Factors Affecting Sweet Cherry Fruit Pitting Resistance/Susceptibility

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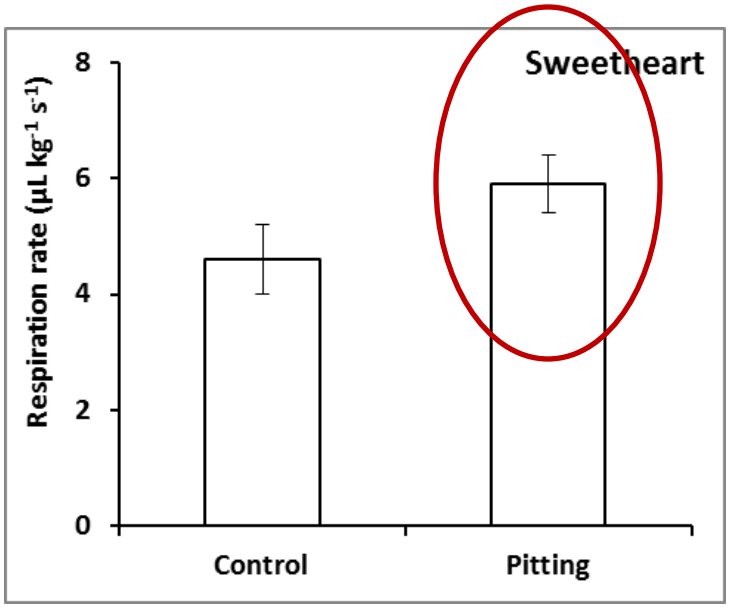
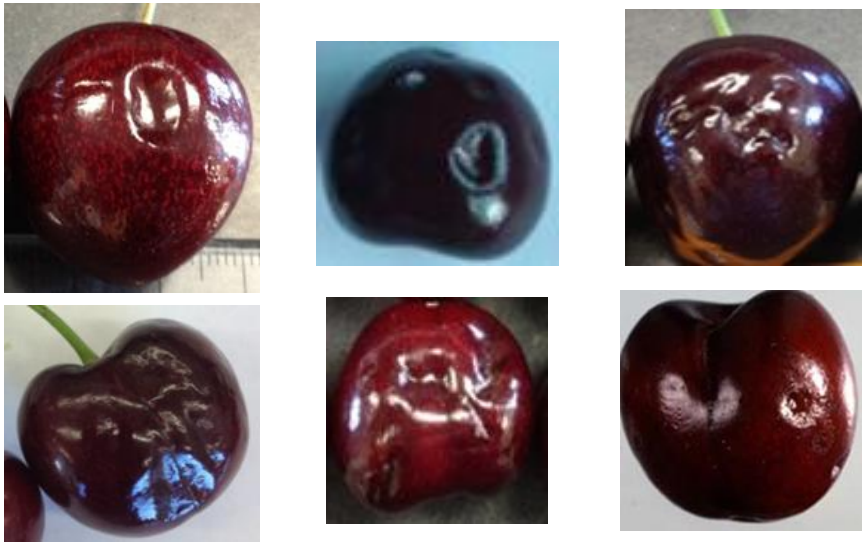
Sweet cherry pitting

- #1 postharvest disorder
- **Pitting not only <u>detract from the appearance</u> but also <u>hasten fruit deterioration</u>**



Rational of the study

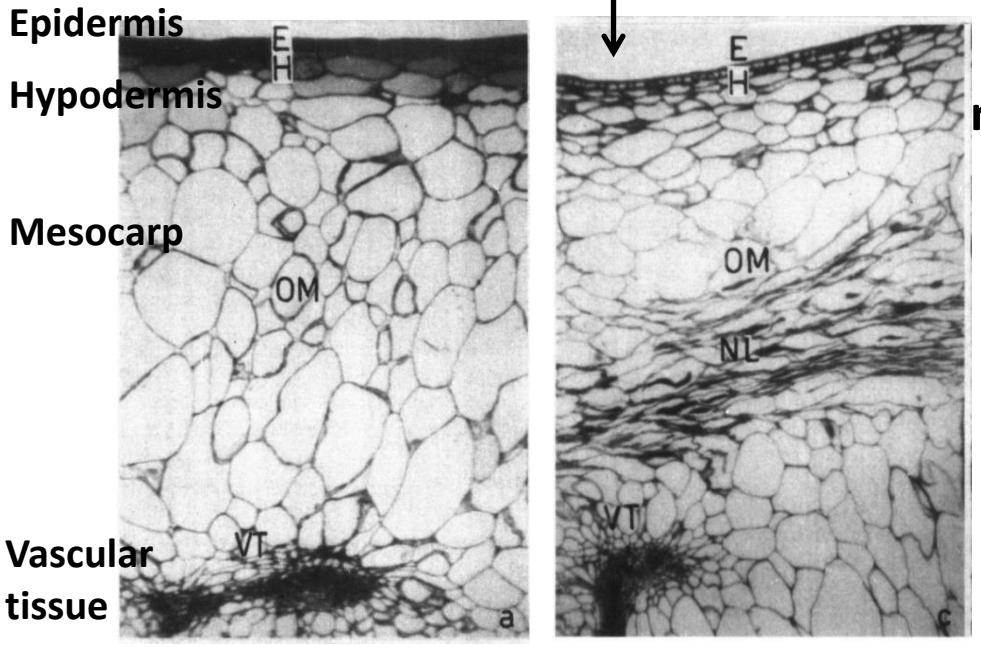
- **However, limited research on pitting of the new late-season cultivars.**
  - **'Sweetheart', 'Lapins', 'Skeena'**
  - Pitting data in literature were generated on Lambert, Van, and Bing, with extremely contradictory results.
- **Both growers and packers need the information on**
  1. **What cause pitting,**
  2. **Factors influence pitting susceptibility,** on the **c**urrent major cultivars.



Scenario of pitting formation

Healthy fruit

Pitting



Wade and Bain, 1980. cv. Ron's Seedling

Impact/compact damage on skin

↓

10 layers of parenchyma cells in mesocarp collapsed and water loss

↓

Necrotic lesion formed after 1-2 weeks in storage/shipping

↓

Skin depression occurred underlied the necrotic lesion

↓

What cause pitting of sweet cherries

- Heat/moisture stresses cause pitting on trees (>90°F for 3d)
  - 'Skeena'
  - 'Regina'

➢ **Mechanical stresses**

Mechanical stress & Pitting

- Picking
  - Pitting generated by
    - Squeezing by hands
    - Fruit-to-bucket
    - Fruit-to-fruit
    - Fruit-to-stem

Mechanical stress & Pitting

- Picking
- Packing line
  - Cluster-cutting
  - Box-filling
    - Fruit-to-fruit
    - Fruit-to-stem
- Transportation:
  - compact damage

Pitting resistance/susceptibility

- However, It is often not possible to avoid all these mechanical stresses during picking, packing, and transportation. Therefore, **increasing fruit pitting resistance** is important.

- **Pre-harvest factors**
  - Pre-harvest GA_3 and Ca^{2+} sprays
  - Harvest maturity
  - Crop load

- **Postharvest factors**
  - Postharvest Ca^{2+} treatment
  - Edible coating
  - Fruit pulp temperature

