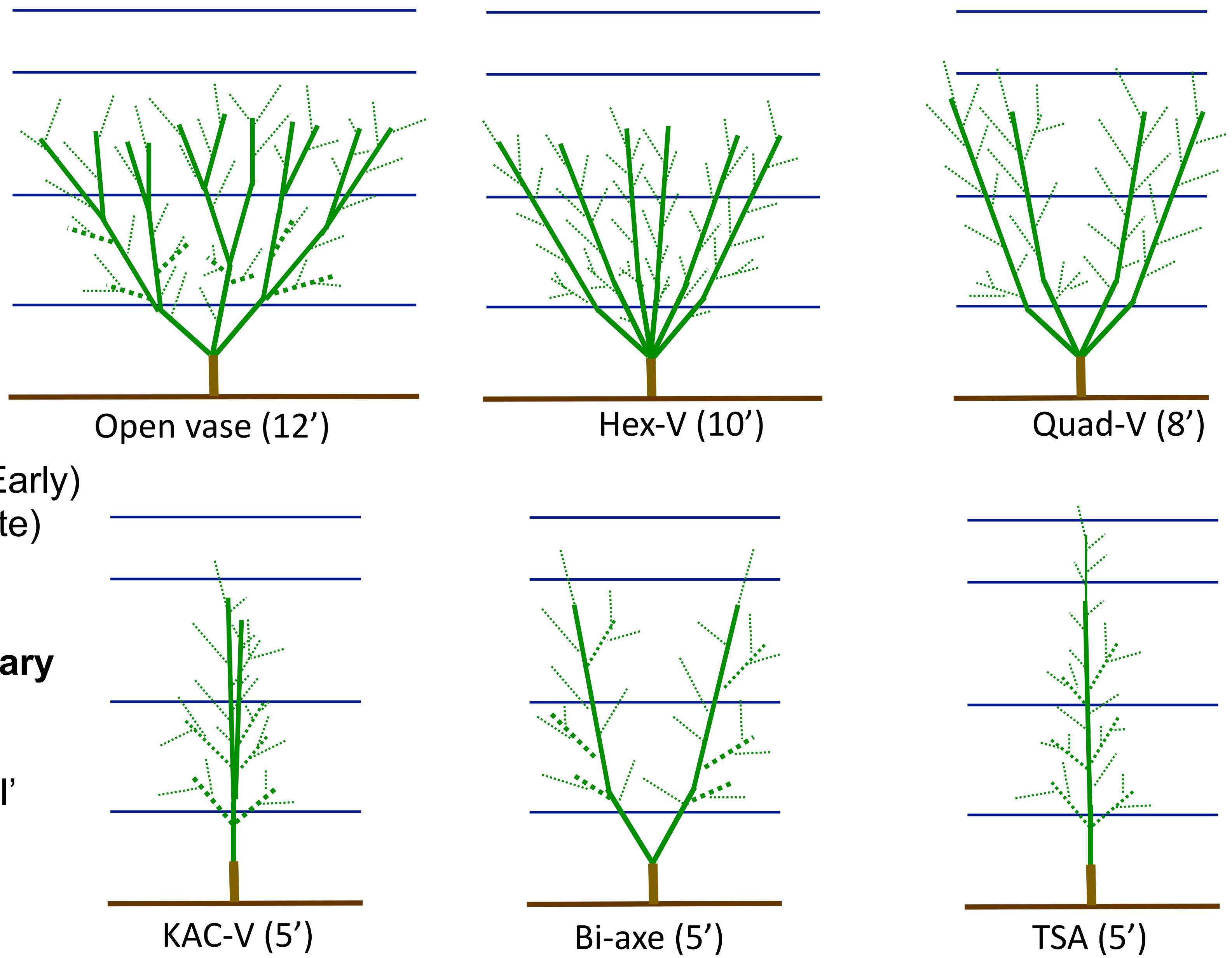
Good Fruit Grower, February 1st, 2018

Training Systems Trial: 2016 – 2021

Today @ 2:30 PM
CSU Showcase

Brendon Anthony

Planted: May, 2016
Cultivars x Rootstocks:
- Red Haven x St. Julien (Early)
- O'Henry x Krymsk 86 (Late)



CDA funded project starting January 2020: 'Management strategies to maximize Colorado peach orchards productivity and fruit quality potential'
PI: Minas

COLORADO
Department of Agriculture

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Training Systems: Before and after dormant pruning in ‘O’Henry’ on ‘Krymsk®86’ in 2019

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Open vase | Hex-V | Quad-V | KAC-V | Bi-Axis | TSA

