



## Stone Fruit and Kiwifruit Ripening

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Slides courtesy Carlos Crisosto



**UC DAVIS**  
**POSTHARVEST TECHNOLOGY**  
Maintaining Produce Quality & Safety



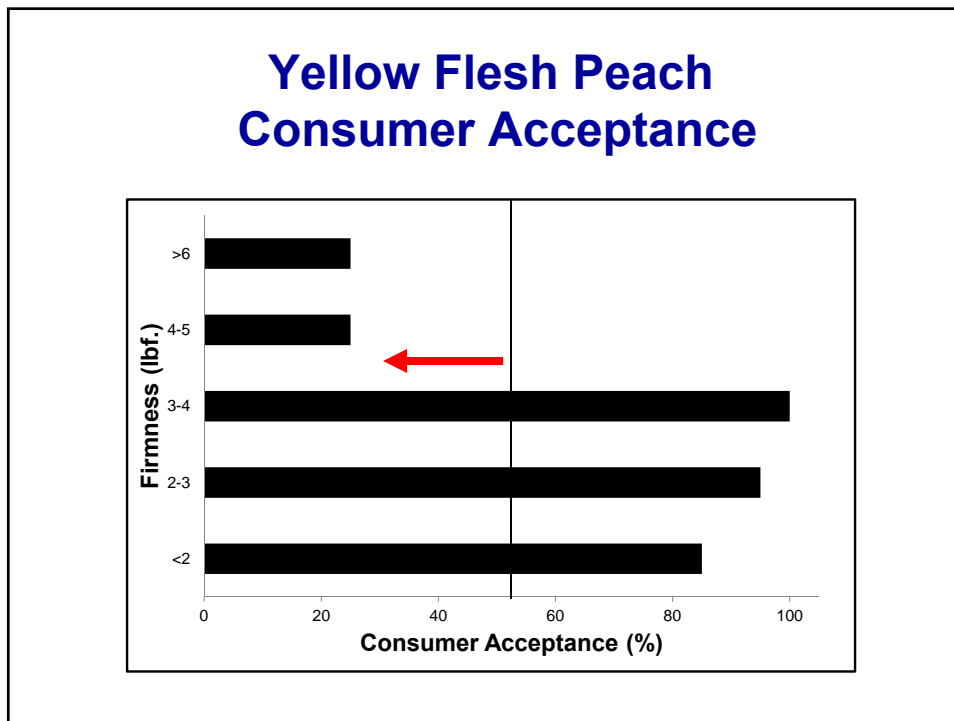
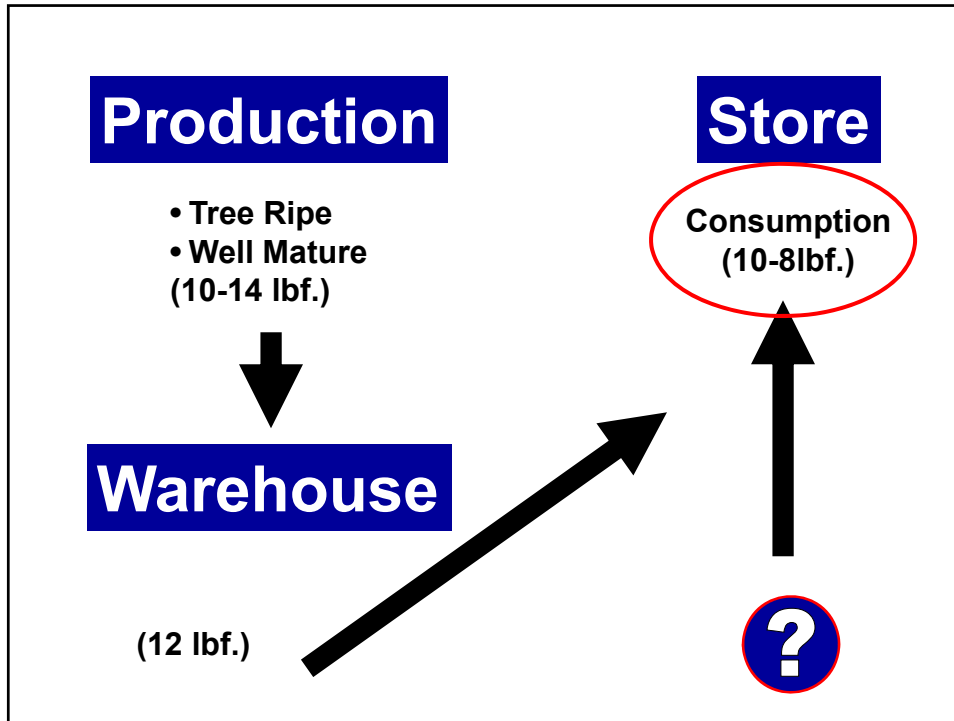
## Stone Fruit Ripening Terminology

