HORTICULTURE AND
LANDSCAPE ARCHITECTURE
COLORADO STATE UNIVERSITY

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January 2024

Peach Fruiting Wall And Other Field Trials At WCRC- Orchard Mesa

David Sterle, PhD
Research Scientist for Colorado State Univ.
David.sterle@colostate.edu

Overview

- 2-Dimensional Peach Fruiting Wall Trials (est. 2019 and 2021)
  - Training
  - Benefits
  - Yields
- Cold Hardiness Trials
  - Metabolomics
  - Current and Future study
- Cold Hardiness Modelling across different locations

2-Dimensional Peach Training Systems (2019)

- 4 Training systems
  - Single leader, Bi-axe U, Bi-axe V, and Inline Quad
- Rootstocks
  - Medium-high to low vigor rootstocks
    - Krymsk86©, Hansen 536, Lovell, Guardian, Rootpack 20, Rootpack 40, Controller 6

2-Dimensional Peach Training Systems

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- Trying to diffuse vigor through proper training.

Single Leader

Bi-axe U

Bi-axe V

Inline Quad

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Yields 2023 (5th Leaf)

- Best Performers overall per training system
  - Best performers are those with good fruit size and quality in addition to yields

Training System	Rootstock	Average of Yield ton/acre	Average of Avg. Fruit size (g)	Average of Total No. of Fruit (Both Pick)
Single Leader SSA	K86	10.4	170	54
Bi-axe U	Lovell	15.5	183	118
Bi-axe V	K86	14.3	175	114
Inline-Quad	Hansen	15.0	157	136

2-Dimensional Peach Training Systems (2019)

- 4 Training systems
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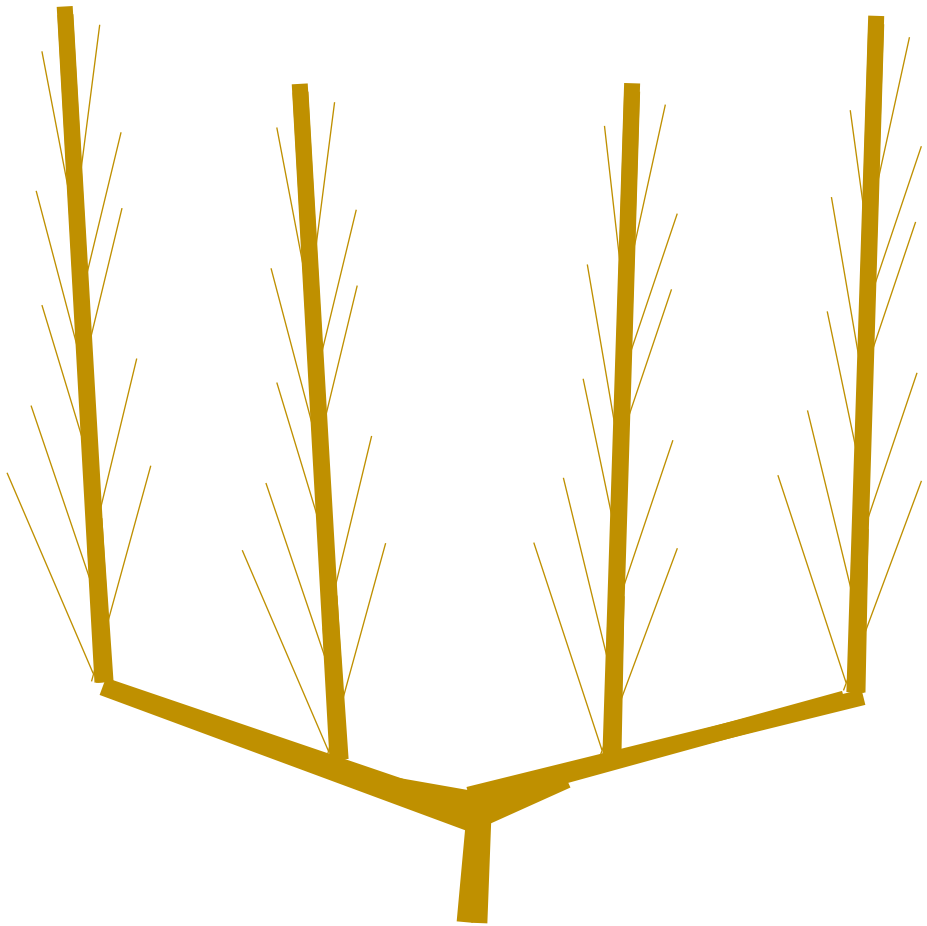
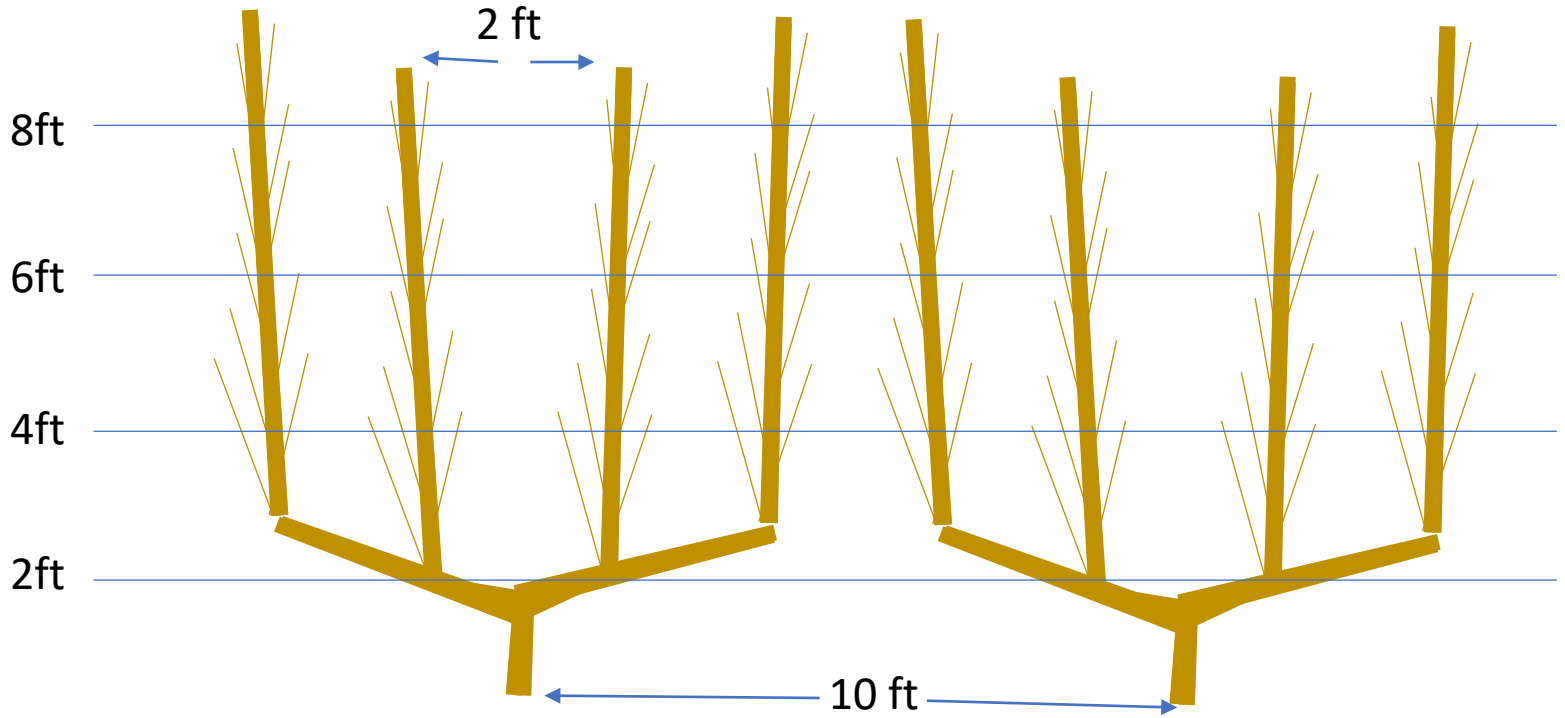
2-Dimensional Peach Training Systems (2019)

- Expected benefits
- Better light penetration into canopy
  - Better fruit quality
  - Fruit set closer to scaffold= more efficient use of space
  - More labor efficient
    - Pruning
    - Thinning
    - Harvesting
  - More mechanizable
  - Better spray penetration
  - Possibly more uniform ripening

Inline Quad

(2 ft upright spacing)