Before

After

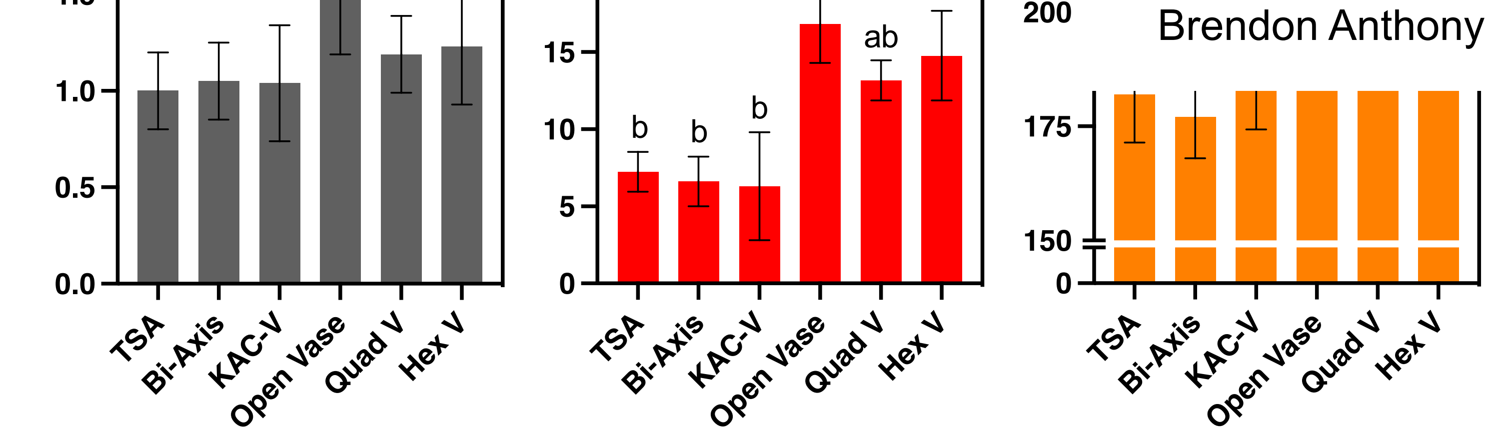
Recently Published: Anthony, B.M. and Minas, I.S., 2021. *Optimizing Peach Tree Canopy Architecture for Efficient Light Use, Increased Productivity and Improved Fruit Quality.* Agronomy, 11(10), p.1961. DOI: https://doi.org/10.3390/agronomy11101961

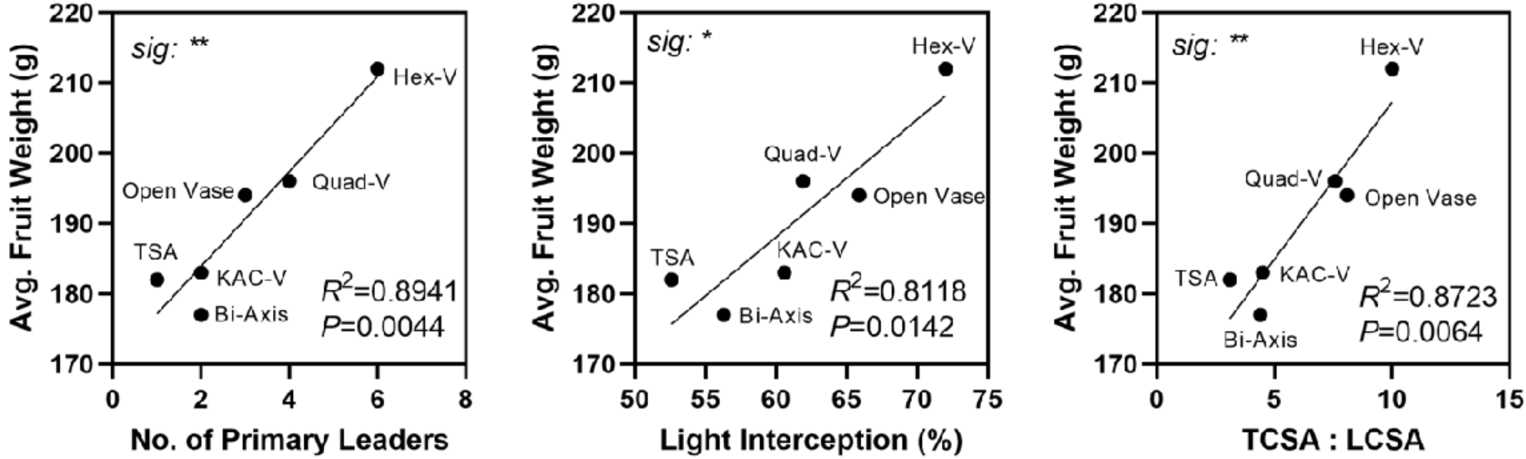
Training Systems: Light, vigor diffusion & FW in 'Redhaven' 2