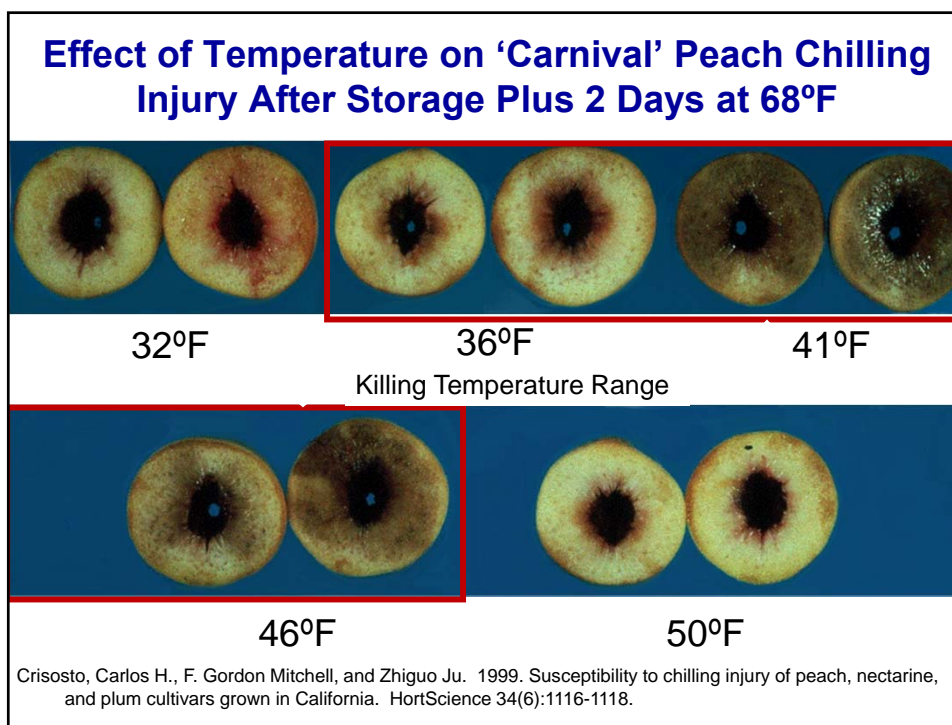
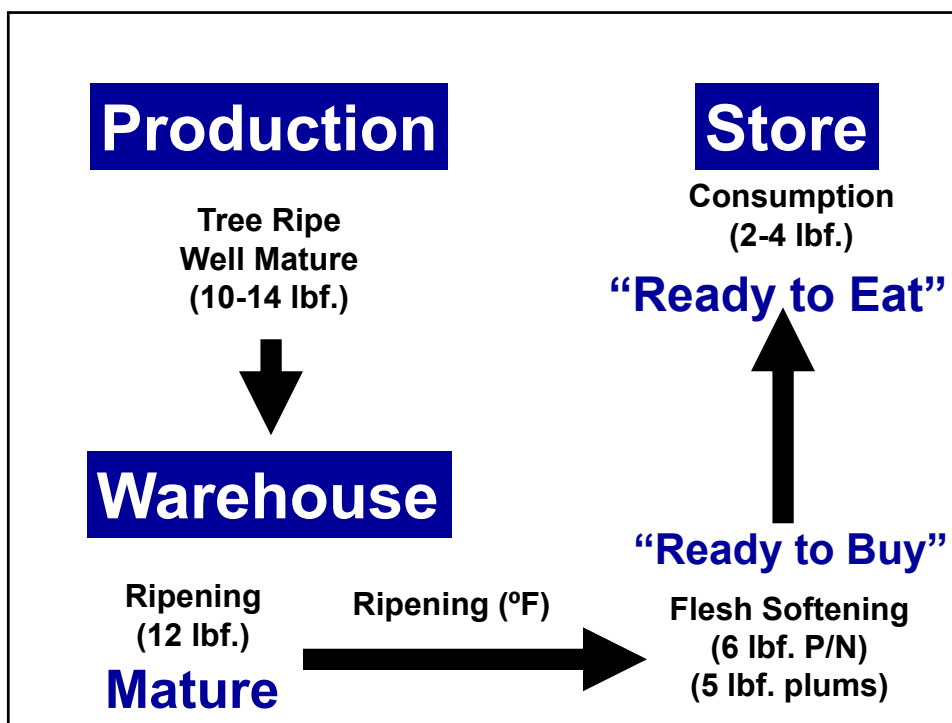
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- "Mature" (14-10 pounds)
- "Ready to Eat" (2-4 pounds)
- "Ready to Transfer" (6-8 pounds)  
"Ready to Buy" (6-8 pounds)
- Preconditioned (4-8 pounds)