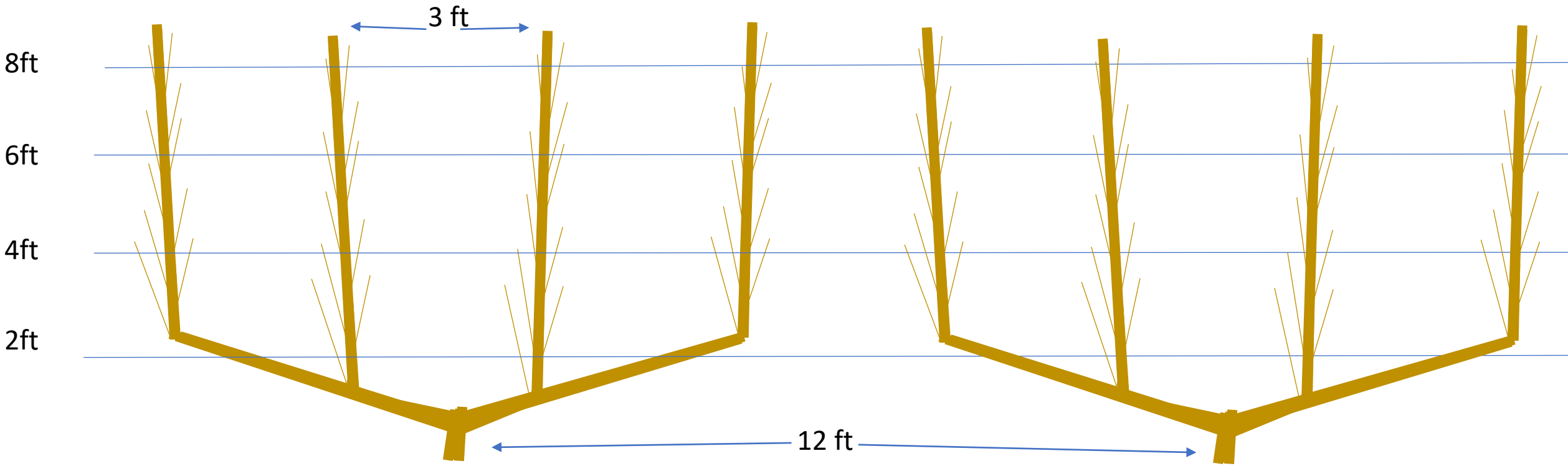




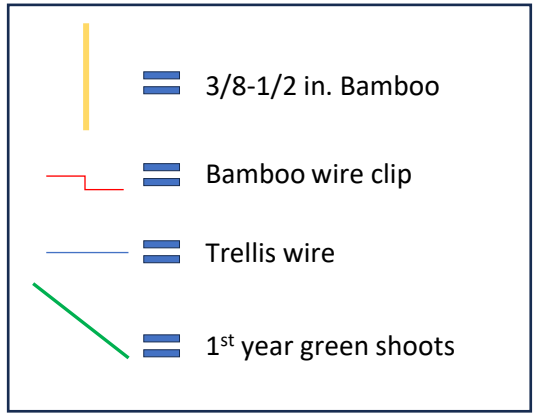
Inline Quad

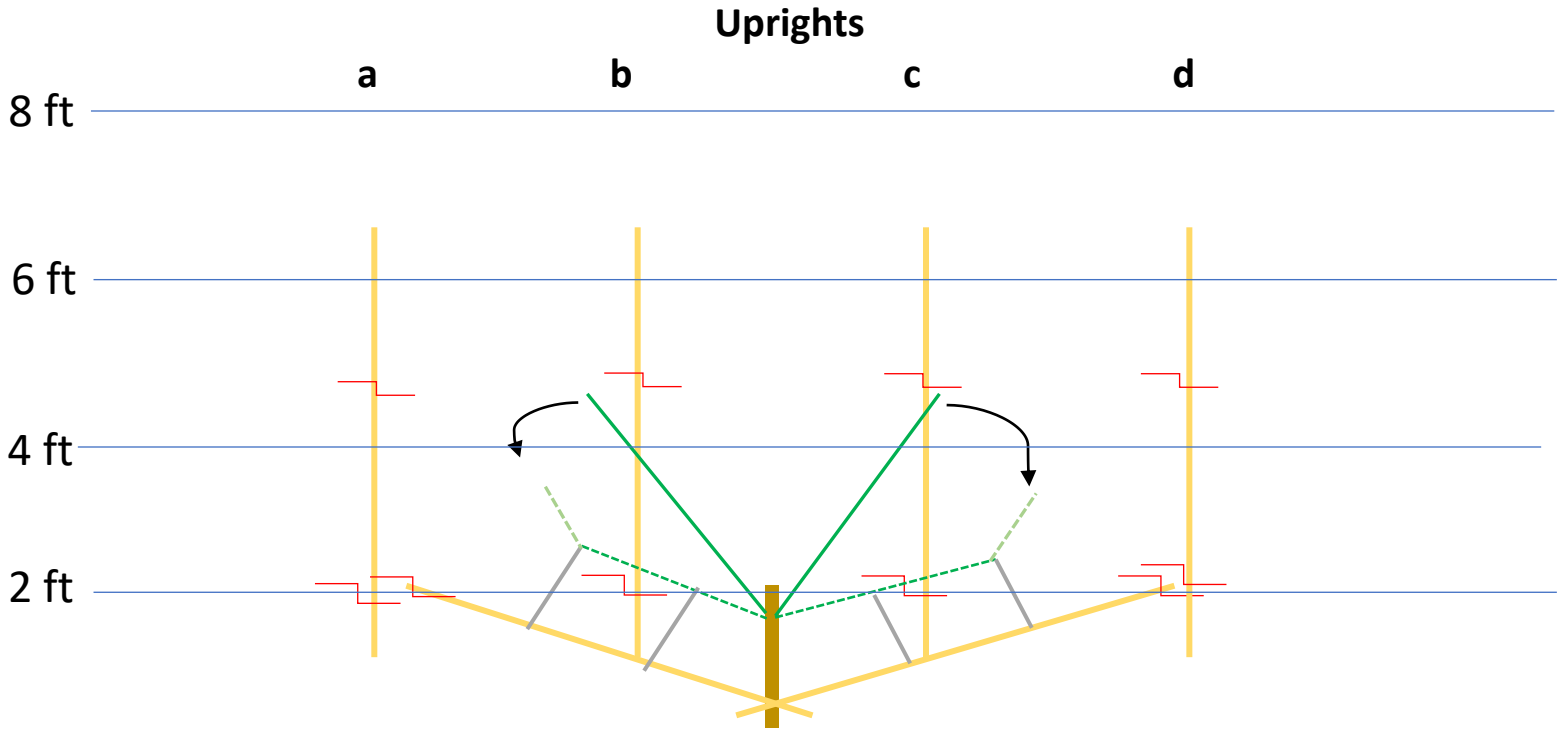
(3 ft upright spacing)

