# 51 Peach and Plum

**Where: Grand Gallery Overlook Room G & H**
**Mi Recertification Credits: 2 (1C, COMM CORE, PRIV CORE)**
**CCA Credits: CM (1.5) PM (1.5)**
**Moderator: David Jones, Michigan State University Extension**

**9:00 AM** **Pre- and Post-Harvest Quality of Peach and Plum**
- Ioannis Minas, Colorado State University

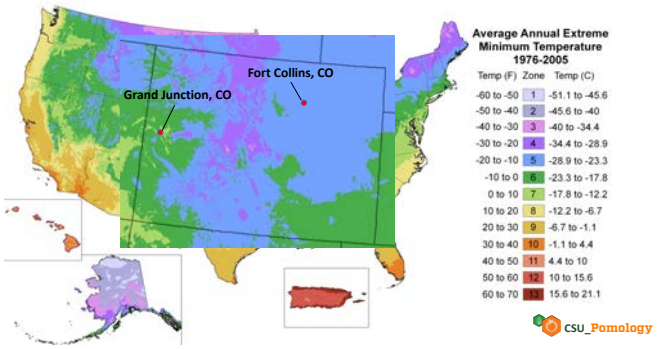
**9:30 AM** **Frost Protection Options in Tree Fruit Crops**
- Hemant Gohil, Rutgers Cooperative Extension - Gloucester County

**10:00 AM** **Peach Cold Hardiness**
- Ioannis Minas, Colorado State University

**10:30 AM** **New Insights on Oriental Fruit Moth Monitoring in Michigan Peach Orchards**
- David Jones, Michigan State University Extension

**11:00 AM** **Session Ends**


## USDA-Plant Hardiness Zones Map




## Mitigating cold damage in Colorado tree-fruit

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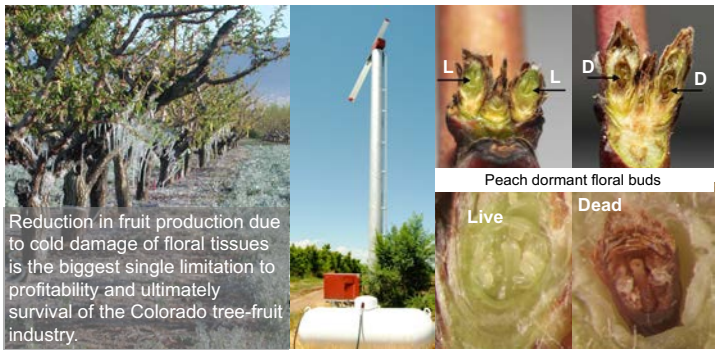



Reduction in fruit production due to cold damage of floral tissues is the biggest single limitation to profitability and ultimately survival of the Colorado tree-fruit industry.

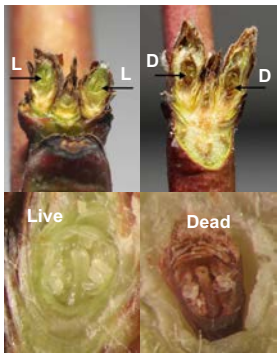
Peach dormant floral buds

## Objectives

- Develop reliable tools (other than oxidative browning) to determine lethal temperatures of peach floral buds of different cultivars under CO climatic conditions
- Evaluate horticultural practices and genetic material to mitigate or avoid cold damage
- Develop cold hardiness prediction models based on weather patterns
- Provide growers accurate data during dormant season on cold hardiness status to make informed frost control decisions (i.e., decision-support)
- Understand environmental and molecular bases for peach cold hardiness and damage

## Oxidative browning method (standard)

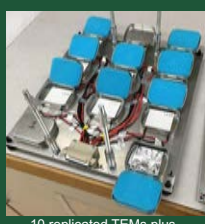
- Following freezing, the buds are held at room temperature (70°F) for 24 h
- Using a single-edged razor blade a longitudinal sectioning is made to confirm the injury of the ovary
- Buds with vibrant **green tissue** are judged as **viable** whereas buds with **brown tissue** are judged to be **dead**
- Brown coloration: oxidation of the phenolic compounds being released in the damaged tissues
- Can be performed at any phenological stage
- Labor intensive and not friendly for large data volumes
- Development of prediction models?