1. Pre-harvest GA_3, Ca^{2+} applications to increase pitting resistance of sweet cherries

Yan Wang and Todd Einhorn

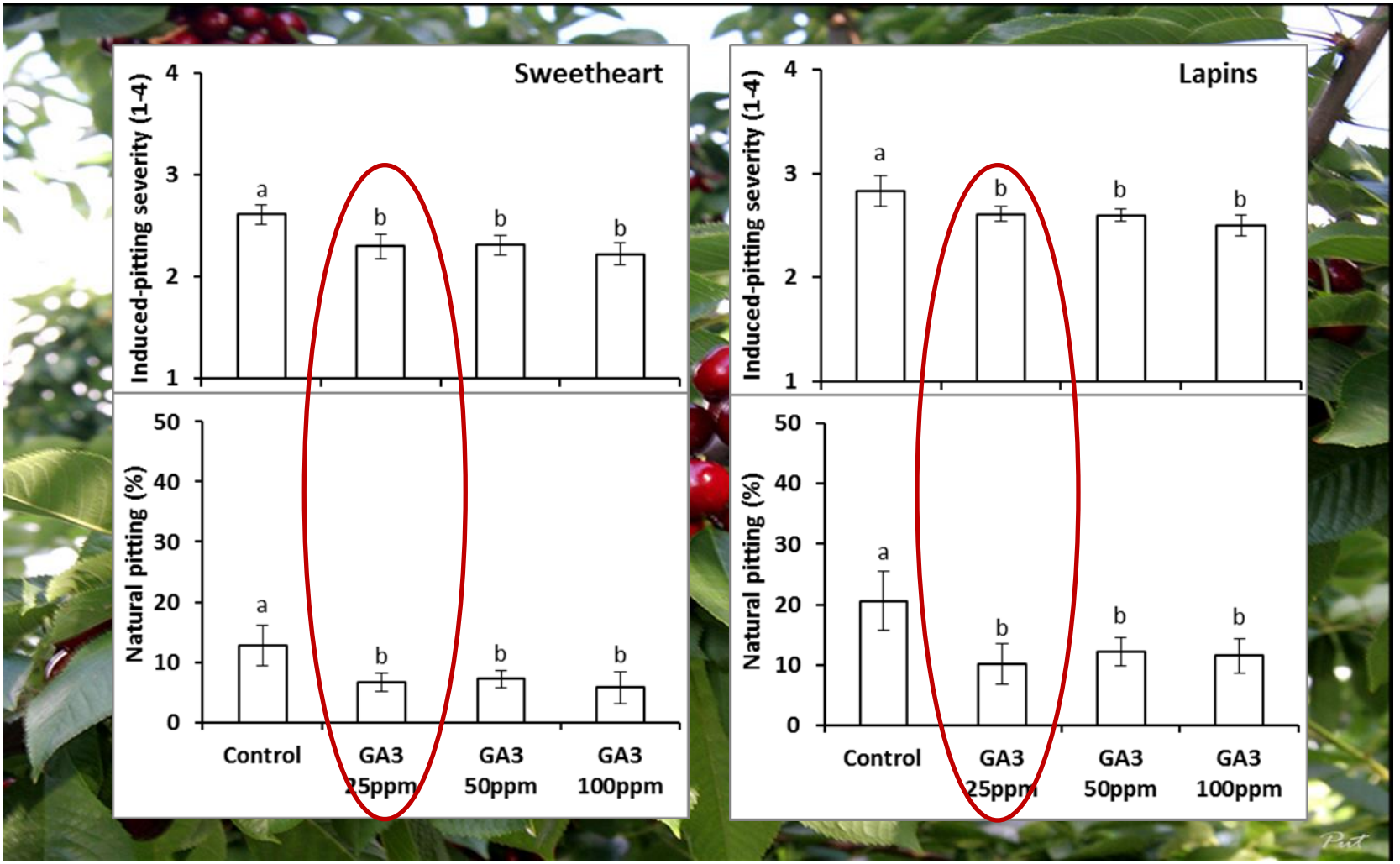
1.1. GA_3 increased fruit firmness

- 'Sweetheart', 'Lapins'
  - Two pitting susceptible cultivars
- Application rate,
- Application frequency,
- Production year,
- Application timing.

GA Rates	2010 Sweetheart	2012 Sweetheart	2012 Lapins
0	380 a	298 b	261 b
0+ surfact.		305 b	250 b
20	417 a		
25		331 a	297 a
30	416 a		
30 (20+10)	418 a		
40	419 a		
40 (20+20)	414 a		
50		345 a	281 a
60	417 a		
60 (20+40)	417 a		
100		352 a	262 b

- **GA_3 increased FF on both cultivars in different years**
- **Response saturated at a single, low rate (20-25 ppm)**
- **There is a wide application window: ±10d from straw color stage**

As a result of the increased FF, GA_3 reduced pitting



- Response saturated at a single, low rate (20-25 ppm)
- Application window: ±10d from straw color stage

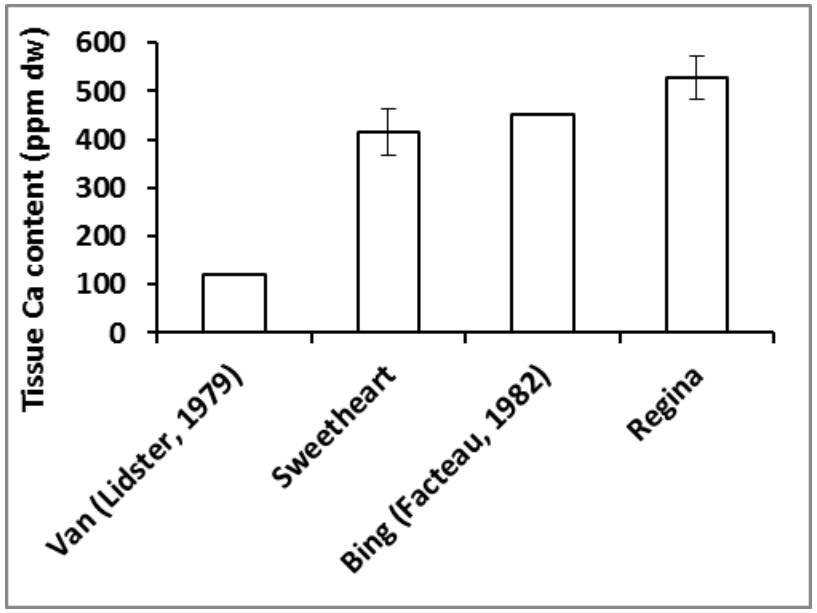
1.2. Pre-harvest calcium (Ca) sprays

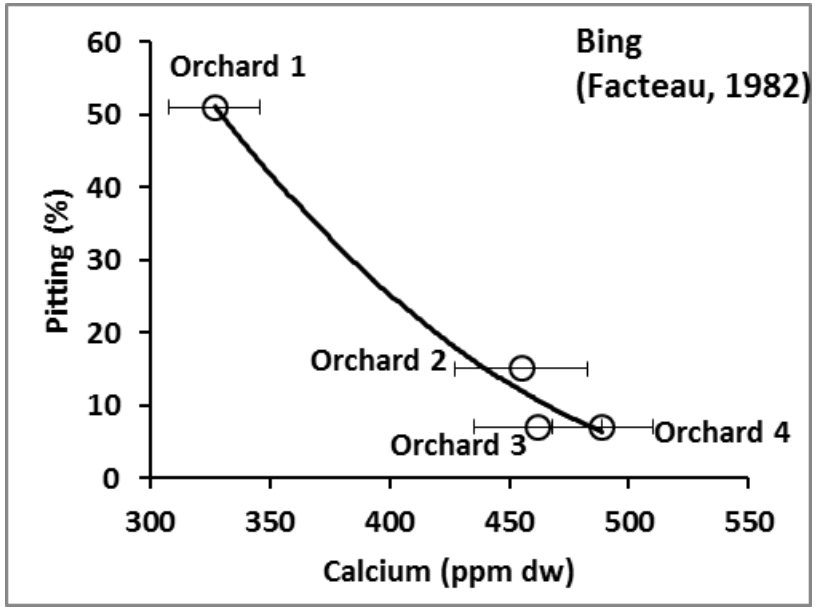
- **Ca plays an extremely important role in the fruit for**
  - Cell wall structure and strength
  - Cell plasma membrane structure and integrity
- **However, fruit are often deficient in Ca due to its low mobility in plants:**
  - Acid soil
    - Ca in soil at low pH (i.e., <6) is not available for root uptake.
  - High growing temperature
    - Inhibit Ca uptake and transportation.
  - Water stress, high humidity
    - Plant uptakes and transports Ca by water flow in xylem.
  - Low crop load
    - Ca tends to move into actively growing leaves and shoots in stead of fruit in the condition of low crop load.
  - High N and K levels……
    - Competition

Tissue Ca content & pitting susceptibility

- **Different cultivars**
  - Pitting susceptible cultivars, like ‘Van’, have low Ca content,
  - Pitting resistant cultivars, like ‘Regina’, have higher Ca content.

- **‘Bing’ from different orchards**
  - Higher Ca content, less pitting,
  - Lower Ca content, more pitting.

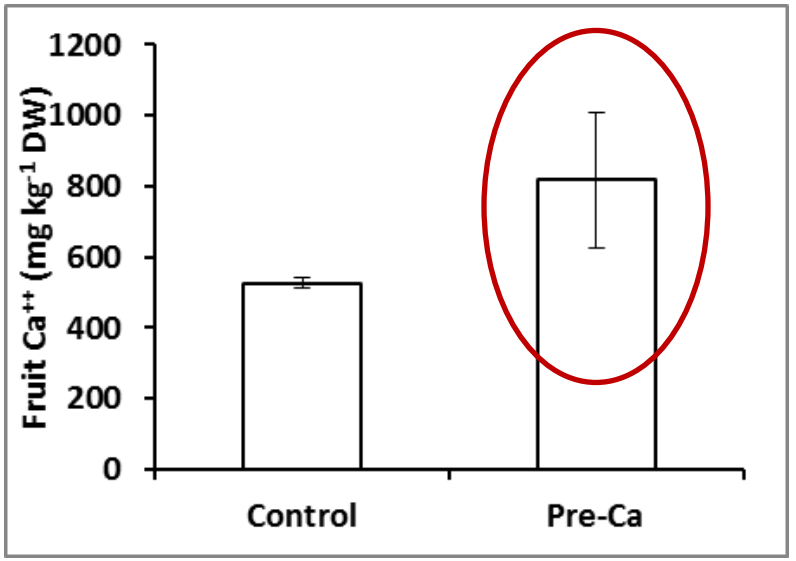




Different orchards: ‘Skeena’