\*Measured at weak position on the fruit





## Internal Breakdown

**Mealiness**

**Lack of Flavor**

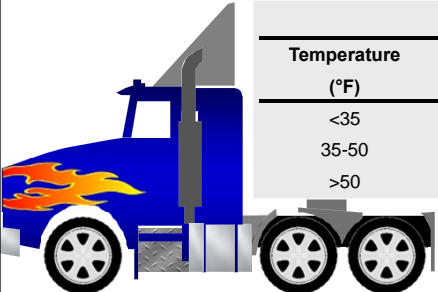
**F. Browning**

**Uneven Ripening**



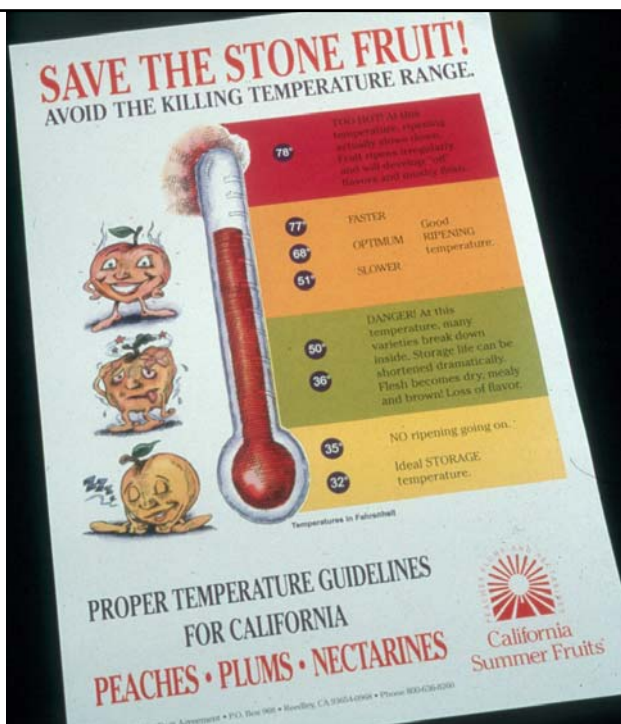
## Stone Fruit Transport

- Stone fruit temperature measured upon arrival at the retail warehouse after 3 days truck shipment, 1996