## Differential Thermal Analysis (DTA)

- Monitors difference in temperature between sample and a reference thermocouple
- Thermoelectric modules (TEMs) detect temperature gradients generated by the exotherms (methodology described by Mills et al. (2006) AJEV)

10-12 peach buds per TEM



10 replicated TEMs plus one reference

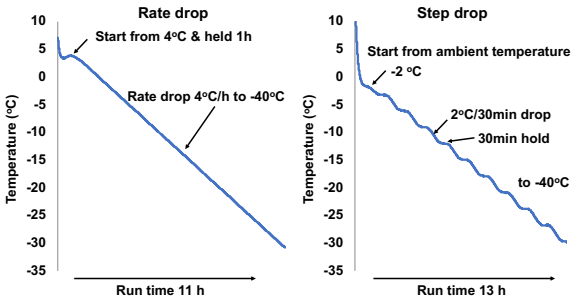
## Experimental approach

- Fifteen 8-years old 'Sierra Rich', 'Cresthaven' and 'Red Haven' ('Suncrest was added in 2017-18) peach trees (Lovell rootstock) located at the CSU's experimental orchard in WCRC-OM, Grand Junction, CO
- Dormant buds were collected weekly or 2 times per week from shoots of moderate vigor and placed in a container that had been previously cooled to 4°C
- Buds were separated and randomly assigned to 15 sets of 10 buds per cultivar (150 buds)
- Five sets (50 buds) were kept as a control (not frozen) for visual evaluation of oxidative browning to check variability and dead material that was present in the orchard
- The remaining 10 sets per cultivar (100 buds) were used for DTA

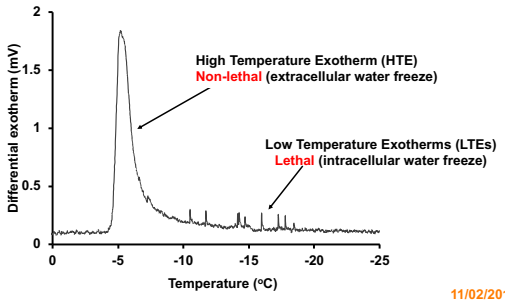
## Differential Thermal Analysis (DTA)


- Programmable freezer (Tenney Jr Test Chamber, Thermal Product Solutions)
- For each TEM a voltage signal that corresponds to the temperature at which super cooled water in the bud tissue freezes is being send to an output directly to an Excel spreadsheet through a data logger

**Question:** Does the T drop method affects hardiness estimation?
**Answer:** No for the T drop methods tested
**Method selected:** Rate drop (4°C/h)