- This training system is in a 2021 trial

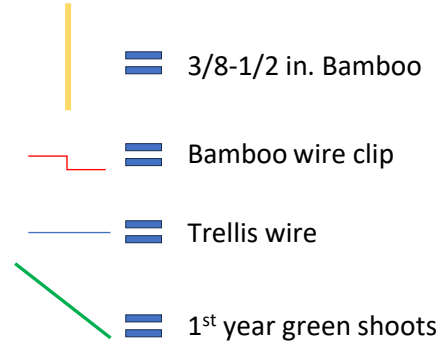


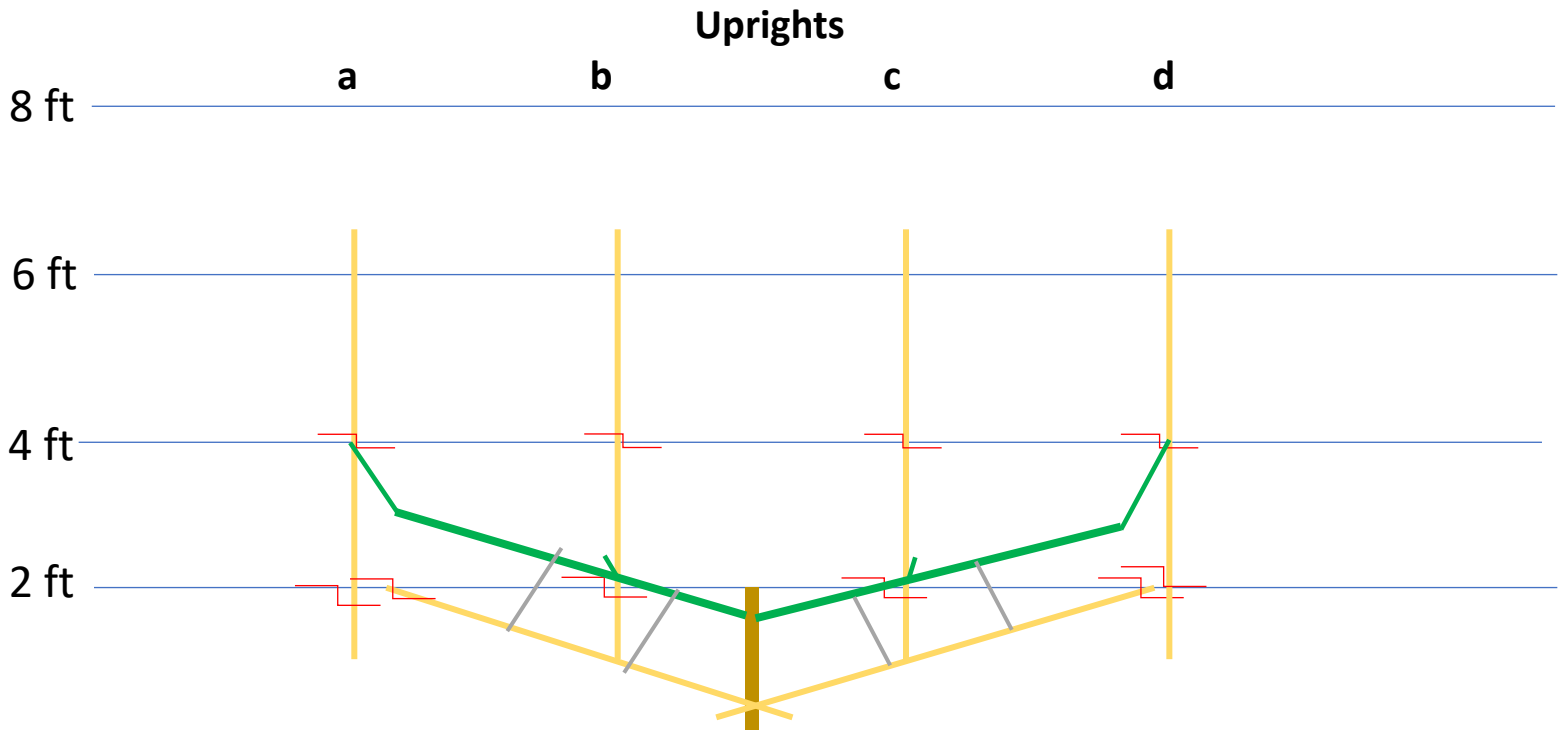
Inline Quad- Early growing season





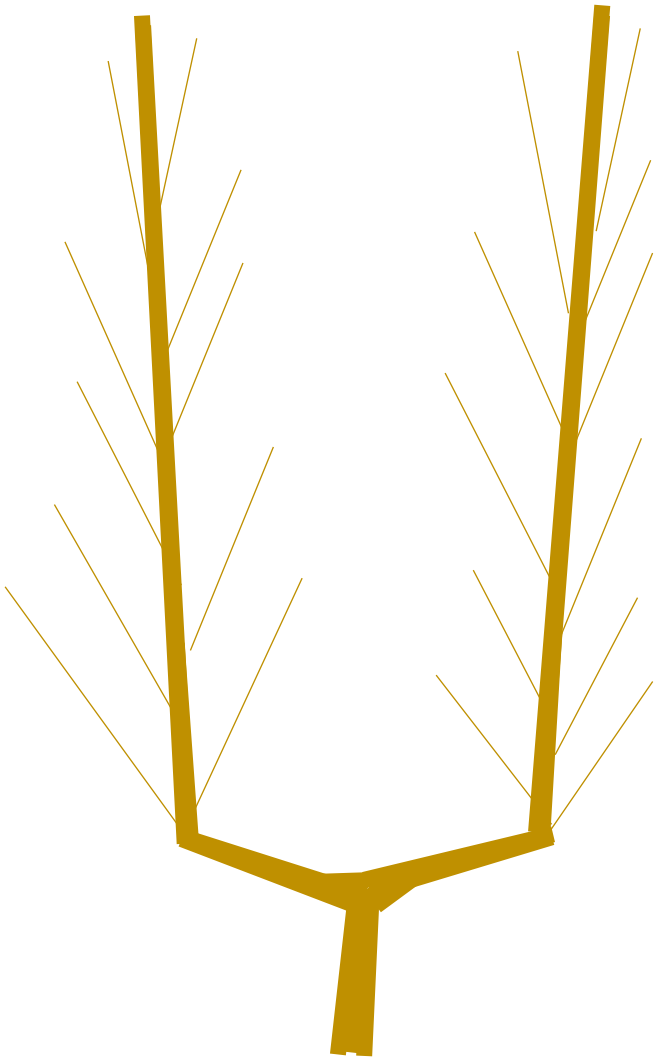
Inline Quad- Early establishment of cordon

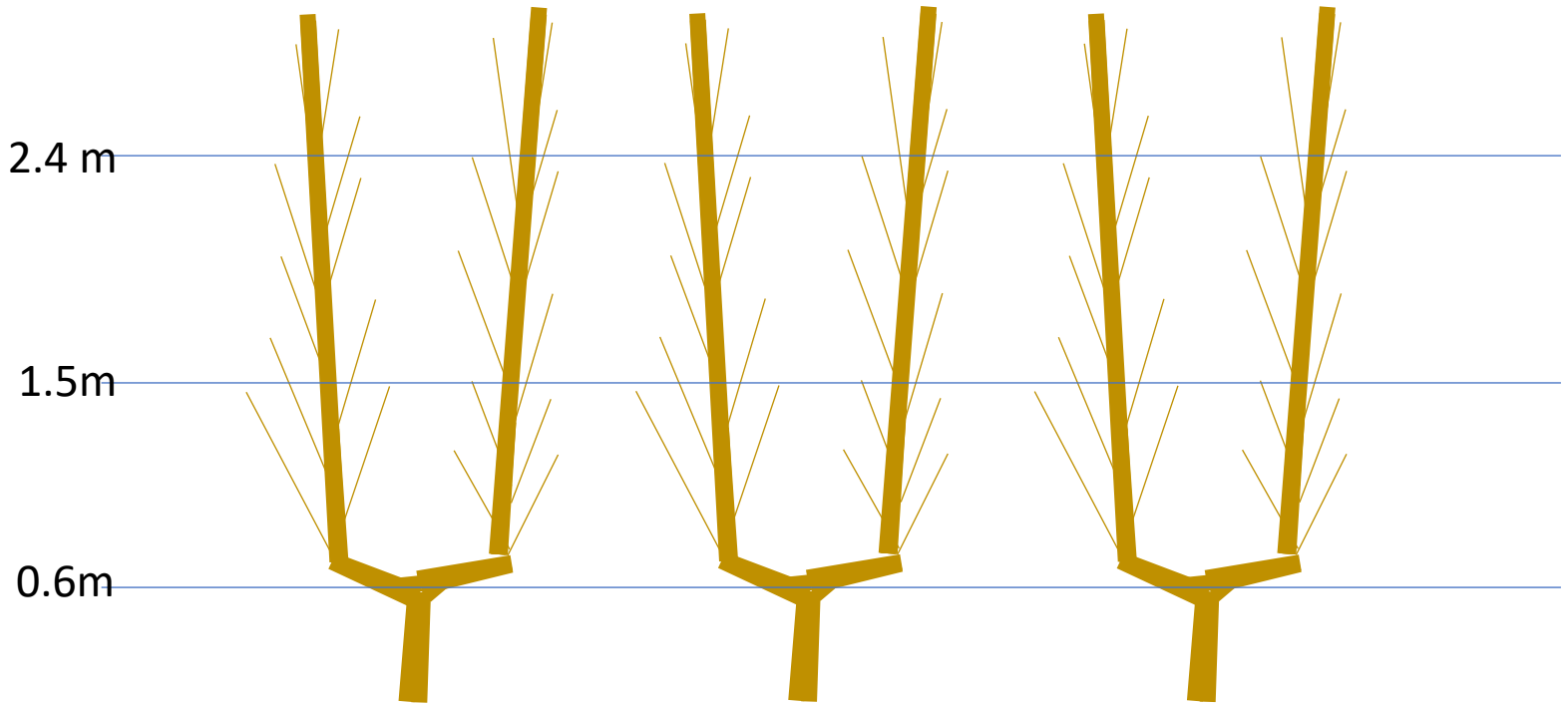




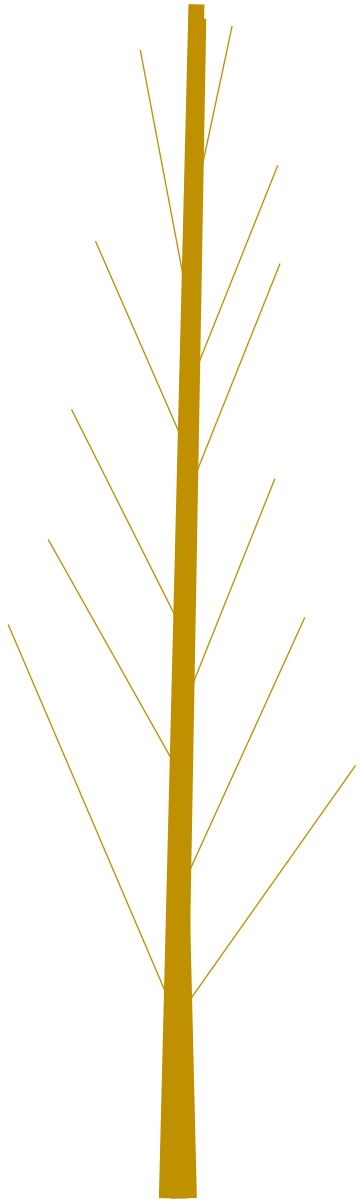
Establishment of 2 cordons by the end of 1st season