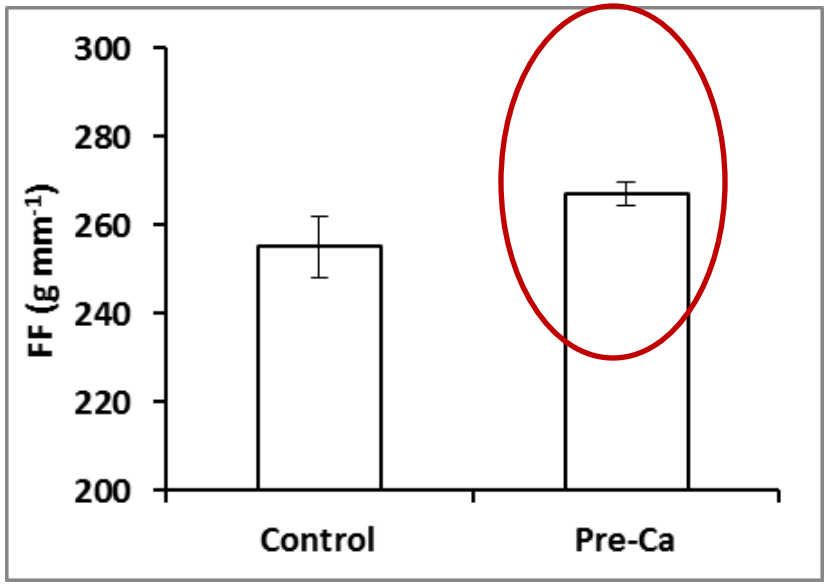
Pre-harvest Ca^{2+} sprays on 'Lapins'

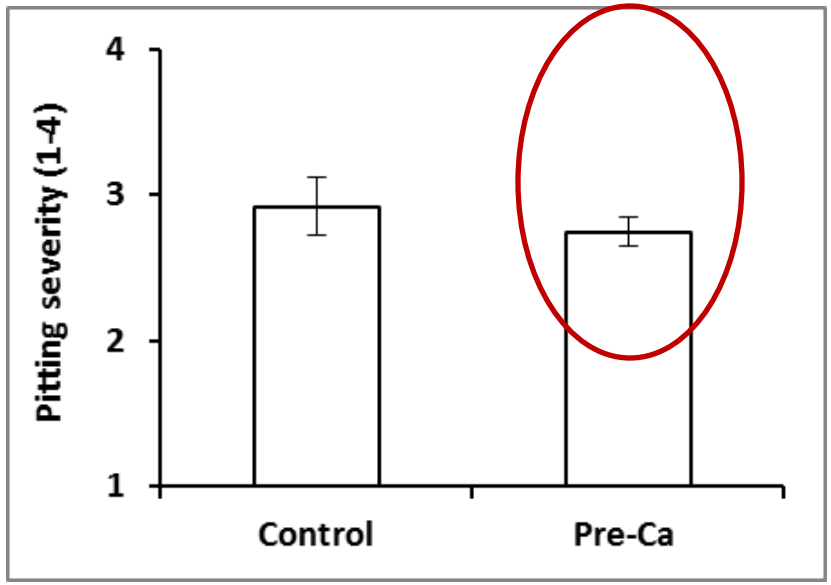
- A preliminary trial: $CaCl_2$ at 0.2% multiple sprays (6) on 'Lapins'
  - **Increased tissue Ca content**



Pre-harvest Ca^{2+} sprays on 'Lapins'

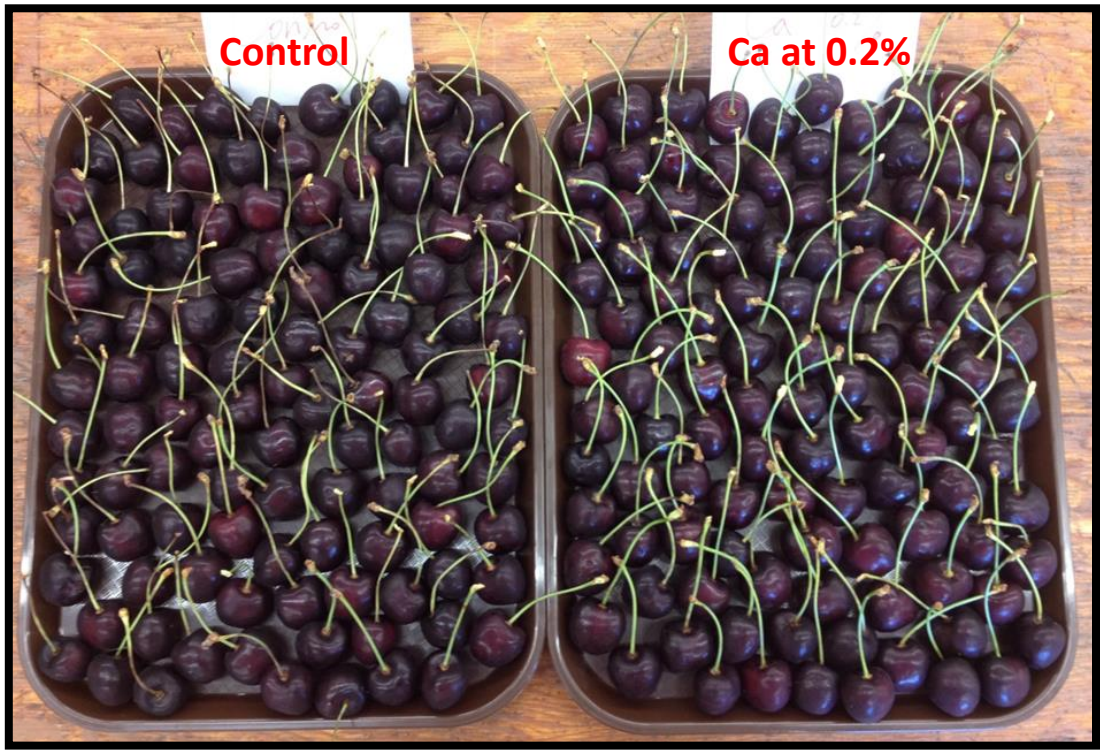
- A preliminary trial: $CaCl_2$ at 0.2% multiple sprays (6) on 'Lapins'
  - Increased tissue Ca content
  - **Increased FF**
  - **Reduced pitting susceptibility**





Pre-harvest Ca^{2+} sprays on 'Lapins'

- A preliminary trial: $CaCl_2$ at 0.2% multiple sprays (6) on 'Lapins'
  - Increased tissue Ca content
  - Increased FF and pitting resistance
  - **Limited pedicel browning after 3 weeks of storage/shipping**



Pre-harvest Ca^{2+} sprays on 'Lapins'

- A preliminary trial: $CaCl_2$ at 0.2% multiple sprays (6) on 'Lapins'
  - Increased tissue Ca content
  - Increased FF and pitting resistance
  - **Limited pedicel browning**
  - **Reduced decay after 4 weeks of storage + 2d at room temperature.**

Pre-harvest Ca^{2+} sprays improve heat resistance

- A preliminary trial: $CaCl_2$ sprays on 'Skeena' before heat stress.
  - Reduced pitting caused by heat stress.

Control

$CaCl_2$ at 0.2%

Need more research on pre-harvest Ca^{2+} sprays

- **To optimize:**

1. **Ca sources:** $CaCl_2$, $Ca(NO_3)_2$, Ca citrate, Ca acetate, Chelated Ca
2. **Application rate**
3. **Application timing**
4. **Application frequency**

2. Harvest maturity affects pitting susceptibility of sweet cherries

Yan Wang and Todd Einhorn

Harvest maturity affects fruit quality

- **As harvest timing delayed:** ‘Sweetheart’ ctifl 3-6; ‘Lapins’ ctifl 4-7
  - Fruit size increased,
  - **SSC accumulated.**

SSC	2012 Lapins	2012 Sweetheart	2013 Lapins	2013 Sweetheart
H1	18.1b	20.2b	14.8c	19.4b
H2	19.5ab	19.3b	16.6b	19.7b
H3	20.3a	21.6a	20.6a	21.8a

- **However, fruit softened.**
  - **‘Sweetheart’ 5.0-6.0**
  - **‘Lapins’ 6.0-7.0**

FF	2012 Lapins	2012 Sweetheart	2013 Lapins	2013 Sweetheart
H1	325a	391a	316a	492a
H2	325a	359b	289a	510a
H3	289b	350b	257b	456b

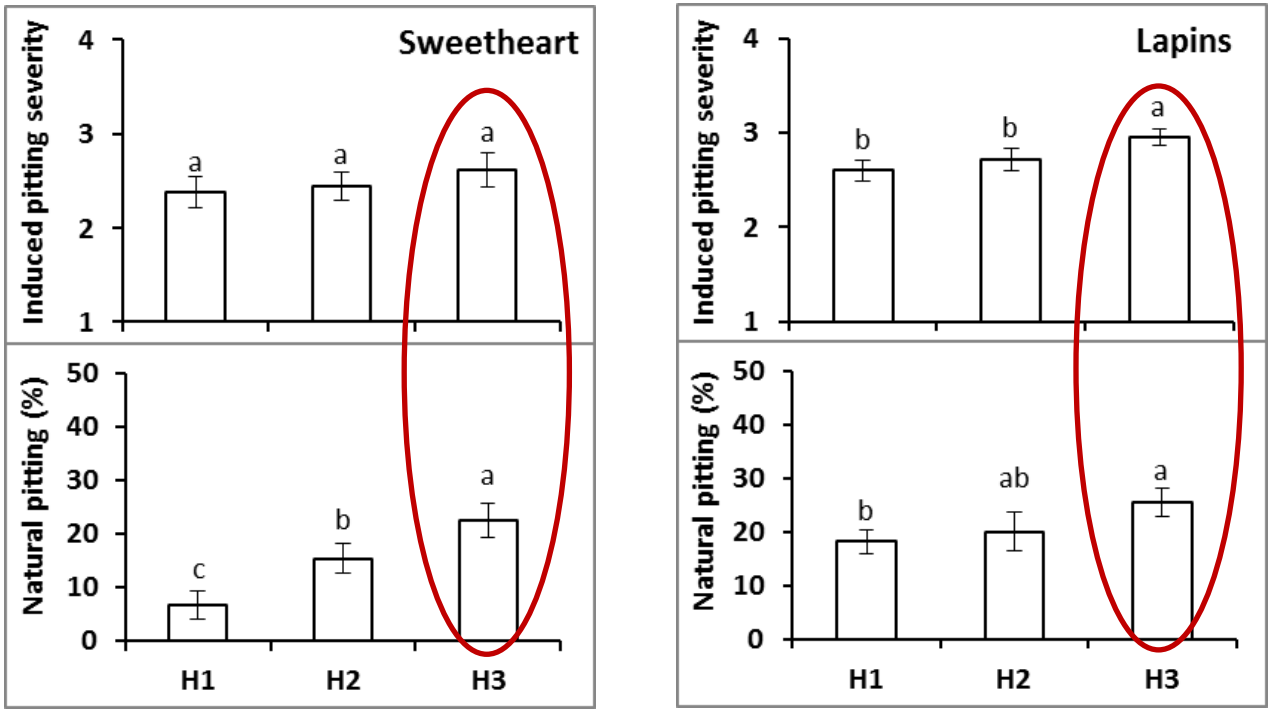
Harvest maturity affects pitting susceptibility