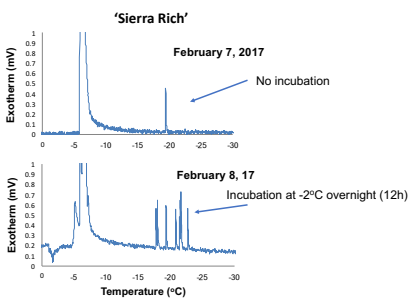



## DTA on 'Red Haven' peach dormant floral buds

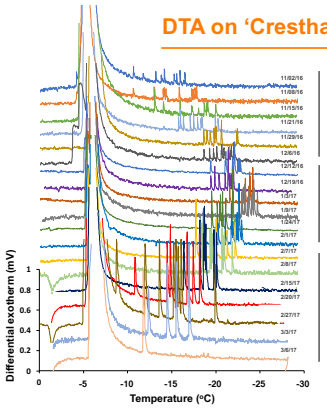



11/02/2016

## Incubation at -2°C overnight (12h) can reversed disappearance of LTEs during deacclimation




## DTA on 'Cresthaven' floral buds

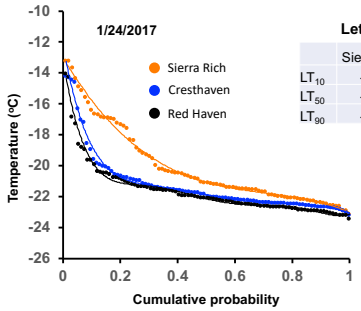



**Acclimation:** the gradual increase of cold hardiness **(Fall – Dec 6th, 2016)**

**Maximum Hardiness** **(Dec 12th - Feb 1st, 2017)**

**Deacclimation:** the decrease of cold hardiness towards bud break **(Feb 7nd - March 6rd, 2017)**

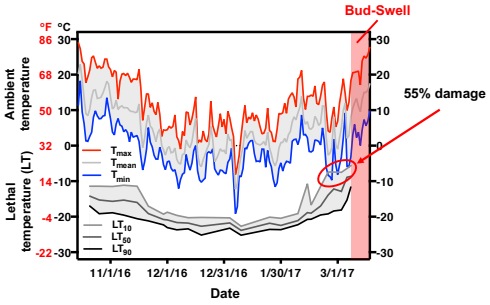
## Critical temperatures for floral bud kill




**Lethal Temperatures (LT, °C)**

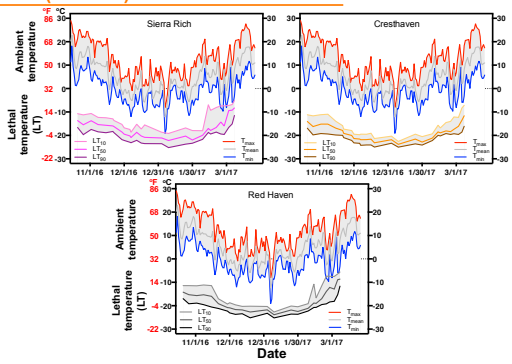
| | Sierra Rich | Cresthaven | Red Haven |
|---|---|---|---|
| $LT_{10}$ | -16.4 | -19.6 | -19.9 |
| $LT_{50}$ | -21.1 | -22.0 | -22.1 |
| $LT_{90}$ | -22.4 | -22.6 | -23.0 |

## 'Red Haven' peach floral buds cold hardiness (Lovell)




Seasonal patterns of temperature and cold hardiness (expressed as lethal temperature, LT) for 'Red Haven' peach floral buds from trees grown at WCRC-OM, Grand Junction, CO

## Peach floral buds seasonal weather and cold hardiness patterns (2016-17)




## Peach bud cold hardiness monitoring updates

http://minas.agsci.colostate.edu/tree-fruit-information/cold-hardiness/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**Cold hardiness assessment of peach flower buds using differential thermal analysis (DTA) in western Colorado (dormant season 2016-17)**

Ioannis S. Minas*, David Sterle & Horst Caspari

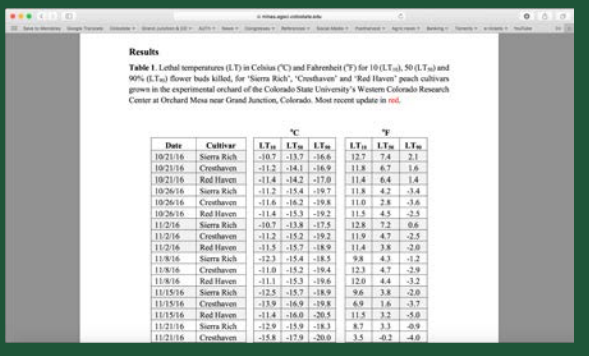
*Colorado State University, Department of Horticulture & Landscape Architecture, Western Colorado Research Center at Orchard Mesa, 3168 B 1/2 Rd, Grand Junction, CO 81503*