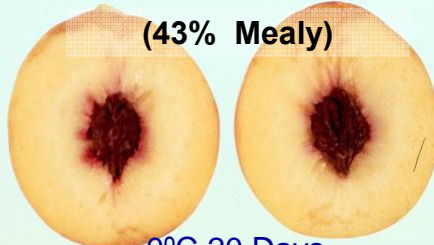
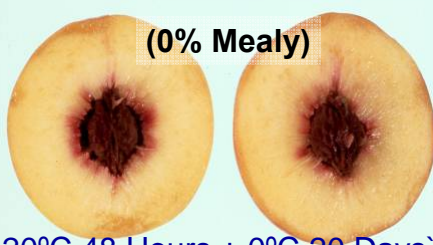




| Temperature<br>(°F) | Percent of Shipment  |                  |                |
|---------------------|----------------------|------------------|----------------|
|                     | Nectarine<br>(n=103) | Peach<br>(n=102) | Plum<br>(n=87) |
| <35                 | 14.7                 | 5.9              | 4.6            |
| 35-50               | 69.9                 | 79.4             | 71.4           |
| >50                 | 15.7                 | 14.7             | 24.0           |

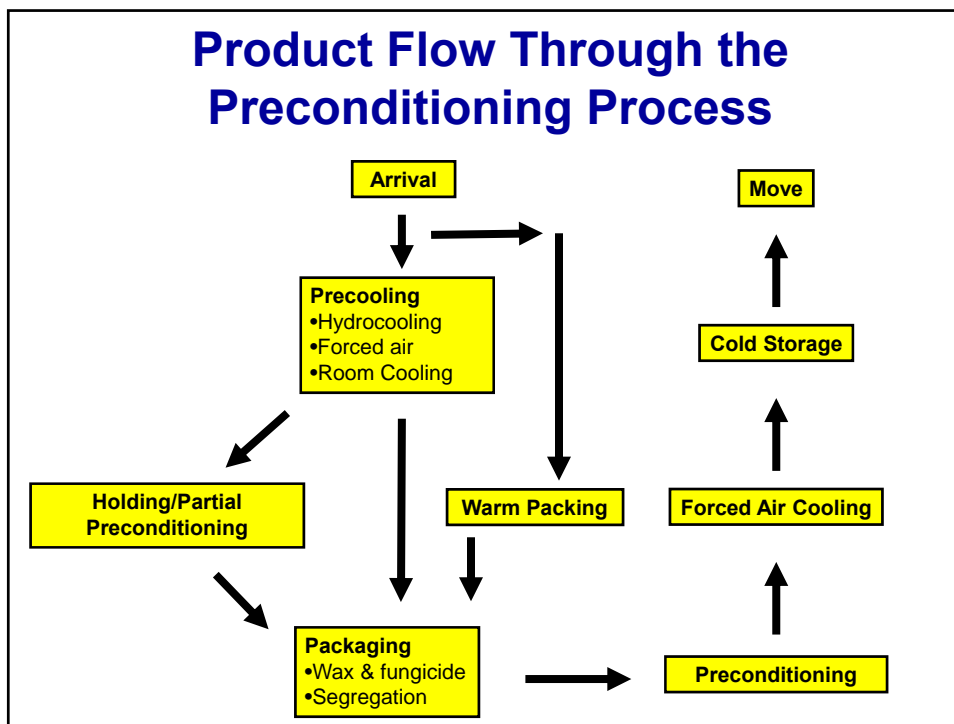
**Stone Fruit  
 Ripening**



**Peach Delayed Cooling**

|   |   |
|---|---|
| <p><b>(43% Mealy)</b></p>  <p>0°C 20 Days</p>  | <p><b>(0% Mealy)</b></p>  <p>20°C 48 Hours + 0°C 20 Days`</p> |
| <p><b>(100% Mealy)</b></p>  <p>5°C 20 Days</p> | <p><b>(0% Mealy)</b></p>  <p>20°C 48 Hours + 5°C 20 Days</p>  |

Crisosto, Carlos H., David Garner, Harry L. Andris, and Kevin R. Day. Controlled delayed cooling extends peach market life. HortTechnology 14:99-104.



### Do we need to apply Ethylene?

**NO**

The image shows an ethylene gas cylinder on the left, labeled 'ETHYLENE'. On the right, there is a photograph of a person using a small ethylene ripening machine to ripen fruit. The machine is a small, rectangular device with a control panel and a fruit basket on top.