- As harvest timing delayed, ‘Sweetheart’ ctifl 3-6; ‘Lapins’ ctifl 4-7

– **However, fruit softened.**

– **Pitting susceptibility increased.**

  - **‘Sweetheart’ at 5.0-6.0; ‘Lapins’ at 6.0-7.0**

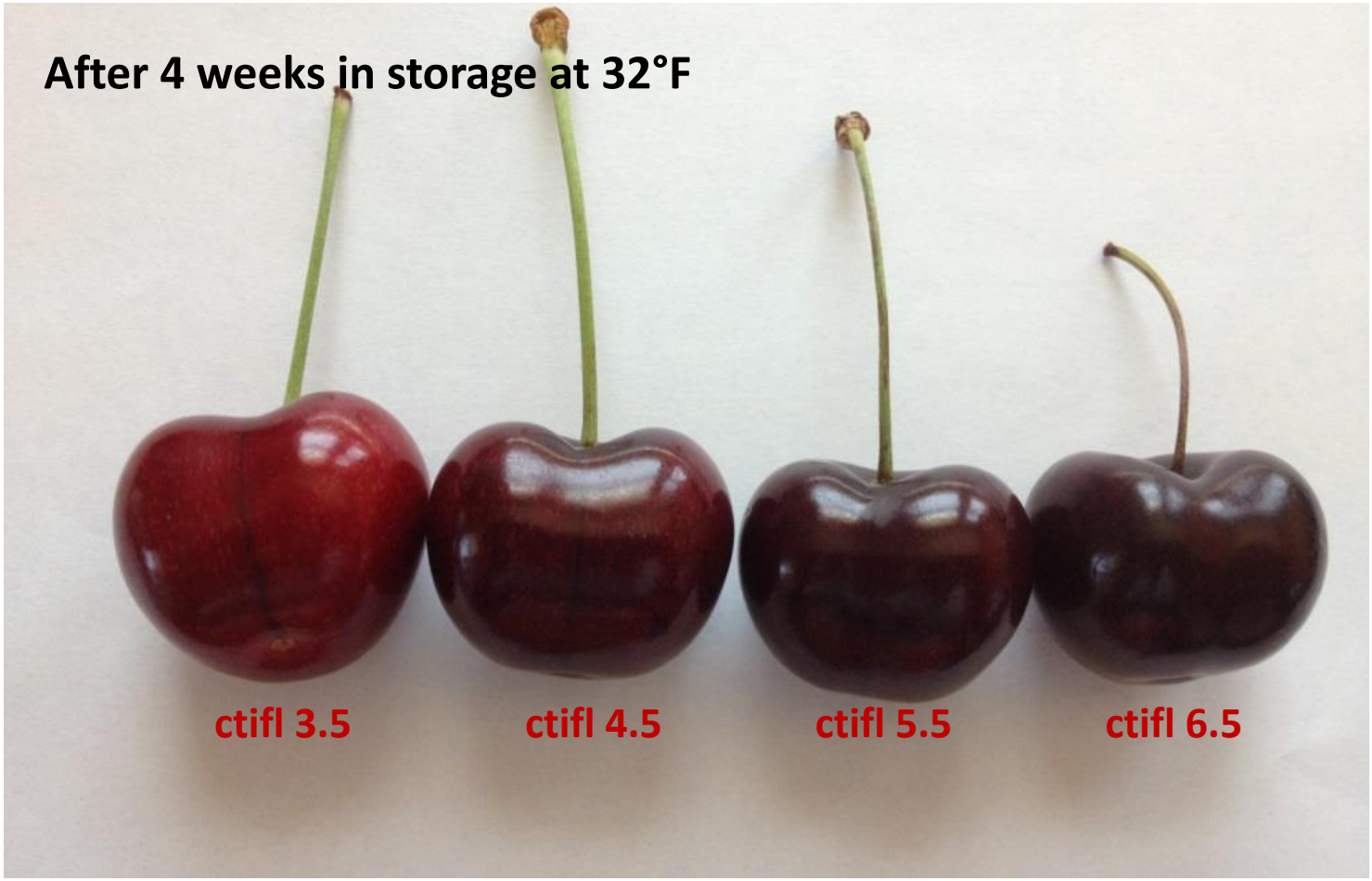


More mature, more susceptible to pitting

- Collected on line

Late harvest

- Pedicel browning: senescence
- Luster color loss



Conclusion (harvest maturity)

- **To balance eating quality and shipping quality:**
  - **'Sweetheart' at ctifl 4.5**
  - **'Lapins' at ctifl 5.5**

- Enough size and sugar,
- Less pitting, better luster, limited pedicel browning after storage/shipping.

3. Crop load (Yan Wang and Todd Einhorn)

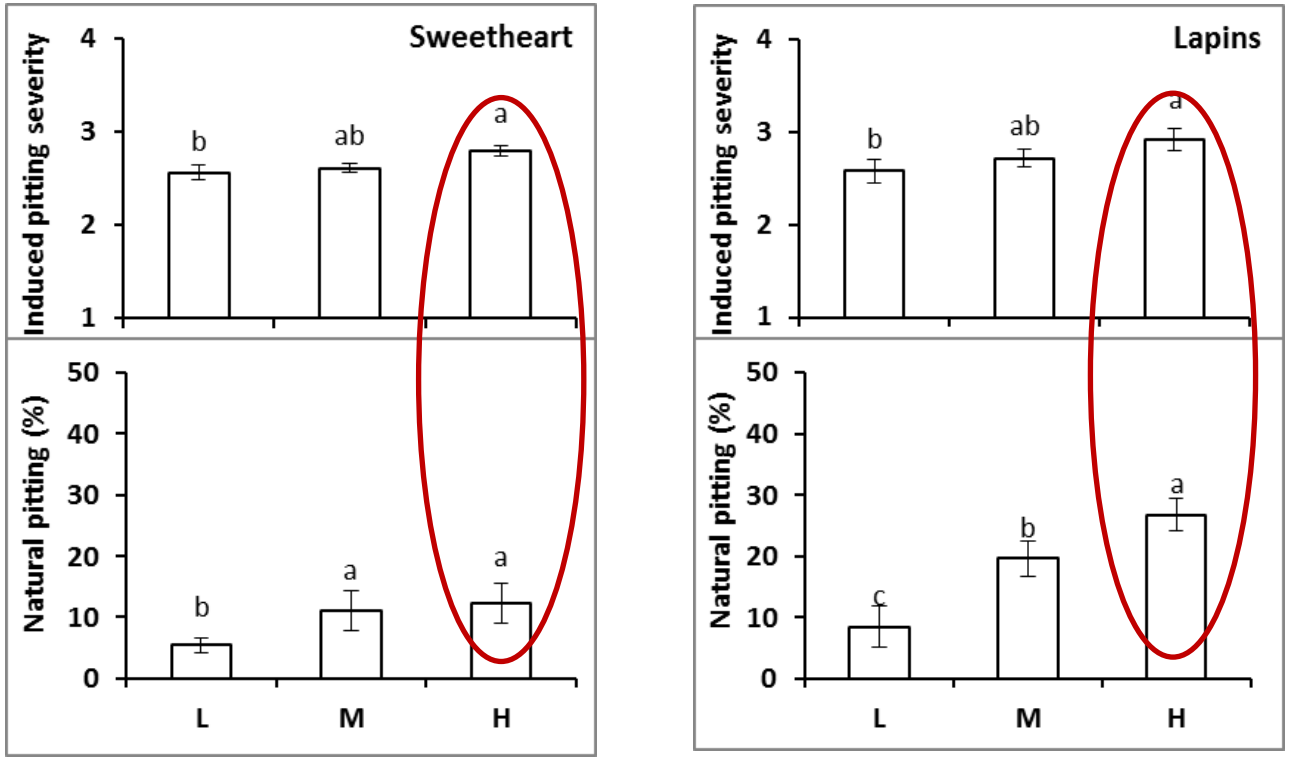
- Three Crop loads:
  - Low = 2-3 fruit/spur; Moderate = 5-7 fruit/spur; Heavy = >10 fruit/spur.