**Introduction**

Cold hardiness is influenced by many different factors, including variety, crop load, harvest time and postharvest conditions, and orchard weather conditions. There is a genetically determined limit to cold hardiness. However, while this is true for mid-winter hardiness, the ranking might be different at the start or end of the dormant season. Some varieties will acclimate earlier in fall and will be able to withstand colder temperatures earlier in the dormant season than varieties that have otherwise more mid-winter hardiness. Likewise, early bud-breaking varieties tend to lose their hardiness earlier in spring and might be damaged at warmer temperatures than late-breaking varieties, irrespective of their mid-winter hardiness. Also, cultural practices can have a profound influence if the genetic potential of a given cultivar is achieved. In very general terms, warm temperatures tend to reduce bud hardiness while cold temperatures tend to induce more hardiness

## Peach bud cold hardiness monitoring updates

http://minas.agsci.colostate.edu/tree-fruit-information/cold-hardiness/



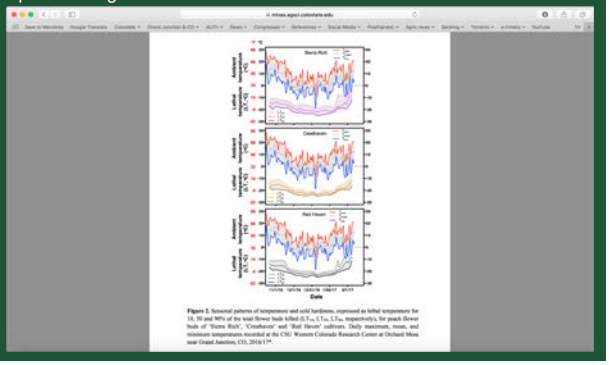
**Results**

**Table 1.** Lethal temperatures (LT) in Celsius (°C) and Fahrenheit (°F) for 10 ($LT_{10}$), 50 ($LT_{50}$) and 90% ($LT_{90}$) flower buds killed, for 'Sierra Rich', 'Cresthaven' and 'Red Haven' peach cultivars grown in the experimental orchard of the Colorado State University's Western Colorado Research Center at Orchard Mesa near Grand Junction, Colorado. Most recent update in red.

| | | °C | | | °F | | |
|---|---|---|---|---|---|---|---|
| Date | Cultivar | $LT_{10}$ | $LT_{50}$ | $LT_{90}$ | $LT_{10}$ | $LT_{50}$ | $LT_{90}$ |
| 10/21/16 | Sierra Rich | -10.7 | -13.7 | -16.6 | 12.7 | 7.4 | 2.1 |
| 10/21/16 | Cresthaven | -11.2 | -14.1 | -16.9 | 11.8 | 6.7 | 1.6 |
| 10/21/16 | Red Haven | -11.4 | -14.2 | -17.0 | 11.4 | 6.4 | 1.4 |
| 10/26/16 | Sierra Rich | -11.2 | -15.4 | -19.7 | 11.8 | 4.2 | -3.4 |
| 10/26/16 | Cresthaven | -11.6 | -16.2 | -19.8 | 11.0 | 2.8 | -3.6 |
| 10/26/16 | Red Haven | -11.4 | -15.3 | -19.2 | 11.5 | 4.5 | -2.5 |
| 11/2/16 | Sierra Rich | -10.7 | -13.8 | -17.5 | 12.8 | 7.2 | 0.6 |
| 11/2/16 | Cresthaven | -11.2 | -15.2 | -19.2 | 11.9 | 4.7 | -2.5 |
| 11/2/16 | Red Haven | -11.5 | -15.7 | -18.9 | 11.4 | 3.8 | -2.0 |
| 11/8/16 | Sierra Rich | -12.3 | -15.4 | -18.5 | 9.8 | 4.3 | -1.2 |
| 11/8/16 | Cresthaven | -11.0 | -15.2 | -19.4 | 12.3 | 4.7 | -2.9 |
| 11/8/16 | Red Haven | -11.1 | -15.3 | -19.6 | 12.0 | 4.4 | -3.2 |
| 11/15/16 | Sierra Rich | -12.5 | -15.7 | -18.9 | 9.6 | 3.8 | -2.0 |
| 11/15/16 | Cresthaven | -13.9 | -16.9 | -19.8 | 6.9 | 1.6 | -3.7 |
| 11/15/16 | Red Haven | -11.4 | -16.0 | -20.5 | 11.5 | 3.2 | -5.0 |
| 11/21/16 | Sierra Rich | -12.9 | -15.9 | -18.3 | 8.7 | 3.3 | -0.9 |
| 11/21/16 | Cresthaven | -15.8 | -17.9 | -20.0 | 3.5 | -0.2 | -4.0 |