## **Basic Requirements of the Preconditioning Program**

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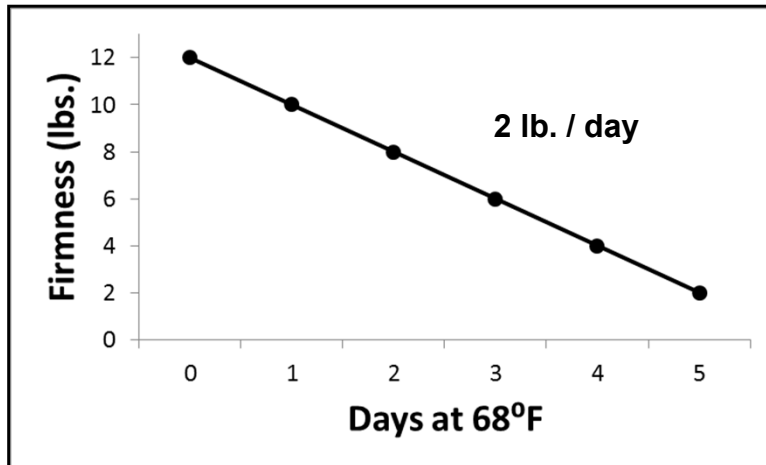
- Infrastructure such as a ripening room and forced air capacity should be available for a reliable preconditioning/pre-ripening program.
- Trained and experienced quality assurance personnel and a “ripeners” are key components of this program.

## **Critical Points for a Successful Preconditioning Program**

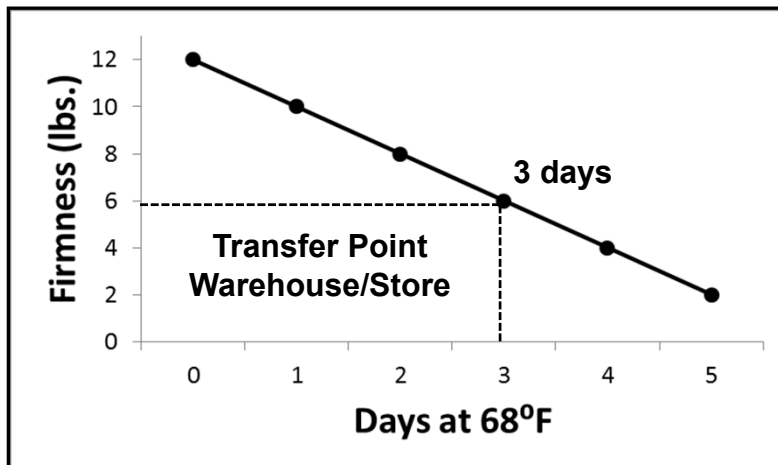
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- Optimize your fungicide application operation.
- Control fruit and chamber temperature conditions and fruit firmness changes during the preconditioning-pre-ripening process.
- Monitor and determine the end of the preconditioning-pre-ripening process.
- Slow fruit softening after preconditioning-pre-ripening process through temperature management.