➢ **Heavy crop load reduced fruit size, SSC, and fruit firmness (FF).**

	At harvest					2 weeks at 32 °F				
	FD (mm)	RR (mL kg^{-1} h^{-1})	FF (g mm^{-1})	SSC (%)	TA (%)	FF (g mm^{-1})	SSC (%)	TA (%)	IP (1-4)	PI (%)
					Lapins 2012					
L	30.9a	21.4b	304a	18.7a	0.84a	316a	17.9a	0.60a	2.58b	8.5b
M	29.1b	24.7ab	279b	15.9b	0.82a	295b	15.3b	0.61a	2.72ab	19.6ab
H	27.3c	25.9a	263b	14.3c	0.85a	287b	14.5b	0.55b	2.92a	26.8a
					Lapins 2013					
L	31.4a	22.6b	258a	20.1	0.63	295	20.1	0.55	2.82b	
M	29.3b	23.1b	263a	16.8	0.54	254	16.6	0.47	2.80b	
H	27.2c	28.6a	218b	14.4	0.56	257	16.1	0.46	3.01a	
					Sweetheart 2012					
L	28.9a	16.7b	366a	20.6a	0.87a	388a	21.2a	0.77a	2.56b	5.5b
M	27.0b	16.8b	338b	19.5a	0.89a	365b	19.3b	0.76a	2.61ab	11.1a
H	26.2c	23.5a	329b	17.3b	0.84a	356b	16.9c	0.70b	2.79a	12.3a
					Sweetheart 2013					
L	28.4a	17.6a	409a	22.5a	0.91a	511a	22.1a	0.85a	2.22a	
M	28.2a	18.8a	415a	22.7a	0.85b	520a	21.3a	0.8b	2.28a	
H	27.5a	19.3a	394a	20.5b	0.73c	488b	19.7b	0.71c	2.29a	

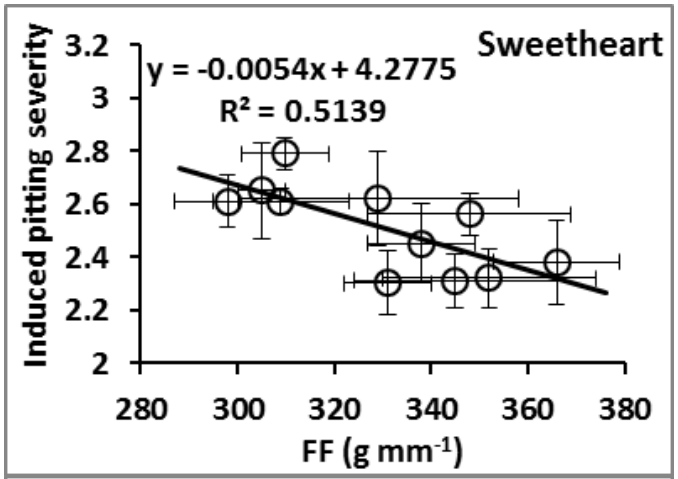
Crop load affects pitting susceptibility

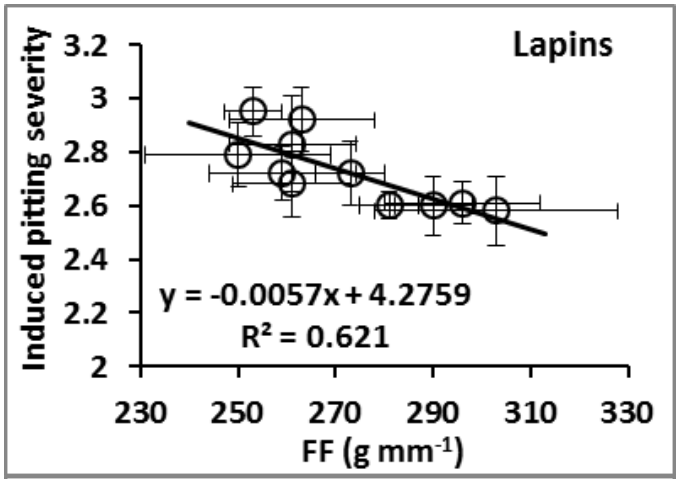
- **Heavy crop load, more susceptible to pitting.**

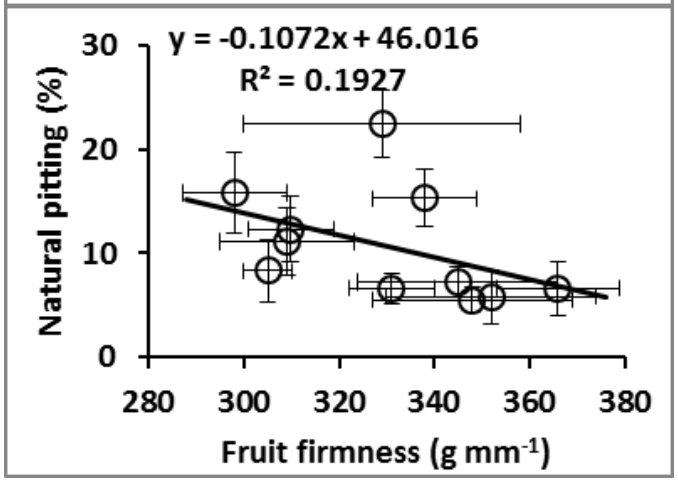


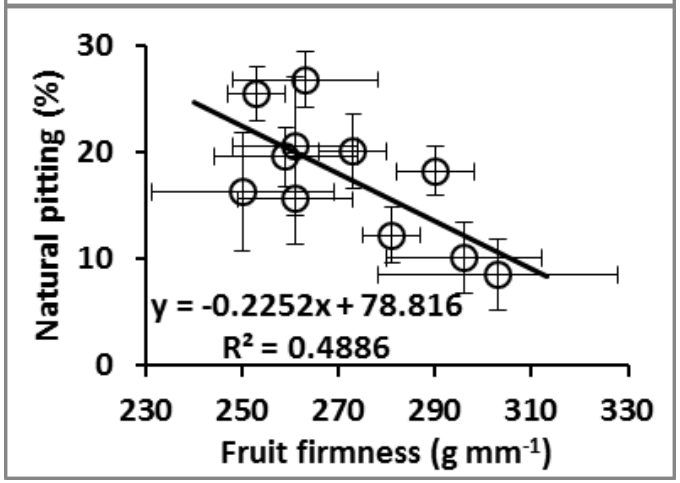
FF is a pitting resistance predictor

- **A wide rang of fruit quality and pitting susceptibility was generated by GA_3, harvest maturity, and crop load treatments:**
  - **FF had a significant negative correlation with pitting susceptibility.**
  - SSC, size, RR, and TA were poorly related to Pitting.









4. Postharvest Ca treatment

- Calcium salts are widely used in food industry.

- **Calcium carbonate**
- **Calcium citrate**
  - Enhance nutritional value

- **Calcium lactate**
- **Calcium chloride**
- **Calcium phosphate**
- **Calcium propionate**
- **Calcium gluconate**
  - Preservation
  - Enhancement of product firmness

Postharvest Ca treatment

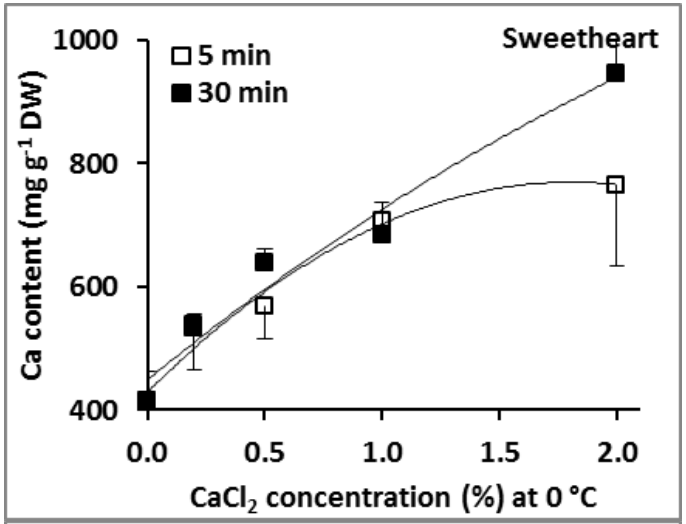
- **Calcium treatments represent a safe and effective method for increasing the quality and storage life of a wide range of fruit.**
  - apple, peach, tomato, cantaloupe, grapefruit, pomegranate, strawberry, papaya…
  - **OptiCAL®**

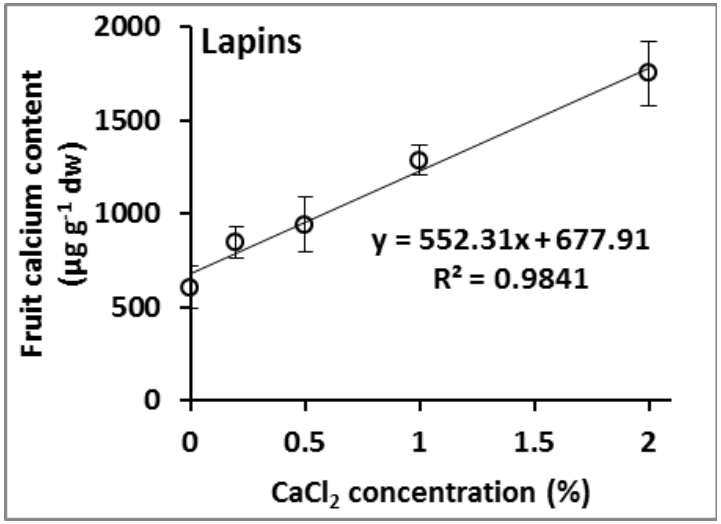
- However, no reports on sweet cherry.