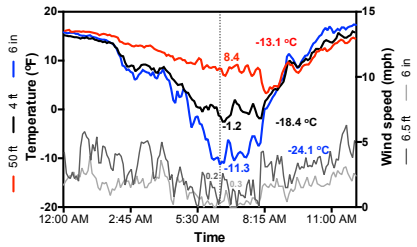
## Peach bud cold hardiness monitoring updates

http://minas.agsci.colostate.edu/tree-fruit-information/cold-hardiness/



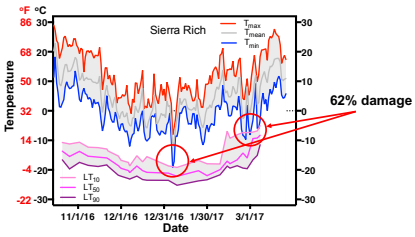

## Mid-winter cold damage early spring frosts and inversions

*DTA Validation*




**Orchard Mesa, CO**
***January 7th, 2017***

## DTA field validation




| Date(s) of event | Actual field damage (%) | DTA Predicted Damage (%) |
|---|---|---|
| January 7, 2017 | 15 | 13 |
| February 24-25-26, 2017 | 23 | 27 |
| March 1 and 7, 2017 | 24 | 22 |


## Peach floral bud phenology stages and critical temperatures (°F)

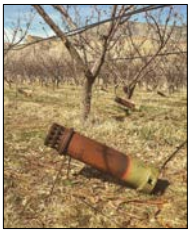
| % kill | Swollen Bud (First Swell) | Calyx Green | 1/4" green (Calyx Red) | Pink (First Pink) |
|---|---|---|---|---|
| 10 | 18 | 21 | 23 | 25 |
| 90 | 1 | 5 | 9 | 15 |

| % kill | First Bloom | Full Bloom | Post Bloom (Petal Fall) | Shuck Split |
|---|---|---|---|---|
| 10 | 26 | 27 | 28 | 28 |
| 90 | 21 | 24 | 25 | 25 |