## O'Henry Ripening

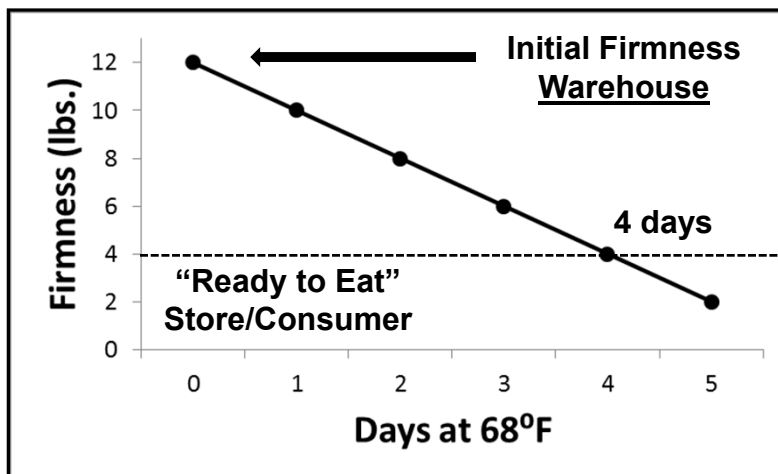


## O'Henry Ripening





## O'Henry Ripening




## KIWIFRUIT RIPENING PROTOCOL



Slides courtesy Carlos Crisosto

## KIWIFRUIT RIPENING




**Mature**  
(Harvest)

**WAIT...**  
I'm not "READY TO EAT" yet!!

- Hard
- Starchy
- Sour
- Odorless
- 6.5 - 7.0% HSSC
- 17% DM

**LOW  
Consumer  
Acceptance**

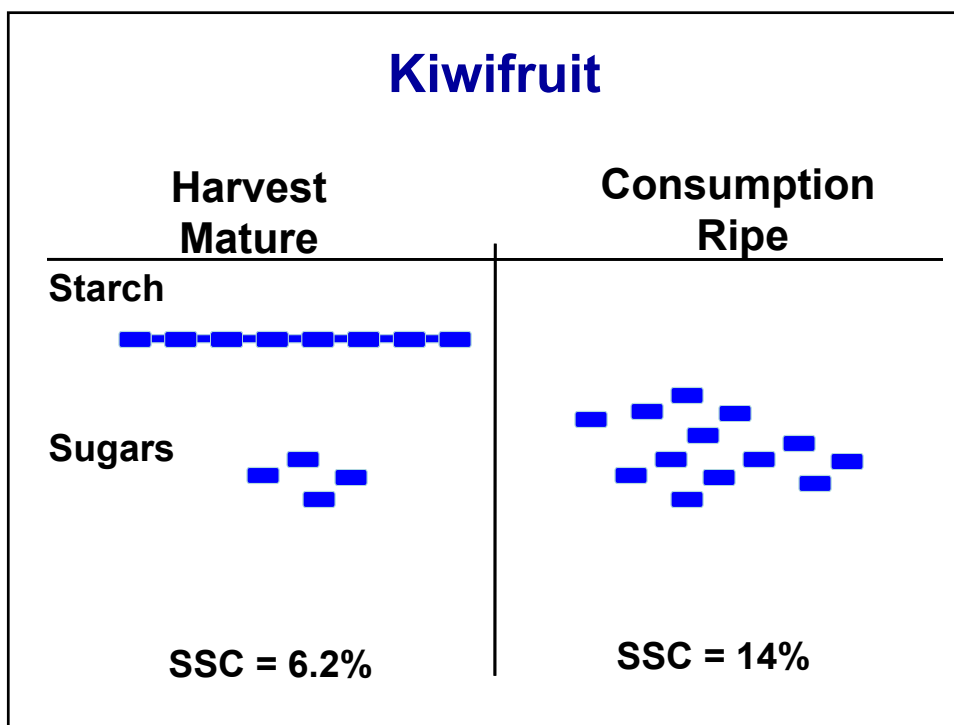


**Ripe**  
(Consumption)

**EAT ME...**  
I'm "READY TO EAT"!!

- Soft, Juicy
- No starch
- Sweet
- Aromatic
- Tasty
- 13.5 - 14.0% RSSC
- 17% DM

**HIGH  
Consumer  
Acceptance**



## How to Assure Consumer Quality

- Minimum Maturity (6.5% SSC)
- Maximum Maturity ( $\leq 14$  pounds)
- Buyers Quality ( $> 16.1\% \text{ D.M.}$ )



## Buyer-Consumer Quality-DM

- Recommend using a minimum of 16.1% DM as a consumer quality index.
- However, for kiwifruit with  $\text{TA} \leq 1.2\%$ , a DM index of **15.1%** would be the minimum quality index required for consumer acceptance.
- These minimum standards will enable marketing of a large proportion of kiwifruits that have a high level of consumer acceptance.