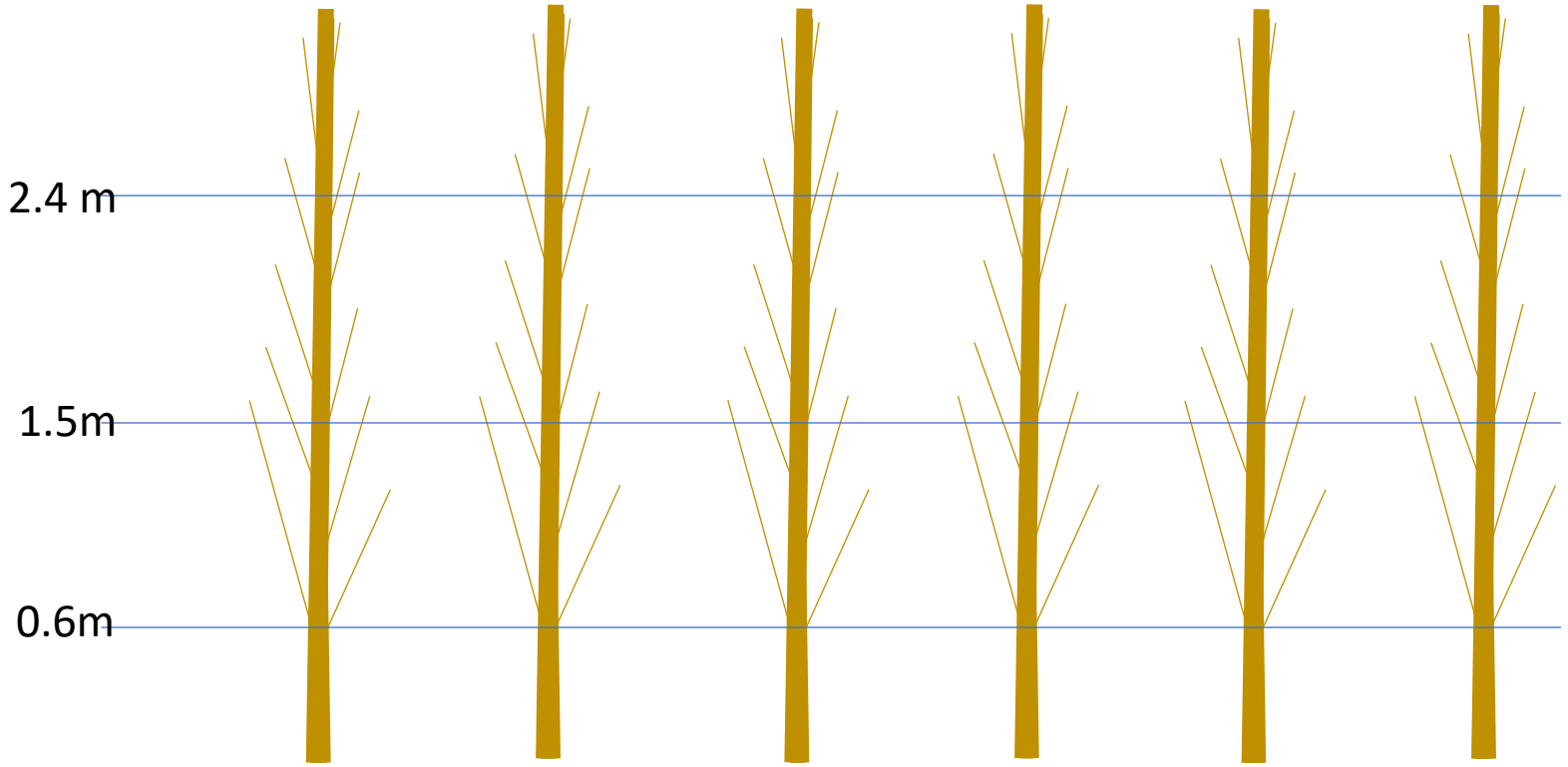
Bi-axe U (6ft spacing)





SSA- Super Slender Axe (3 ft spacing)





Establishment- Cytospora Protection

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- Young tree Cytospora treatment through first 3 years
  - 2 parts Latex paint (white) : 1 part water
  - Captan
  - Topsin
  - Sprayed post-pruning
    - Graco Sprayer

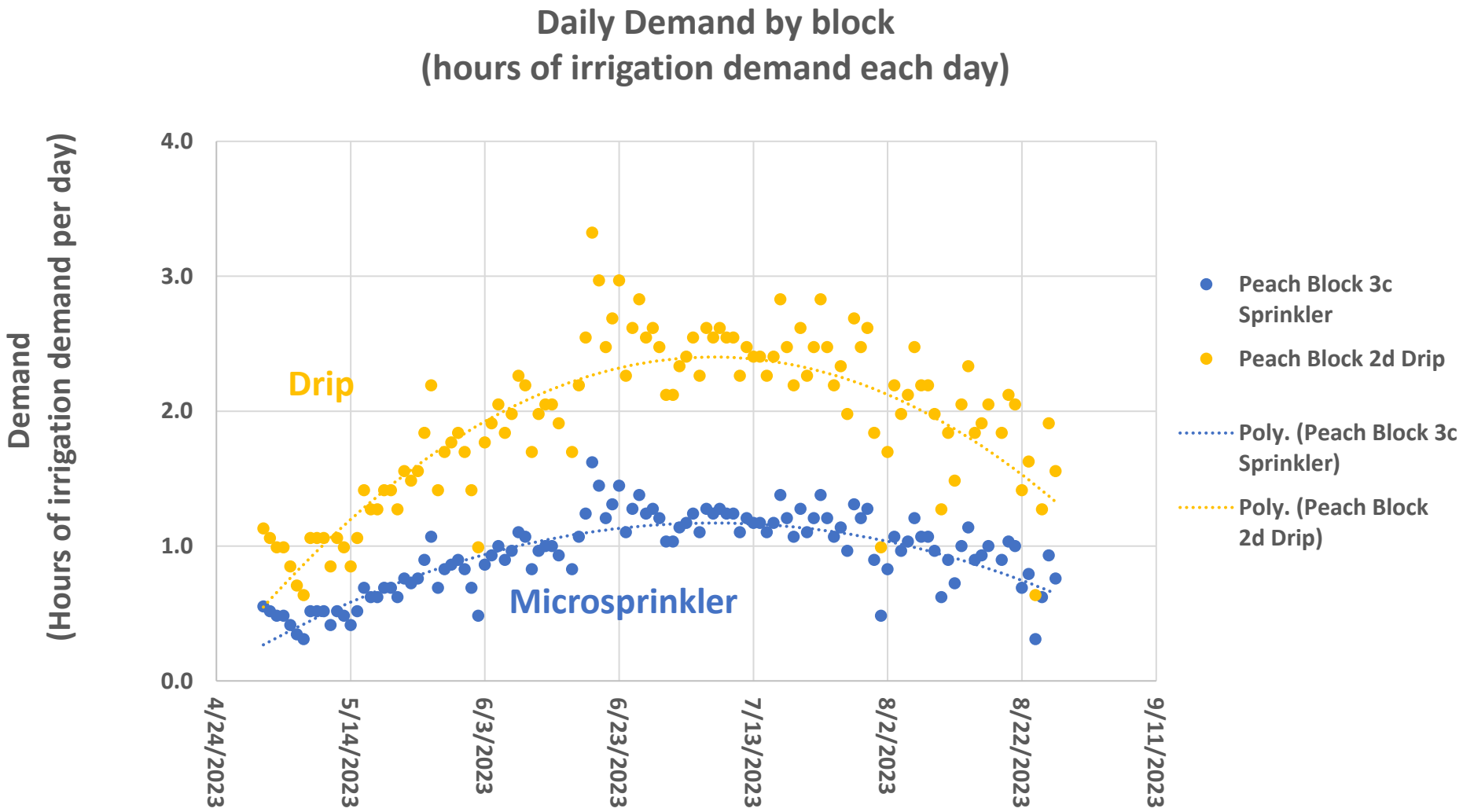
Paint Sprayer

2000W inverter

- Conventional Only, **not** organically certified


MULE
Kawasaki

Irrigation Monitoring



https://coagmet.colostate.edu/ Crop Water Use

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Fertility

- Nitrogen- 45-60 lbs of N per acre (Urea and Prosol 20-20-20)
  - Prosol is 20-20-20 + micro nutrients
- Iron- 5 lb per acre Ferriplus (EDDHA chelated Iron) (In May)
  - This is the most effective **Soil applied** Iron fertilizer chelator in ph 8+ soils
  - We also foliar apply amino acid chelated micros (Fe, Zn, Mn) if chlorosis appears later in season
- Leaf tissue monitoring in early July to check fertility levels

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Summer 2022

2-Dimensional Peach Training Systems (2019)

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Other thoughts from this trial

- We found harvest much more efficient in the planar systems
- Picked orchard in only 2 picks rather than 3
- Would accommodate picking/pruning platforms very well for extra labor efficiency
- Yielding over 15 tons/ac in some cases in 4th leaf with 30% less water than sprinkler

Yields 2023 (5th Leaf)

- Best Performers overall per training system
  - Best performers are those with good fruit size and quality in addition to yields
  - U Diffusing leader vigor consistently better

Training System	Rootstock	Average of Yield ton/acre	Average of Avg. Fruit size (g)	Average of Total No. of Fruit (Both Pick)	Diffusion Factor Trunk/Leader
Single Leader SSA	Krymsk 86	10.4	170	54	2.1
Bi-axe U	Lovell	15.5	183	118	3.0
Bi-axe V	Krymsk 86	14.3	175	114	3.1
Inline-Quad	Hansen	15.0	157	136	4.5

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Cold Hardiness

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What metabolic changes are associate with changes in cold hardiness, and dormancy stages in peach floral buds?