## Frost Protection systems

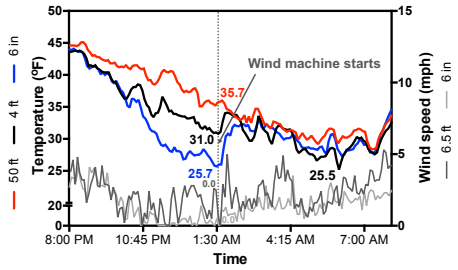
Sprinkler irrigation

Wind machine

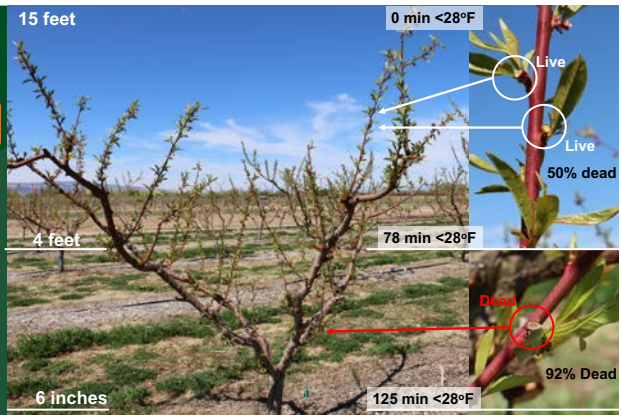


Propane heater

## Spring Frost

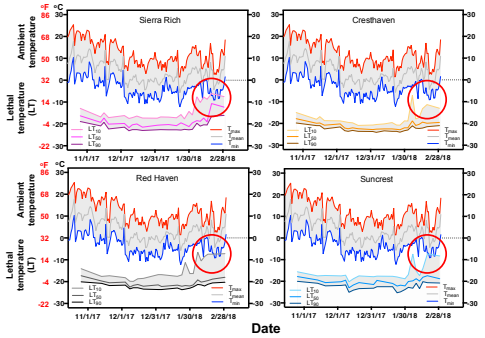



Orchard Mesa, CO
*Night of April 4th to 5th, 2017*





## Peach floral buds seasonal weather and cold hardiness patterns (2017-18) with focus on deacclimation




## Effect of Rootstock on 'Red Haven' peach floral buds acclimation, max hardiness & deacclimation (2017-18)

NC-140

| | Atlas | Bright's Hybrid-5 | Guardian® | Krymsk®86 | Lovell | Krymsk®1 | Date |
|---|---|---|---|---|---|---|---|
| $LT_{10}$ | -14.9 | -14.9 | -14.4 | -13.8 | -15.4 | -15.4 | 11/6/17 |
| | -16.6 | -16.7 | -17.8 | -15.4 | -14.9 | -17.0 | 11/17/17 |
| | -18.4 | -16.7 | -17.8 | -18.6 | -18.7 | -17.9 | 11/28/17 |
| | -18.3 | -19.0 | -16.9 | -15.3 | -19.2 | -18.1 | 12/14/17 |
| | -19.3 | -18.2 | -17.5 | -21.0 | -16.8 | -18.3 | 1/4/18 |
| | -13.6 | -15.0 | -12.7 | -18.4 | -15.3 | -8.2 | 1/24/18 |
| | -8.2 | -7.0 | -8.5 | -8.5 | -6.4 | -6.4 | 2/14/18 |
| $LT_{50}$ | -18.1 | -17.1 | -18.2 | -18.2 | -17.2 | -17.8 | 11/6/17 |
| | -19.3 | -19.0 | -19.5 | -19.4 | -18.6 | -19.0 | 11/17/17 |
| | -19.8 | -19.6 | -19.6 | -19.9 | -20.0 | -19.9 | 11/28/17 |
| | -20.4 | -21.1 | -21.3 | -21.5 | -21.0 | -20.2 | 12/14/17 |
| | -22.6 | -22.3 | -22.5 | -22.9 | -21.5 | -21.9 | 1/4/18 |
| | -20.5 | -22.2 | -22.7 | -22.6 | -22.6 | -21.0 | 1/24/18 |
| | -17.8 | -19.0 | -18.2 | -18.9 | -19.4 | -18.2 | 2/14/18 |
| $LT_{90}$ | -19.1 | -18.8 | -20.1 | -19.8 | -19.5 | -19.4 | 11/6/17 |
| | -20.1 | -20.8 | -20.2 | -20.8 | -20.4 | -20.0 | 11/17/17 |
| | -20.9 | -21.2 | -21.4 | -20.6 | -21.1 | -20.9 | 11/28/17 |
| | -22.1 | -22.0 | -22.5 | -22.1 | -22.4 | -21.8 | 12/14/17 |
| | -23.5 | -23.7 | -24.1 | -23.8 | -23.6 | -21.9 | 1/4/18 |
| | -23.0 | -23.8 | -23.7 | -23.6 | -23.6 | -23.3 | 1/24/18 |
| | -20.9 | -21.4 | -20.9 | -21.3 | -20.9 | -21.0 | 2/14/18 |