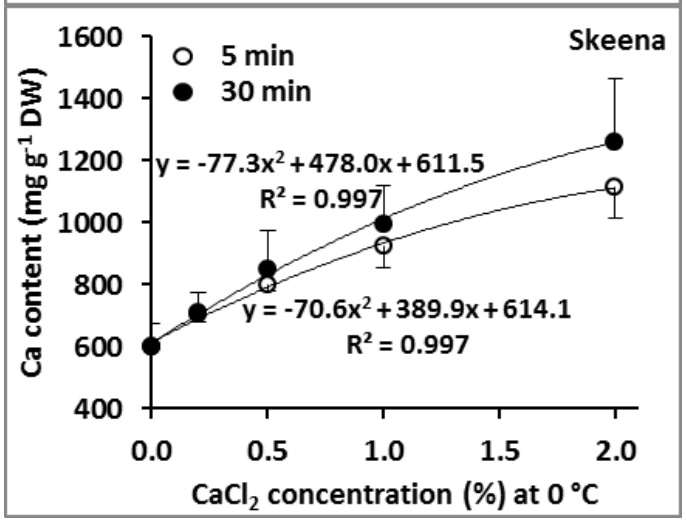
- **Two year study:**
  - The effect of adding OptiCAL® in hydro-cooling water on pitting of sweet cherry

Postharvest Ca treatment and tissue Ca content

- **Opti-CAL®** in hydro-cooling water at 0.2-2.0% for 5 or 30 min.
  - Increase tissue [Ca]
  - Cherry fruit uptake Ca^{2+} pretty fast at low temperature, compared to other fruit.

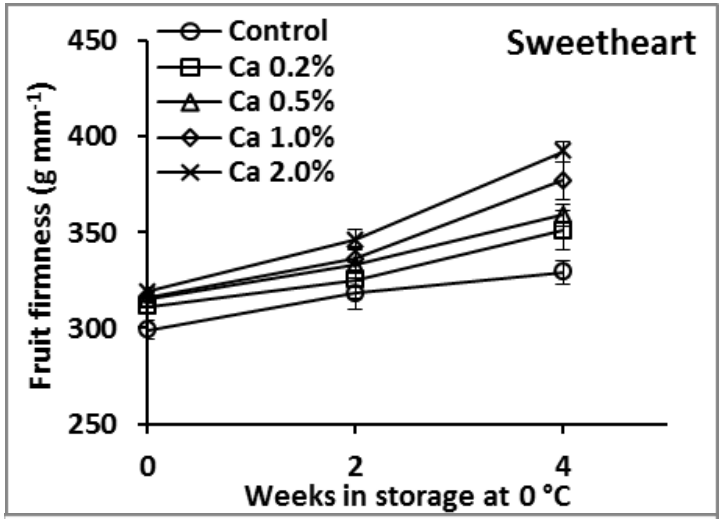


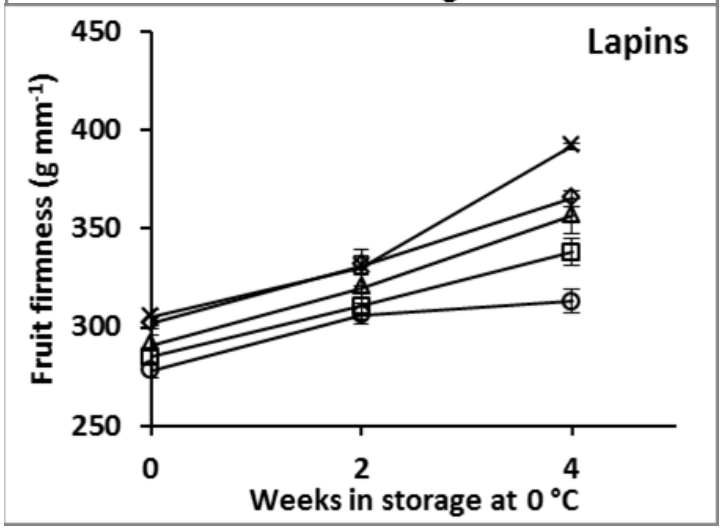


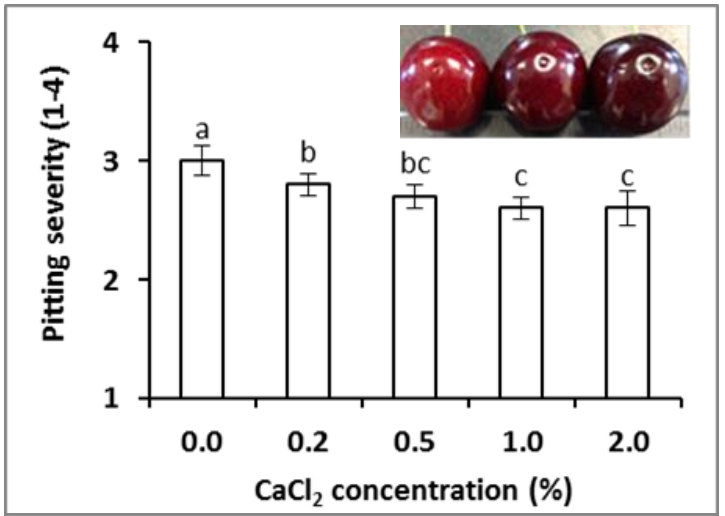


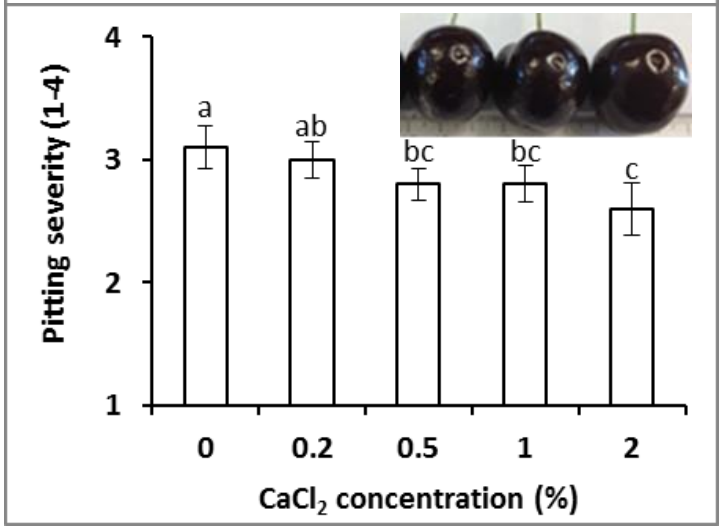
Postharvest Ca treatment and pitting

- **Opti-CAL®** in hydro-cooling water at 0.2-2.0% for 5 min.
  - Increase FF, reduce pitting susceptibility