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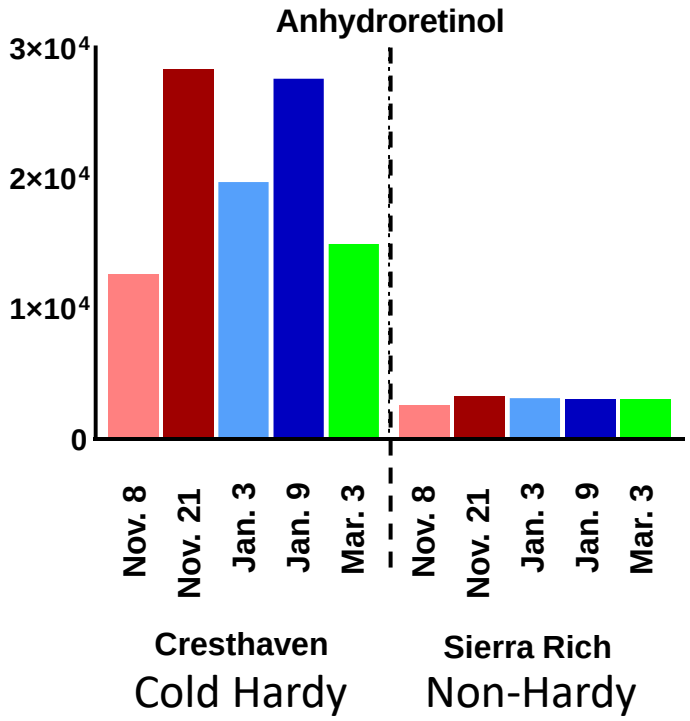
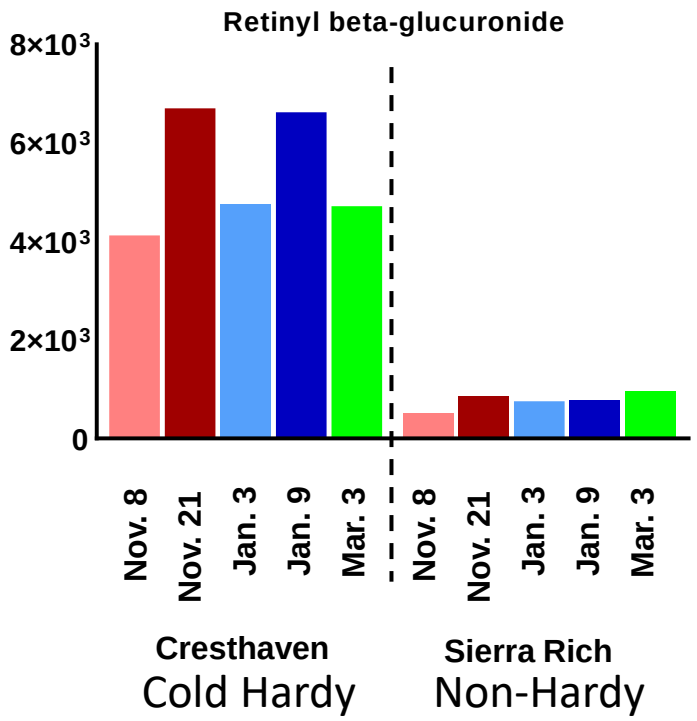
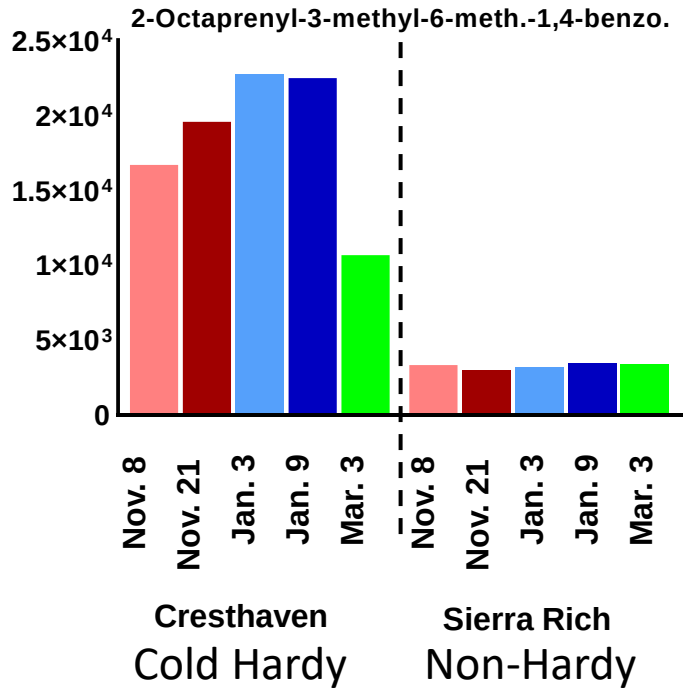
Prenol Lipids

- Includes terpenes, terpenoids and xanthophylls
- Very highly expressed in cold hardy cv
- These were the only three significantly different prenol lipids between cultivars

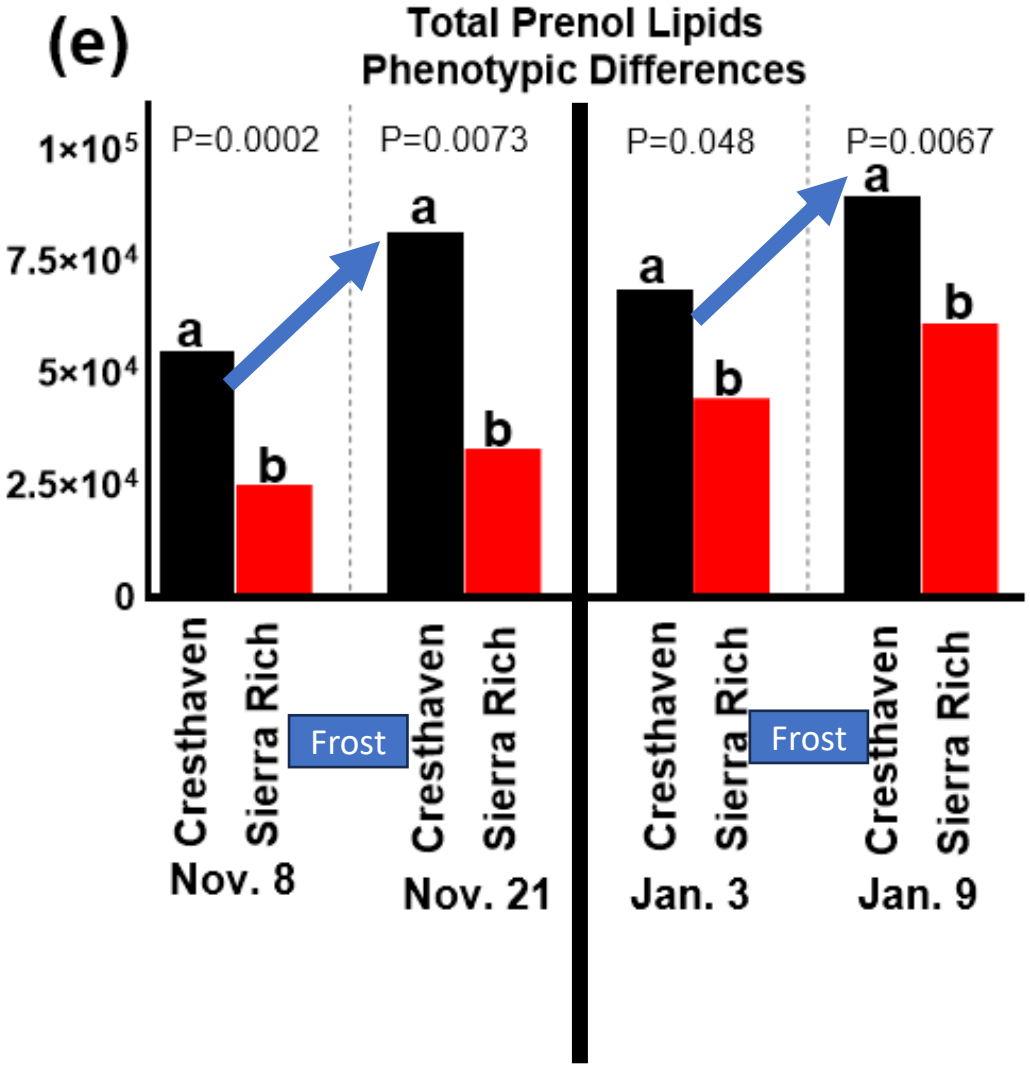






Prenol Lipids

- Different prenol lipids have been found to modulate stress in tea (Zhao et al., 2019, and Zhou et al., 2020)
- Comparison of combined expression of all **significant** prenol lipids
- Significantly higher in cold hardy CV at each of the acclimation and maximum hardiness dates



