Temperature Management and Shipping Operations

Steven A. Sargent
Professor, Postharvest Technology
Horticultural Sciences Department
University of Florida, Gainesville
- *sasa@ufl.edu*

QUALITY MAINTENANCE: Harvest & Handling

The focus was on two primary concerns:

- ***Minimizing mechanical injury***
- ***Cooling rapidly***

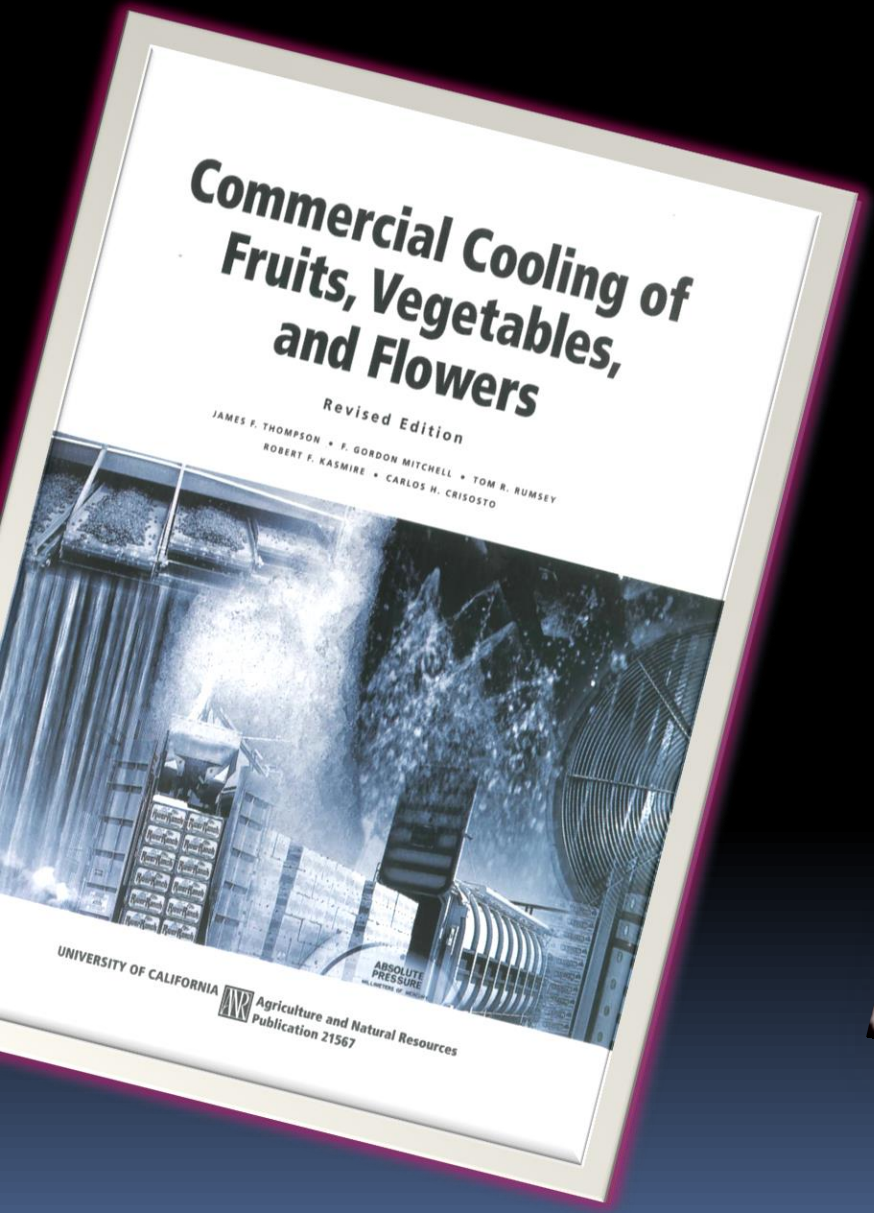
OPTIMIZING TEMPERATURE MANAGEMENT

High-quality fruits and vegetables can be successfully marketed, however:

- Greater care is necessary during harvest and handling operations to minimize damage
  - Use appropriate harvest containers
  - Carefully train & supervise workers
- Effective cooling methods are critical
  - Avoid delays in field, packinghouse
  - Cool rapidly & thoroughly

Cooling and Storage

- Determine optimal conditions
  - Storage temperature; relative humidity
  - Cooling method; atmosphere
- Rapidly cool within a few hours of harvest (7/8 Cooling)
- Cool efficiently


Commercial Cooling of Fruits, Vegetables, and Flowers
Revised Edition
JAMES F. THOMPSON • F. GORDON MITCHELL • TOM R. RUMSEY
ROBERT F. KASMIRE • CARLOS H. CRISOSTO
ABSOLUTE PRESSURE
UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources
Publication 21567


Third Edition
Adel A. Kader
Postharvest Technology of Horticultural Crops
University of California
Agriculture and Natural Resources
Publication 3311

This is NOT Cooling

TEMPERATURE MANAGEMENT

1) During harvest and handling

- Minimize time in the field
  - Once harvested, fruit temperature will increase
  - Place in the shade until transported
- Covering with tarps can promote warming by trapping the heat

TEMPERATURE MANAGEMENT:

Importance of shade:

- After 1 hour in the sun, cantaloupe pulped:
  - top layer: 97°F
  - second layer: 74°F

- This extra heat
  - Increases moisture loss and respiration
  - Increases cooling time and expense later

Shaded collection station

Field lug design affects temp mgmt:

- Cross-brace supports underneath
- Short height (more product per pallet)
- Good ventilation for natural ventilation