## **KIWIFRUIT RIPENING PROTOCOLS** (‘Hayward’)

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- IMMEDIATELY AFTER HARVEST  
(Shipper/Handlers)
- AFTER COLD STORAGE  
(Shipper/Retail)
- HOME (Consumers)

## **IMMEDIATELY AFTER HARVEST**

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### **Ripening at the Shipping Point** **COLD Ethylene Conditioning Treatment**

- Ethylene pre-conditioning treatment is required only on freshly harvested kiwifruit or those that have been in cold storage for less than **5 weeks**.
- No ethylene is required for kiwifruit that has been stored for longer than 5 weeks

## Ripening at the Shipping Point Cold Ethylene Conditioning Treatment

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- Ethylene applied at 100ppm for 6-12 hours at 0 to 7°C (32 to 45°F) will induce ripening as indicated by uniform kiwifruit softening and starch conversion into sugars.
- Ethylene exposure can be shortened to 6 hours by using a catalytic generator (C<sub>2</sub>H<sub>4</sub>) or flow-through application rather than the "shot system".

### Ethylene Penetration & Dehydration



**To avoid or reduce fruit shriveling, kiwifruit should be placed in ripening rooms in tray pack or volume fill packages with polyliners.**

## Ripening Room Conditions



## POST-TREATMENT HANDLING

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- Maintain treated kiwifruit below 36°F.
- Ship and consume fast.
- Cold store away from untreated kiwifruit for long-term storage.

## Postharvest Life Potential of Cold Conditioned Kiwifruit

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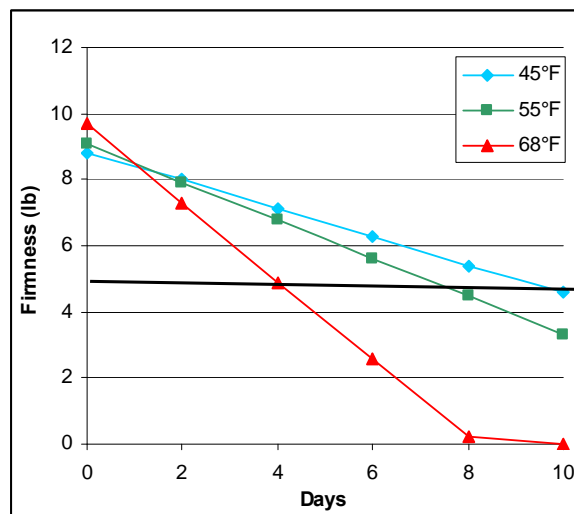
- **Cold** kiwifruit treated at near 0°C (32°F) and maintained at that temperature may be held up to **3-6 weeks**.
- These cold treated kiwifruit will reach a firmness of about 3 pounds in 2 to 3 days after being transferred to 20°C (68°F).

## Temperature Ripening (Receiver)

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- As a general rule, non-preconditioned kiwifruit received in your warehouse which have been in storage **<5 weeks** or have a flesh firmness level of >8-10 pounds should be treated with ethylene to enhance ripening at the warehouse or store levels.
- If the flesh firmness is >5 pounds, but less than 8-10 pounds, kiwifruit ripeness can be triggered and controlled at your warehouse by temperature management.
- Fruit which have been in storage **≥5 weeks** can be ripened to optimum levels by temperature management.
- The fruit temperature at retail storage should be adjusted according to the anticipated consumption schedule based on the rate of softening.

### Relationship between temperature and flesh softening of firm kiwifruit (6-9 lbs.) stored more than 5 weeks



## Determining Stage of Ripening

- Fruit firmness is the best measurement of ripeness.
- Firmness of a **mature** fruit varies from **12-16 pounds**.
- **Minimum shipping/packing** firmness is suggested as **5 pounds**, but varies according to packing type. Fruit with firmness below this level becomes more susceptible to physical damage during transportation and handling.
- During ripening, fruit soften and firmness decreases, reaching values of **2-4 pounds**.
- When fruit reaches **2-4 pounds** it is considered ripe or "ready to eat." This is the level that kiwifruit will achieve its best eating characteristics.



## QUESTIONS?