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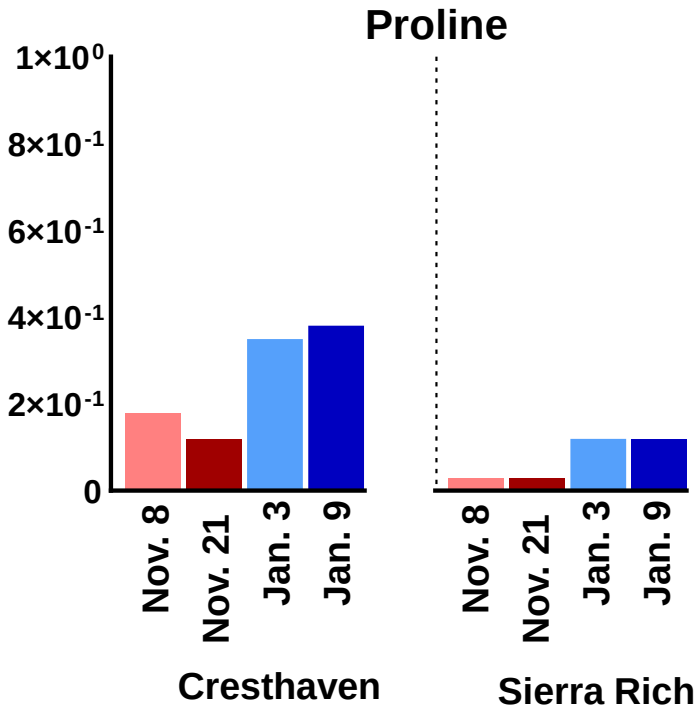
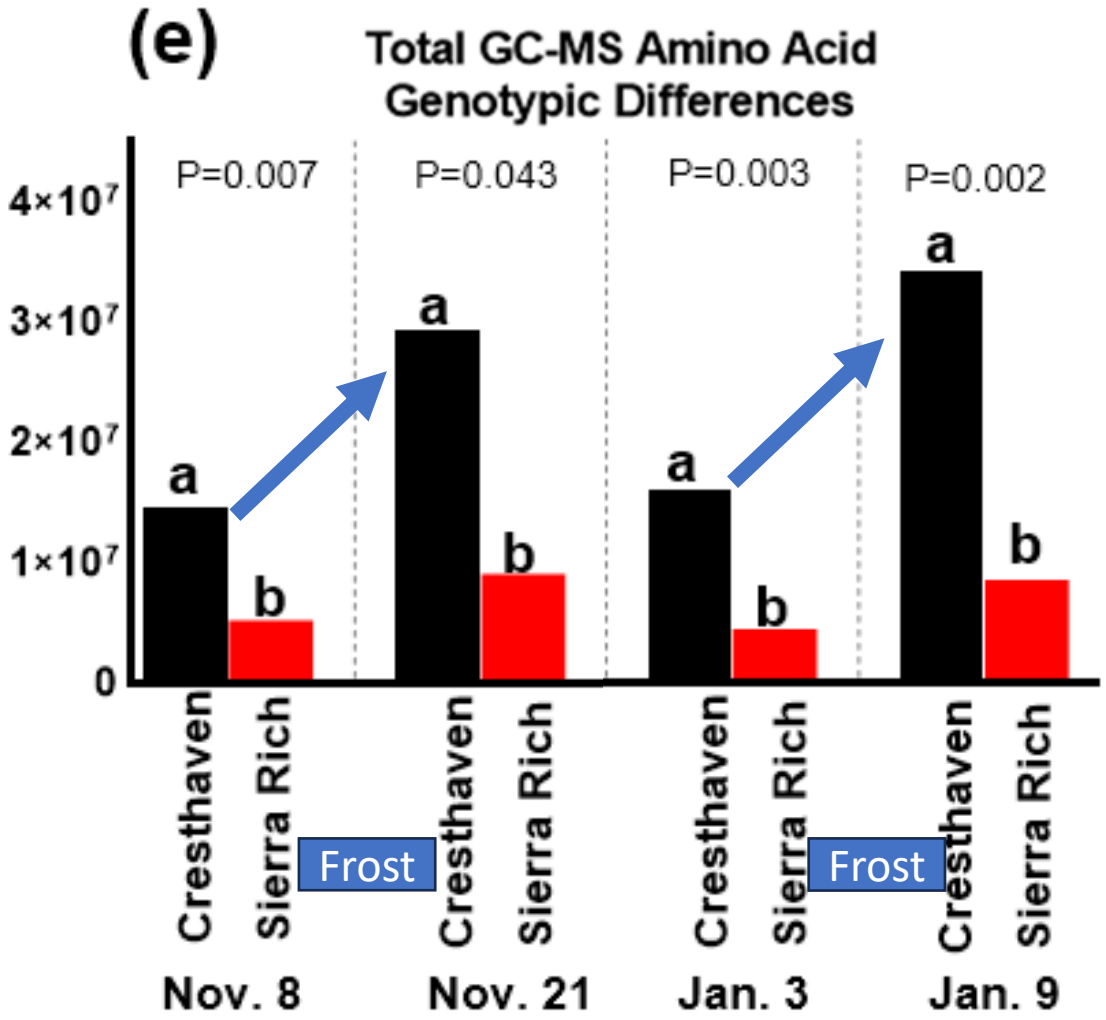
Amino Acids- Nitrogen is not just for vigor

- Proline known to be a response to cold stress, and related to cold tolerance in many plants
- We found it to be highest throughout much of the dormant season, when cold hardy cv was more frost tolerant, which was during January
- Osmolyte, signaling molecule, antioxidant
- Critical to major metabolic pathways:
  - TCA cycle, pentose-phosphate, and phenylpropanoid pathways



Outcomes



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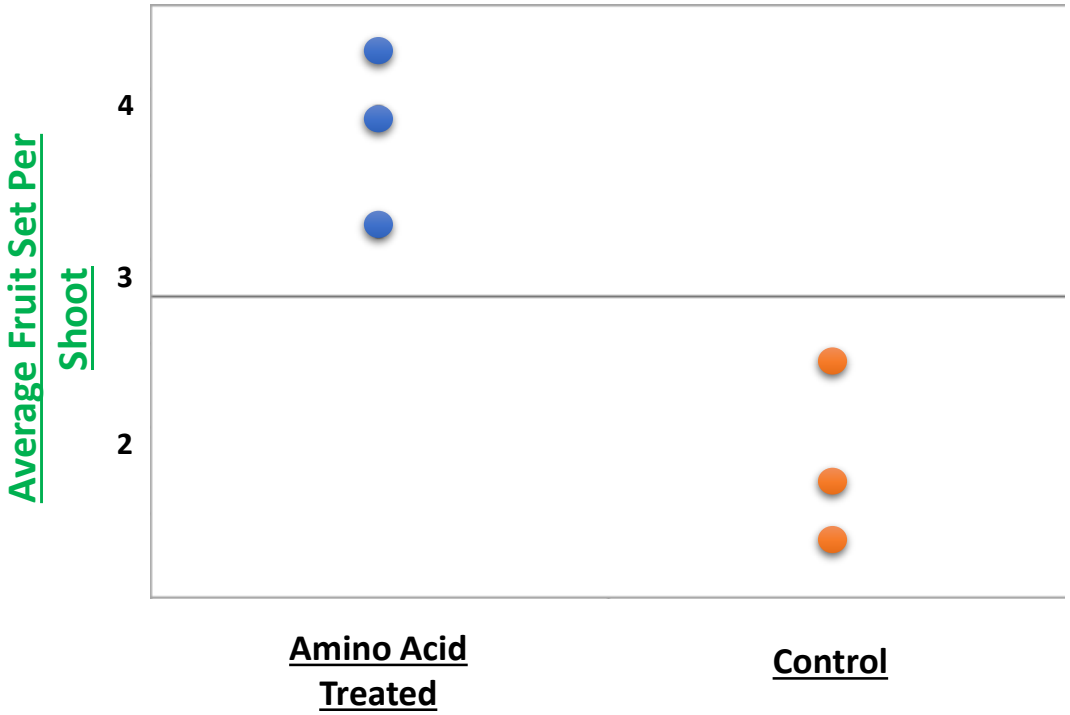
Recent Results

Spray Trial Inspired by amino acid findings

- Bloom time Amino acid treatment, immediately (10 hr) before frost
- Increased Fruit Set 2x when sprayed at full bloom immediately before bloom frost (25.9°F)
- Small trial, Needs to be tested more extensively



P= 0.0059

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Recent Results

Spray Trial Inspired by metabolic analysis findings

	Yield lb per tree	Fruit Count
Amino Acid	40.6a	88a
Control	13.5b	29b
	P=0.0002	P=0.0002

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Cold Hardiness

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Fall hardiness spray experiments

- Protone (Abscisic Acid or ABA)
  - Can be useful if a dangerous cold event is predicted in fall as in 2020
  - This does increase the risk of spring frost, with earlier bloom
- Ethephon (@ 50%+ leaf fall)
  - 3-day bloom delay
  - Can cause gummosis and damage trees if not used carefully

Overview

- Question: if we apply both can we shut down early, and bloom late as well
  - In 2023, the combination of 10/7 ABA and 10/25 (50%+ leaf fall) Ethephon resulted in a bloom date 3 days later than untreated trees

Future Strategy

- **3 stage approach:**
  - **Early Dormancy**
  - **Late Bloom**
  - **Extra Bloom hardiness**

- ABA: how warm does it need to be to enter dormancy faster with ABA application
- Ethephon: In the future we are experimenting with lower concentrations of ethephon and later application times, to minimize risks to tree health
  - ACC is another possible alternative to ethephon, that is safer for trees
- Amino Acid Treatment: Can we replicate success amino acid sprays during bloom to boost hardiness prior to bloom frosts

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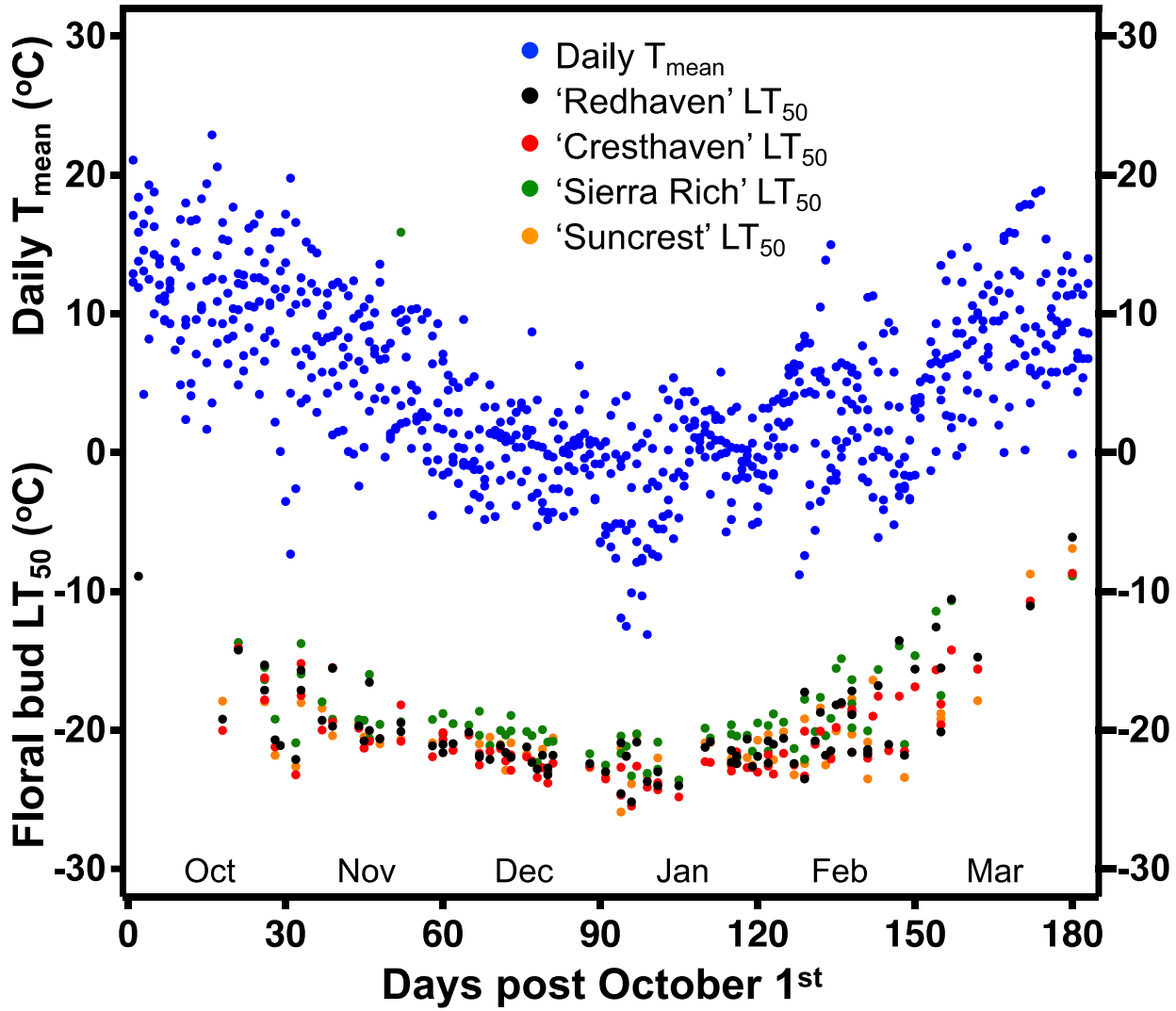
Cold Hardiness Modelling