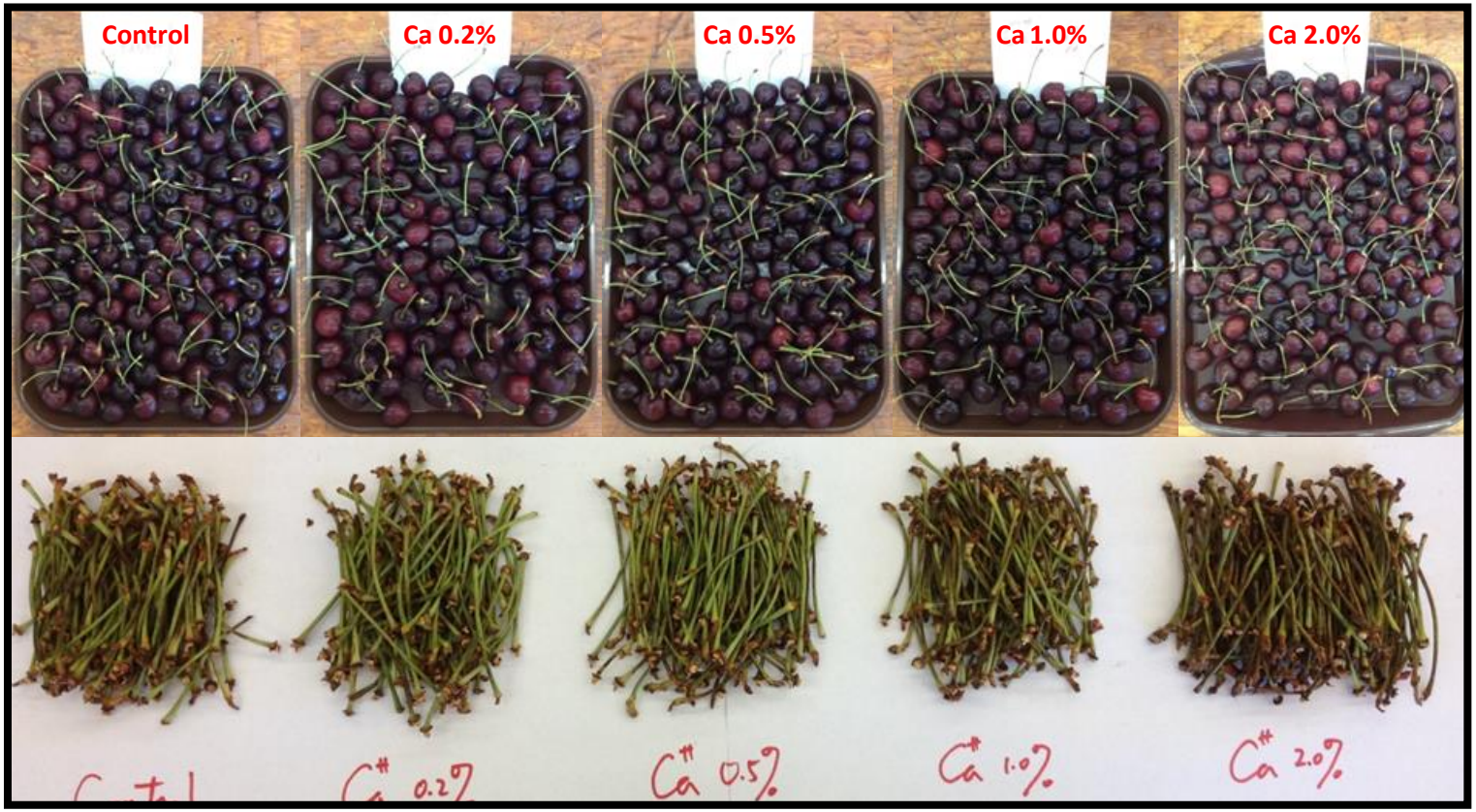






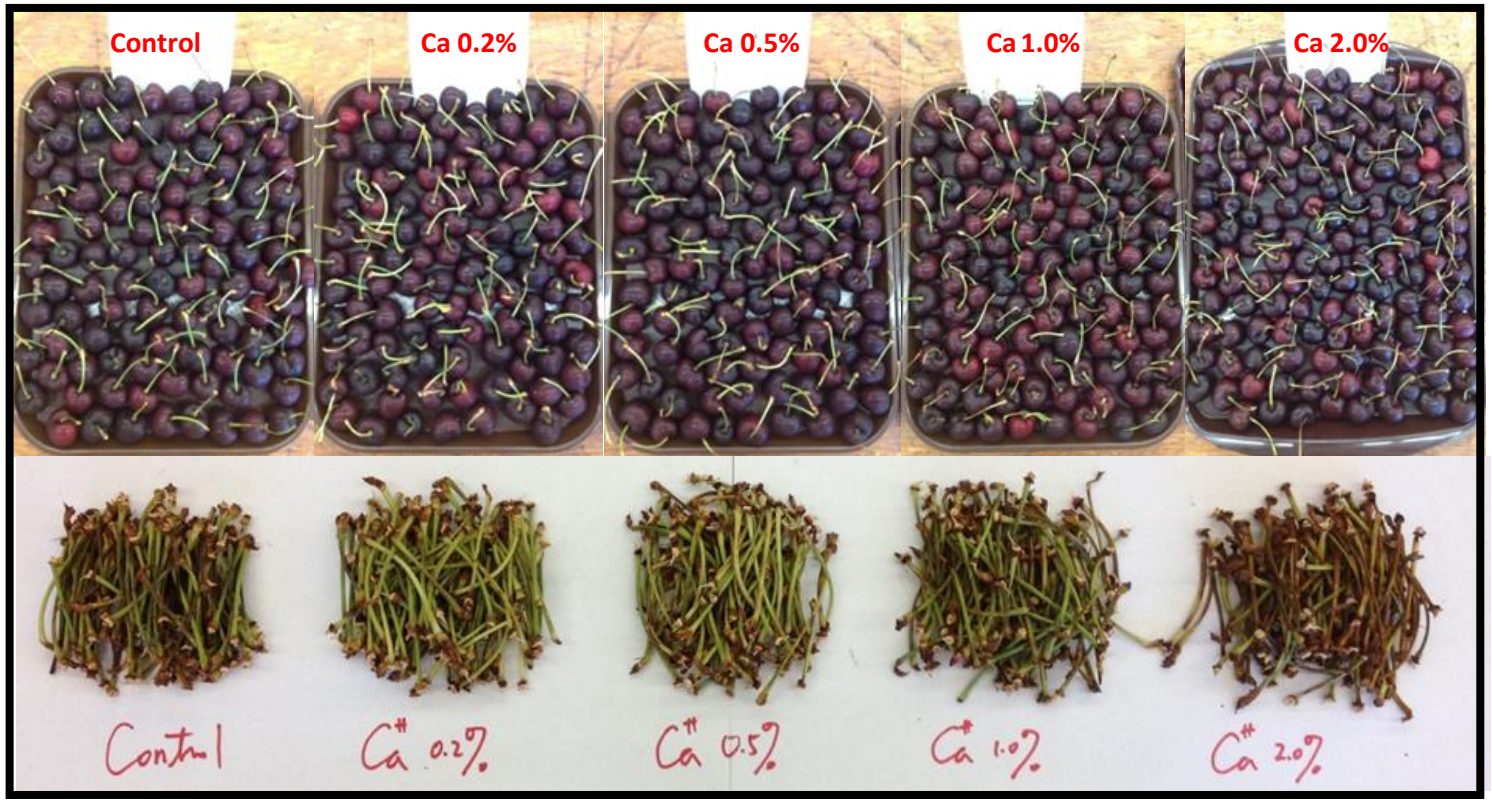
Postharvest Ca treatment and pedicel quality

- Opti-CAL® in hydro-cooling water for 5 min maintained ‘Lapins’ pedicel quality at 0.2-0.5% but damaged pedicel at 1.0-2.0%.



Postharvest Ca treatment and pedicel quality

- Opti-CAL® in cold water for 15-30 min maintained ‘Skeena’ pedicel quality at 0.2-0.5% but damaged pedicel at 1.0-2.0%.



5. Edible coatings

Research reported that the following coatings improve shipping quality of sweet cherries.

- **Semperfresh™**
  - Registered for sweet cherry postharvest use.
- Alginate
  - Brown Algae
- Chitosan
  - Shrimp shells and other sea crustaceans.
- Aloe Vera

Edible coatings

- **Literature indicated that edible coatings improve shipping quality by**

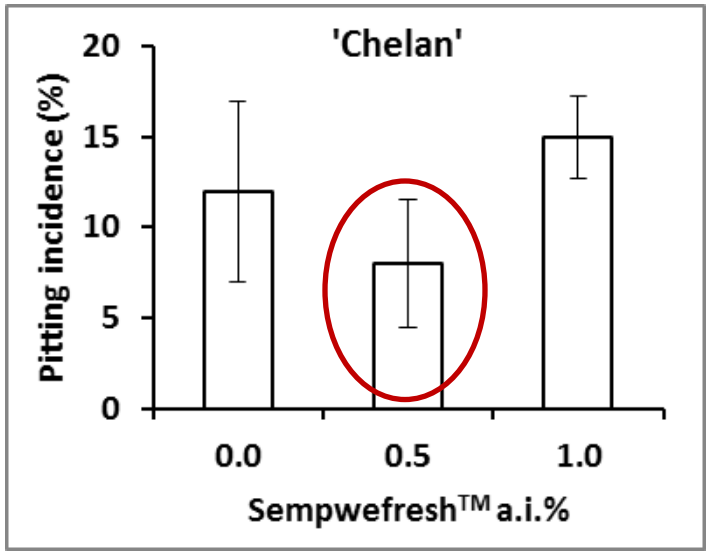
1. Reduce respiration rate
2. Reduce moisture loss
   - Pedicel quality
3. Reduce decay and food safety microbial.

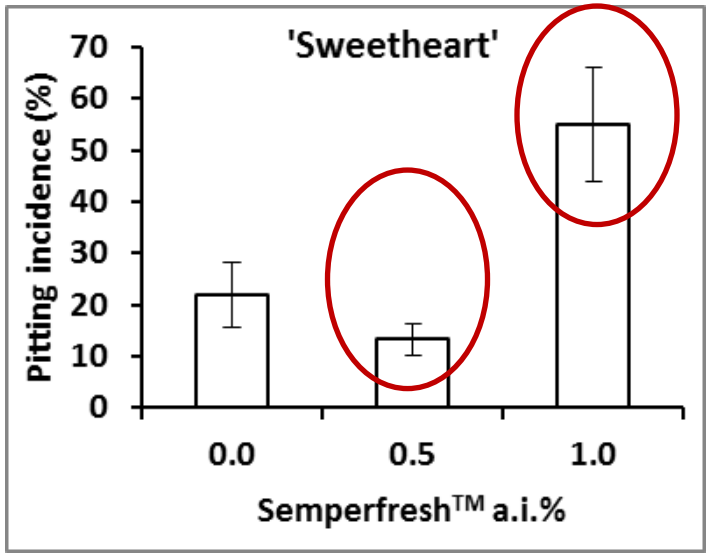
- **We found that edible coating application rates affect pitting expression of PNW sweet cherry.**