**Least hardy:** Atlas and Krymsk®1
**Most hardy:** Guardian, Krymsk 86

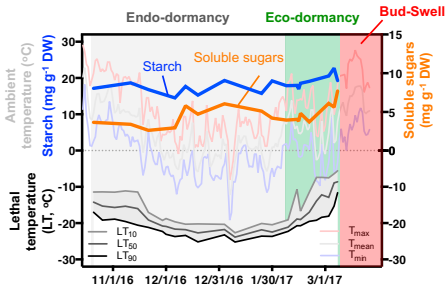
**Early acclimation:** Guardian®, Lovell
**Late acclimation:** Krymsk®86, Atlas, BH-5

**Late deacclimation:** Krymsk®86

## Take home messages!

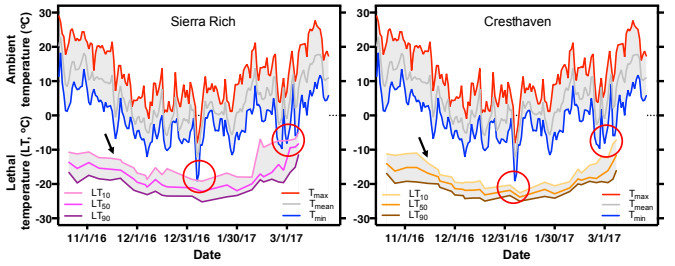
- Peach enters in maximum hardiness following a major frost event
- Peach cultivars tested for 2 seasons do not exhibited any significant mid-winter cold damage (except of 'Sierra Rich' in 2017-18)
- Late January and February deacclimation process prior to visual bud swell can cause severe bud loss (frost protection)
- Different cultivars show different deacclimation speeds (different heat requirements following chilling satisfaction)
- Intermediate cold/heat events at different times during the dormant season can affect differently acclimation/deacclimation process
- Rootstocks affect mainly acclimation and deacclimation timing but maximum hardiness too

## Changes at the biochemical level associated with dormancy transitions




Dormancy phases as described by Lang, 1987. HortScience 22, 817–820

## Metabolomic analysis of floral buds coming from cultivars with distinct cold hardiness responses

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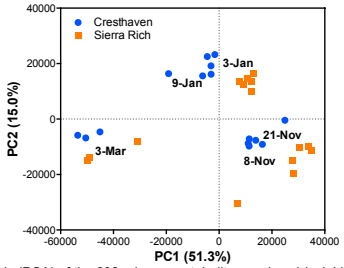
## Metabolite profiling (GC-MS/LC-MS) of peach buds from 'Cresthaven' and 'Sierra Rich' across three phases of dormancy (acclimation: 8-Nov & 21-Nov; maximum hardiness: 3-Jan & 9-Jan; deacclimation: 3-Mar)




Principal component analysis (PCA) of the 232 primary metabolites analyzed (soluble sugars, sugar alcohols, organic acids, free amino acids, free fatty acids, membrane lipids) indicates a genotype x date source of variation in the metabolome

## Conclusions

- DTA predicts accurately mid- and late-winder cold hardiness and damage of peach floral buds
- DTA loses the capacity to determine ice nucleation events as bud development advances in spring
- Overnight incubation at -2°C reversed LTE disappearance in February for up to 1 month
- Sensing and understanding the mechanisms govern the transition from endo-dormancy to eco-dormancy is very important for maximum
- DTA is an objective measure that can accurately identify the transition from eco-dormancy to growth and development in peach floral buds
- Provides reliable data for cold hardiness prediction models development (3-5 years data needed)
- Valuable tool for comparative studies on cultural management practices, rootstocks and cultivars evaluation

## Questions?

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## Acknowledgements

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Western Colorado Horticultural Society

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