Cold hardiness data

- Model training data collected over the last 4 years
  - 80 dates per cultivar
  - Each date comprised of 75 lethal temperatures
  - Roughly 6000 lethal events per cultivar
  - LT_{50} is estimated for each cultivar and date
    - This is our independent variable
    - LT_{50} is more stable than other values



Model Prediction Recap

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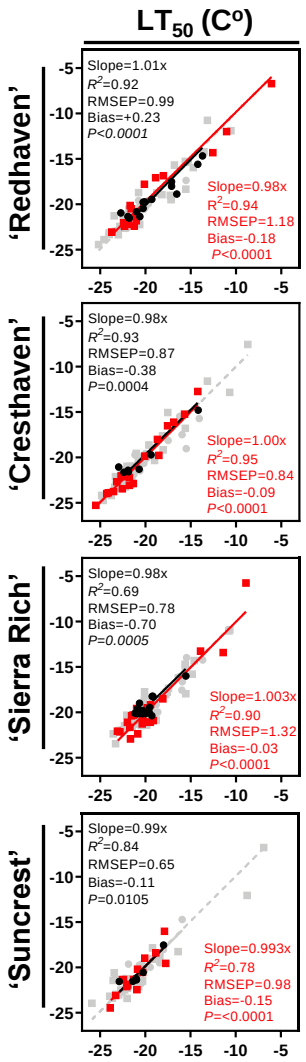
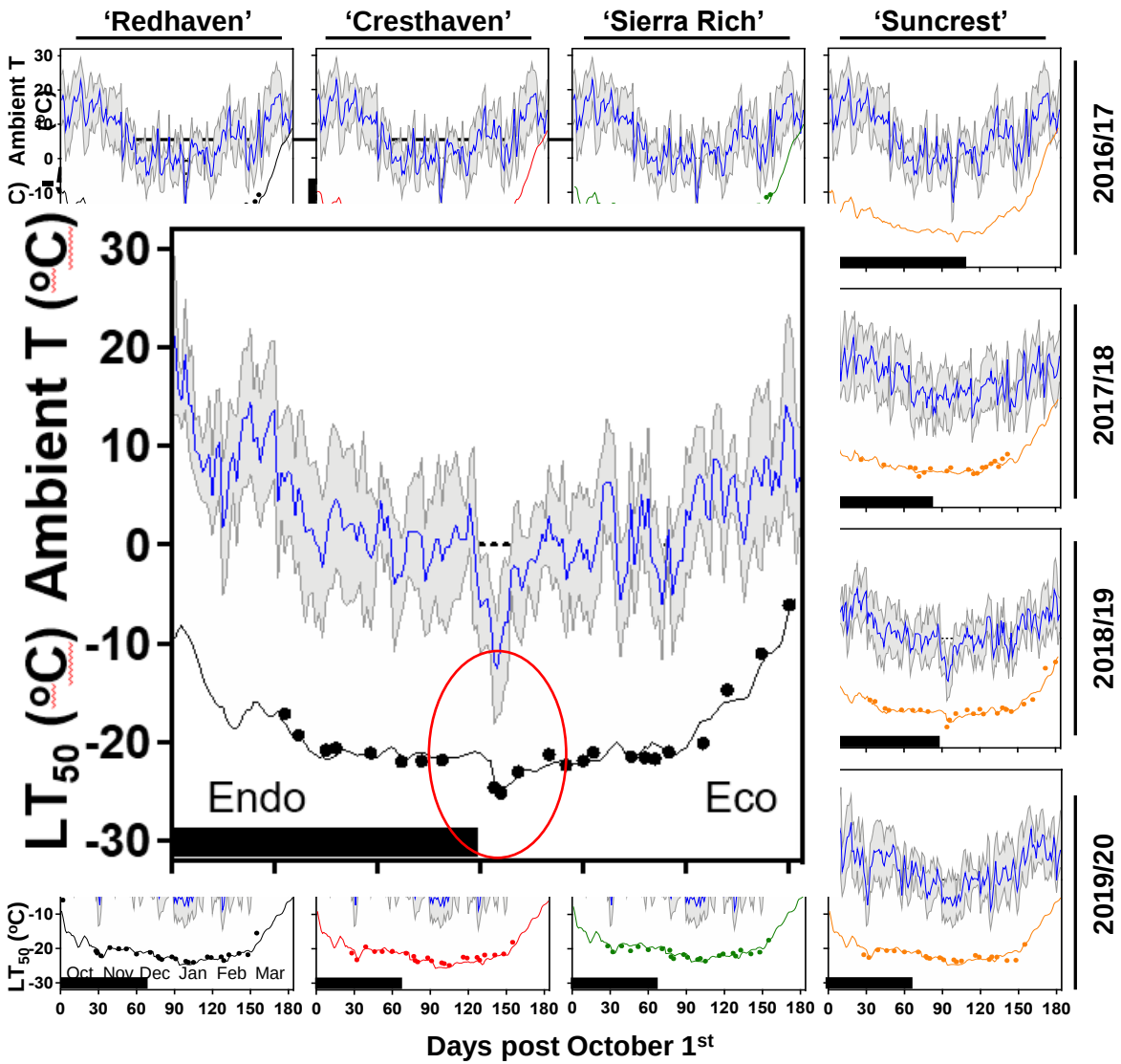


- LT_{50} are predicted very accurately
- RMSEP= error (ºC)

- Endodormancy validation data black
- Ecodormancy validation data red

- Yearly Prediction curves by variety showed great adaptation to different seasonal weather stimuli

- Black line = model prediction
- Black dots = DTA Hardiness data

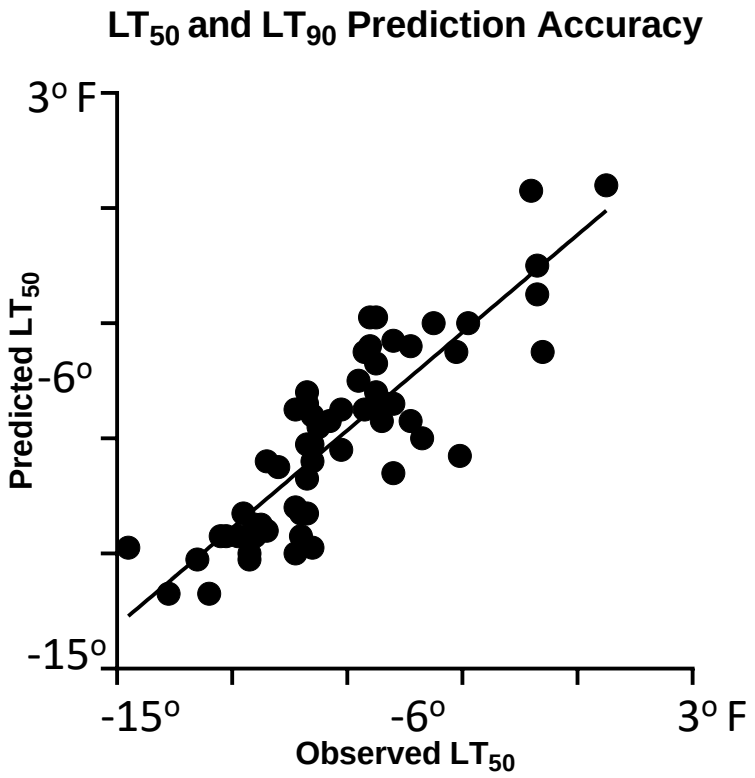


Modelling

- How well do predictions hold for other Colorado Locations?
- 3 Other locations with weather data across 4 years
  - Roger's Mesa, Olathe and Palisade
- Use the weather from the other sites to predict the hardiness using our models

Result

- All three locations LT50 and LT90 Combined
- Average Accuracy = **+/-1.5ºF**
- We consider this accurate enough to base wind machine decisions on
  - Wind machines with a decent inversion usually increase temps 2-4 degrees F