Semperfresh™ and pitting

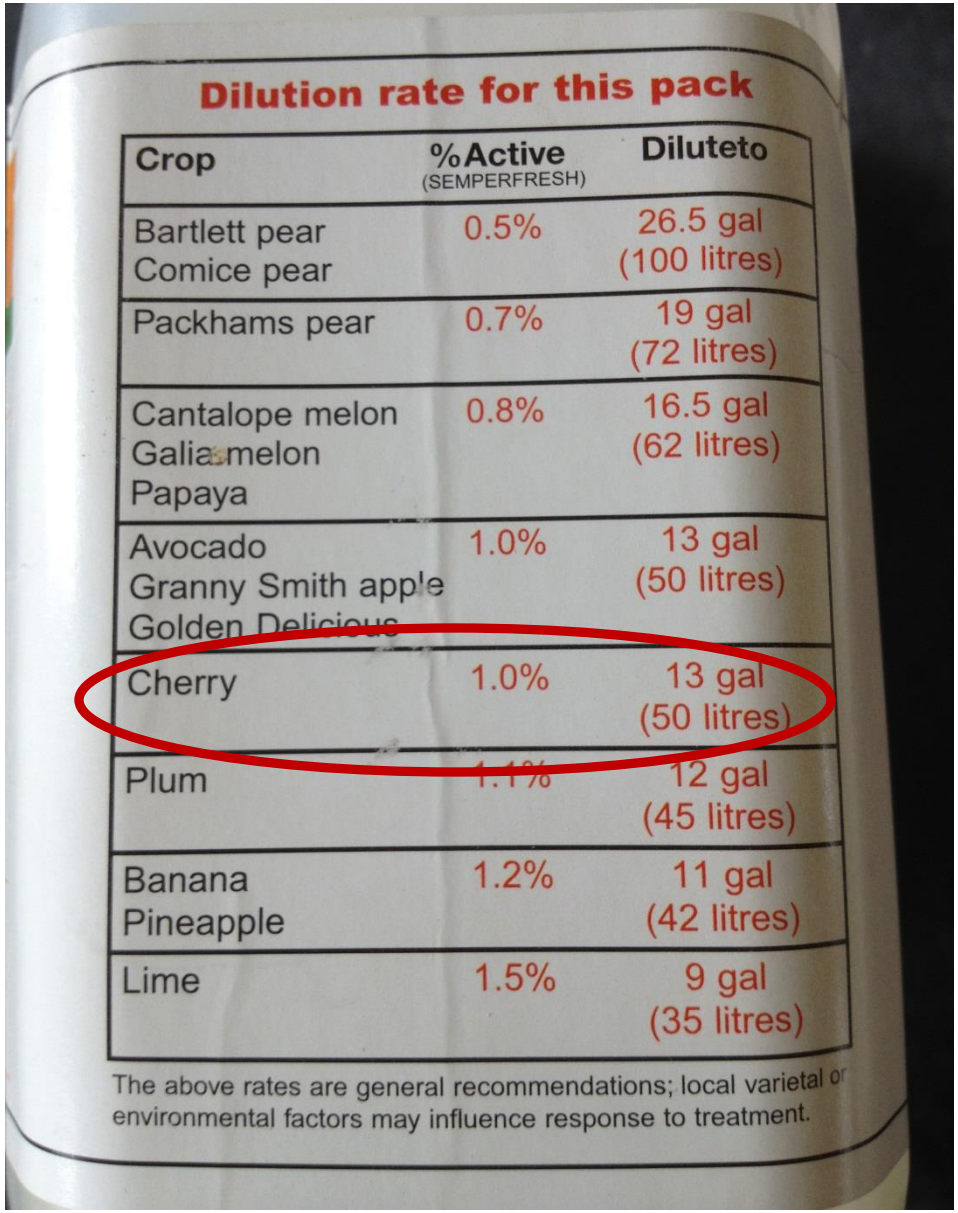
- **Semperfresh™ at 0.5% reduced pitting**
  - **'Chelan'**
  - **'Sweetheart'**
  - Reduced moisture loss

- Higher rate at 1.0% increased pitting of 'Sweetheart'.
  - Localized O_2 deficiency





Semperfresh™ and pitting



Dilution rate for this pack

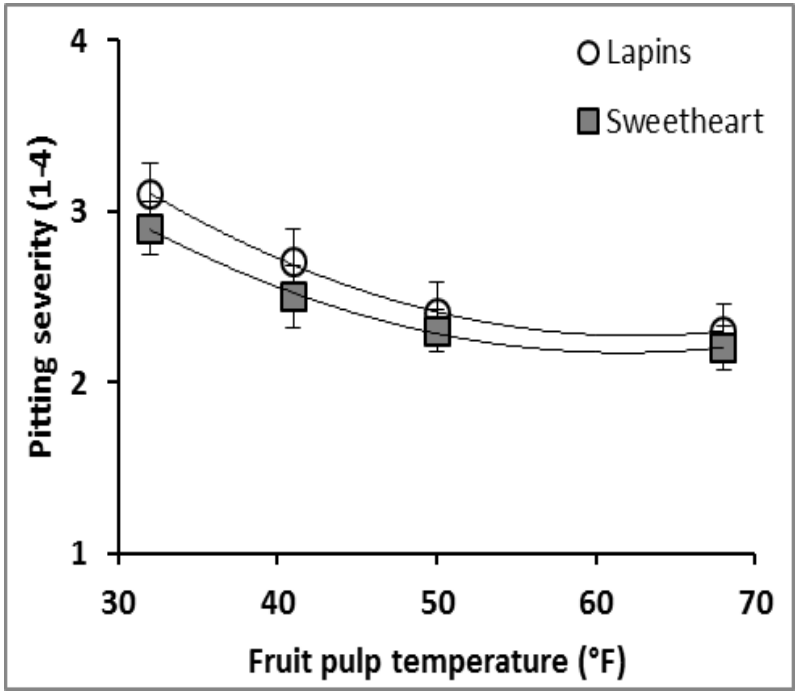
Crop	%Active (SEMPERFRESH)	Diluteto
Bartlett pear Comice pear	0.5%	26.5 gal (100 litres)
Packhams pear	0.7%	19 gal (72 litres)
Cantalope melon Galia melon Papaya	0.8%	16.5 gal (62 litres)
Avocado Granny Smith apple Golden Delicious	1.0%	13 gal (50 litres)
Cherry	1.0%	13 gal (50 litres)
Plum	1.1%	12 gal (45 litres)
Banana Pineapple	1.2%	11 gal (42 litres)
Lime	1.5%	9 gal (35 litres)

The above rates are general recommendations; local varietal or environmental factors may influence response to treatment.

Semperfresh™

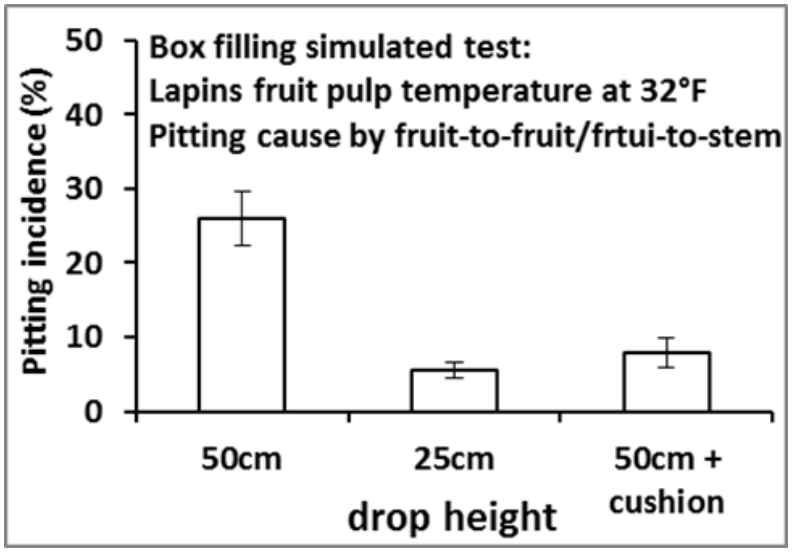
6. Fruit pulp temperature and pitting susceptibility

- The lower the pulp temperature, the more susceptible to pitting.
  - Lapins
  - Sweetheart



Box filling and pitting

- Fruit pulp temperature at **box filling** = 32-35°F, therefore, extremely sensitive to pitting.
- **Reducing the drop height or cushion the drop** reduced pitting incidence.



Take home messages

- **Heat/moisture stresses can cause ‘Skeena’ pitting on the trees.**
- **Pre-harvest GA_3 at a single low rate and Ca^{2+} multiple applications at low rate enhance fruit firmness and reduce pitting susceptibility.**
- **More mature, softer fruit and more susceptible to pitting**
  - The optimum harvest maturity: ‘Sweetheart’ at 4.5; ‘Lapins’ at 5.5
- **Heavy crop load reduces fruit firmness and increases pitting.**
- **Tissue Ca content is related to pitting resistance.**
  - Sweet cherry fruit uptake Ca^{2+} at low temperature fast.
  - Adding OptiCAL™ at 0.2-0.5% in hydro-cooling water for 5min increases fruit Ca^{2+} content and pitting resistance.
  - Higher rates at 1.0-2.0% damage pedicel quality.
- **Semperfresh™ reduce pitting at 0.5%, but increase pitting at higher rate.**
- **The lower the fruit pulp temperature, the higher susceptibility to pitting.**
  - Box filling during on-line packing generates significant pitting.
  - Reducing drop height or cushion the drop during box filling reduce pitting.

Thank you for your attention and research support!