Today @ 2:30 PM
CSU Showcase

Brendon Anthony

- Crop loads were set to equal levels
- Yield increased with increased canopy size; fruit weight in RH was highest in Hex-V
- Fruit weight increased with increased scaffold number, light interception and vigor diffusion factor (TCSA:LCSA)
- Hex-V intercepted an optimal amount of light (~70%) and demonstrated optimal diffusion factor (TCSA:LCSA)=~10
- **Hypothesis:** Fruit size related to light and vigor diffusion; crop loads were n.s.
- At least one more crop to confirm hypothesis





Anthony et al, 2022. *In preparation*

Developing the Next Generation 2D Peach Orchard

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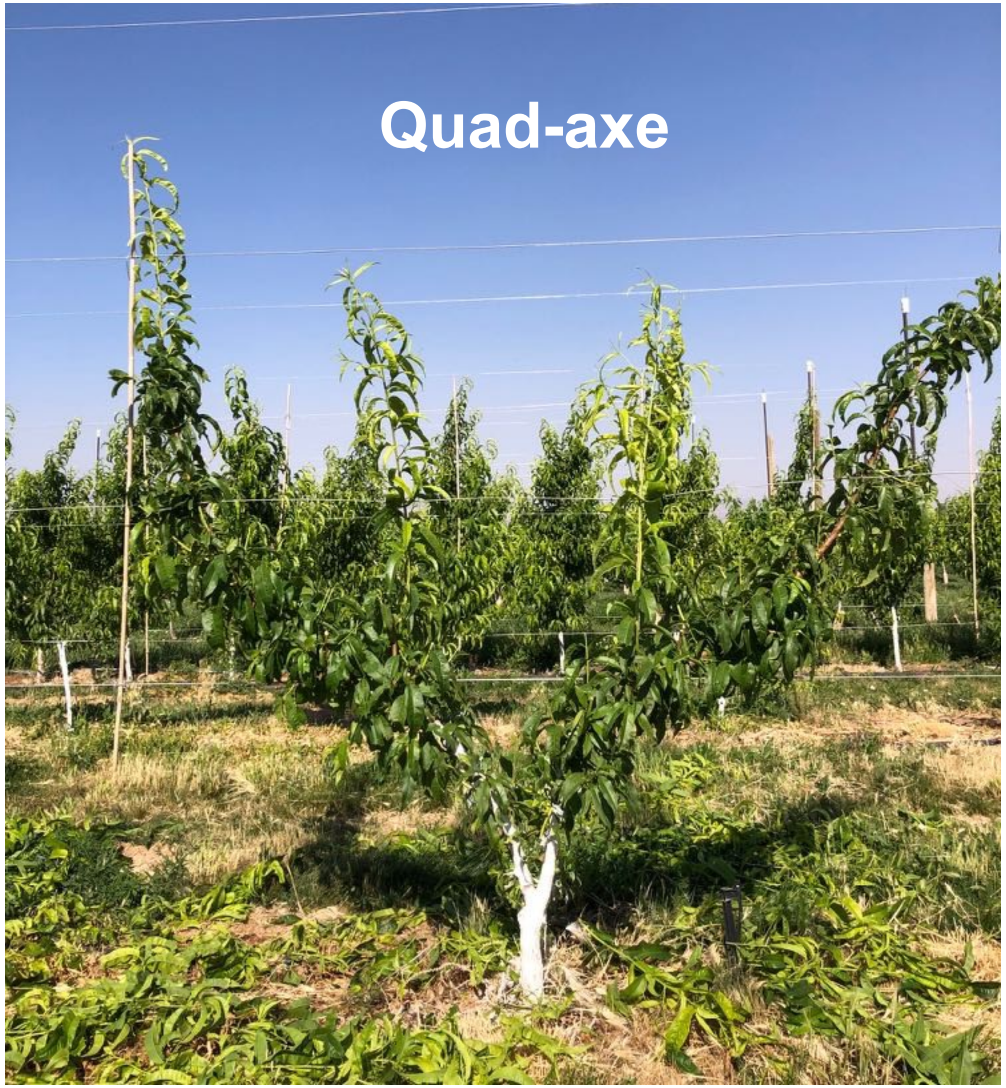

7 Rootstocks: Krymsk®86, Hansen, Guardian®, Lovell, Controller™6, Rootpac®40, Rootpac®20
4 Training Systems: SSA (single leader, 3’), Bi-axe-U (wide crotch, 6’), Bi-axe-V (narrow crotch, 6’), Quad-axe (bi-cordon with 4 uprights, 8’)

SSA (3' x 11', 1320 trees/acre)

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Bi-axe-U (6’ x 11’, 660 trees/acre)

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Quad-axe (8’ x 11’, 495 trees/acre)

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Questions?

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Acknowledgements

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USDA

NC-140

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OEDIT

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Western Colorado Horticultural Society

Talbott FARMS

SINCE 1907 ELA FAMILY FARMS

Cherry Hill Farms

CropwoRx

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