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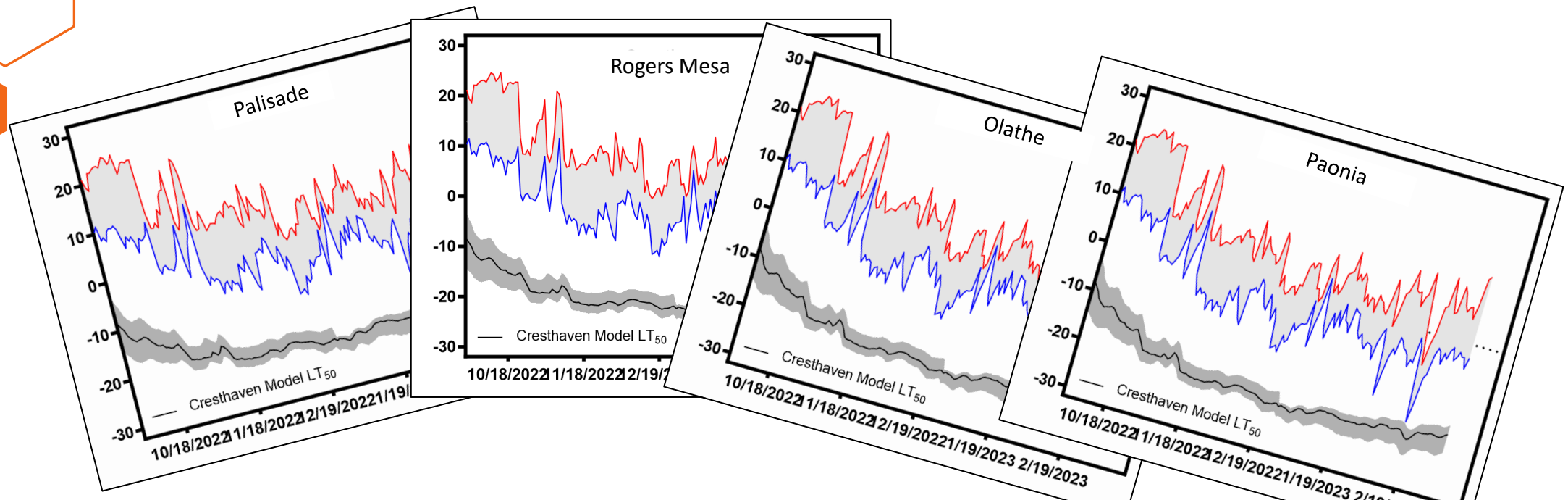
Next Step…

- Next step is linking Coagmet weather stations, daily temperature data with weather models
- Live cold hardiness predictions based on specific weather data from each growing zone
- Collaborating with a computer science colleague on campus



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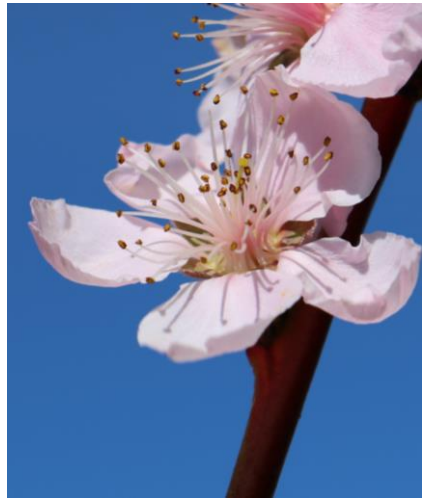
Cold Hardiness Phenology

Bloom Temperature Threshold Recap

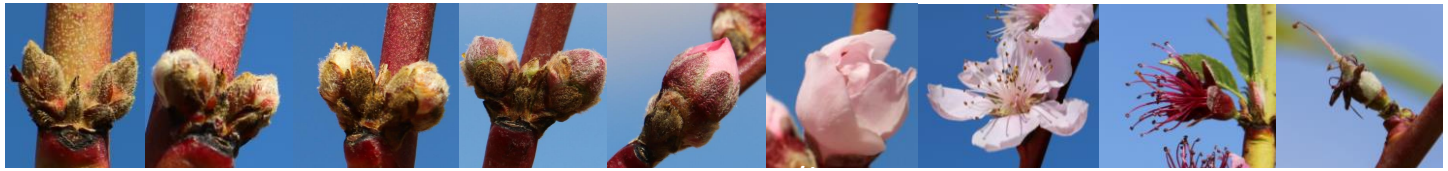
- Older charts are based off Elberta
- I had noticed for several years there were differences in what damage I expected to see at different stages
- Tested each stage of ‘Cresthaven’ (small flowers, from MI) and ‘Suncrest’ (Large flowers from CA)



‘Suncrest’

‘Cresthaven’

LT_{50} Phenology Stages (30 min at these temps)



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PEACH FLORAL BUD PHENOLOGY STAGES & CRITICAL TEMPERATURES (ºF)

'Suncrest'

Bud Stage	1-First Swell	2-Green Calyx	3-Red Calyx	4-Pink Tip	5-First Bloom	6-Full Bloom	7-Petal Fall	8-Shuck Split
LT_{10} (ºF)	19	26	27	27	27	28	28	28
LT_{50} (ºF)	10	18	22	23	24	26	27	27
LT_{90} (ºF)	1	10	17	20	22	24	25	25

'Cresthaven'

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Relationships: Moisture, Hardiness, and Stage

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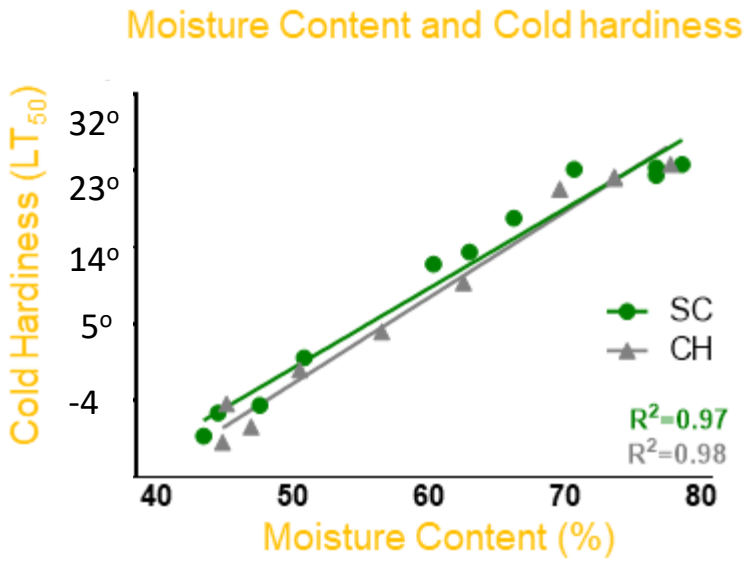
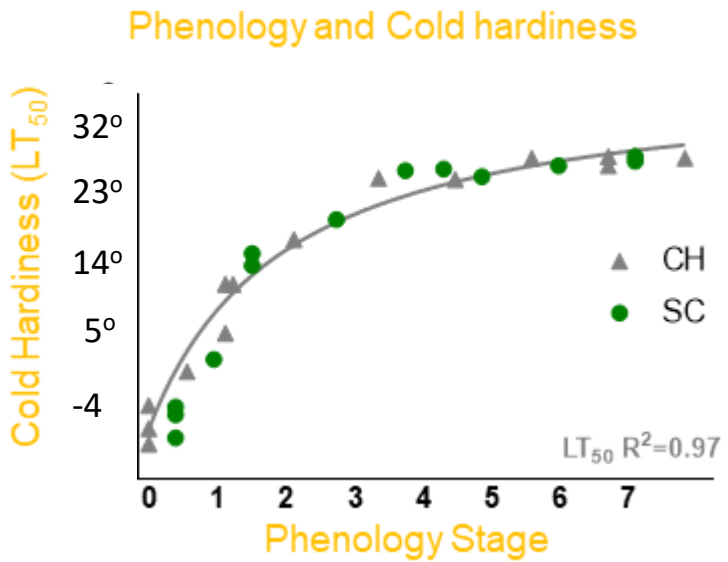
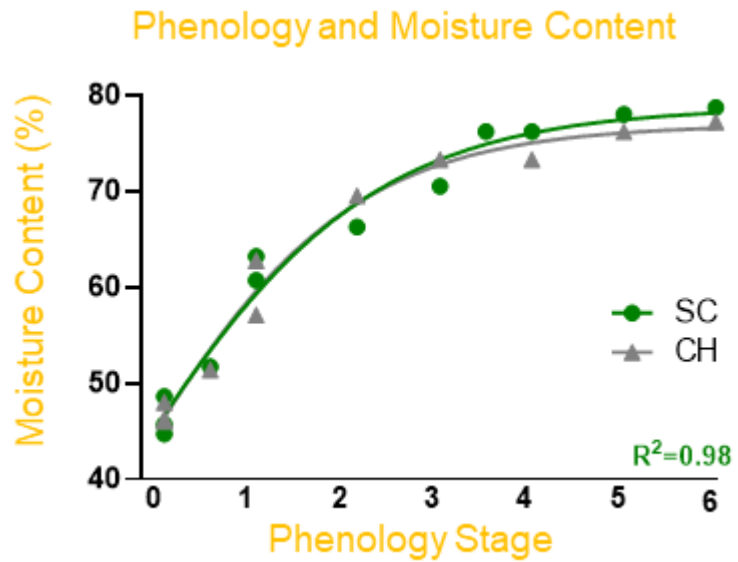
- Both Suncrest (large flower) and Cresthaven (small flower) had the same freezing point at **equal phenology stage**.
- Suncrest started progressing through stages earlier, and were **susceptible longer**.







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Any Questions?