Quickly transport to covered holding area

COOLING IS CRITICAL TO EXTEND QUALITY

After 24 hours at ambient:

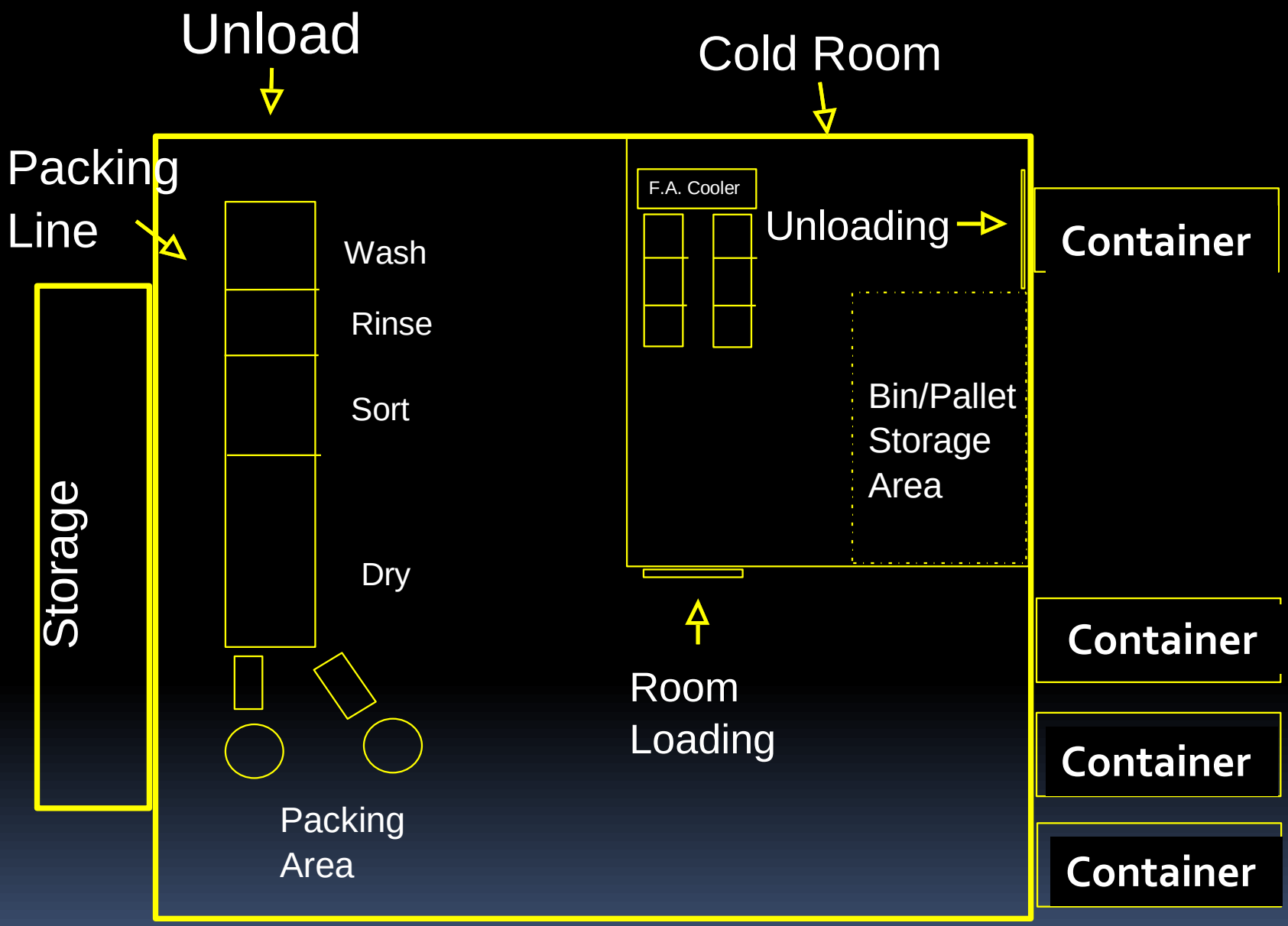
- Note bruises
- Unseen losses:
  - ↓ flavor
  - ↓ Vit. C

2) Cooling delays can lower postharvest quality

Strawberries with a 6-hour delay to cooling had poorer quality than those cooled more quickly after 1 week of storage:

- Significantly softer, more shriveled, had less attractive color
- Lower SSC, acidity, and Vitamin C levels

Nunes et al., 1995



Suggested floor plan of packinghouse.

3) Effective Cooling

Storage conditions for maximum shelf life are crop-dependent:

- Lowest Safe Temperatures for Fruits:
  - 32 °F (some apple varieties)
  - 39 °F (lychee)
  - 41 °F (carambola)
  - 53 °F (mango; avocado; mamey sapote)
  - 57 °F (banana)
  - 58 °F (pineapple)
- Relative Humidity: 90 to 95%
- Shelf life: 2 to 4 weeks

3) Effective Cooling

Storage conditions for maximum shelf life are crop-dependent:

- Lowest Safe Temperatures for Vegetables:
  - 32 °F (broccoli; lettuce; sweetcorn;)
  - 40 °F (snap bean)
  - 45 °F (bell pepper; chayote)
  - 50 °F (basil; cucumber; okra)
  - 53 °F (mature-green tomato)
- Relative Humidity: 85% to 95%
- Shelf life: 1 to 4 weeks

Cooling in the good ‘ole days

Pony reefers were used to transport the strawberries to northern markets. These were actually two crates, one inside the other.

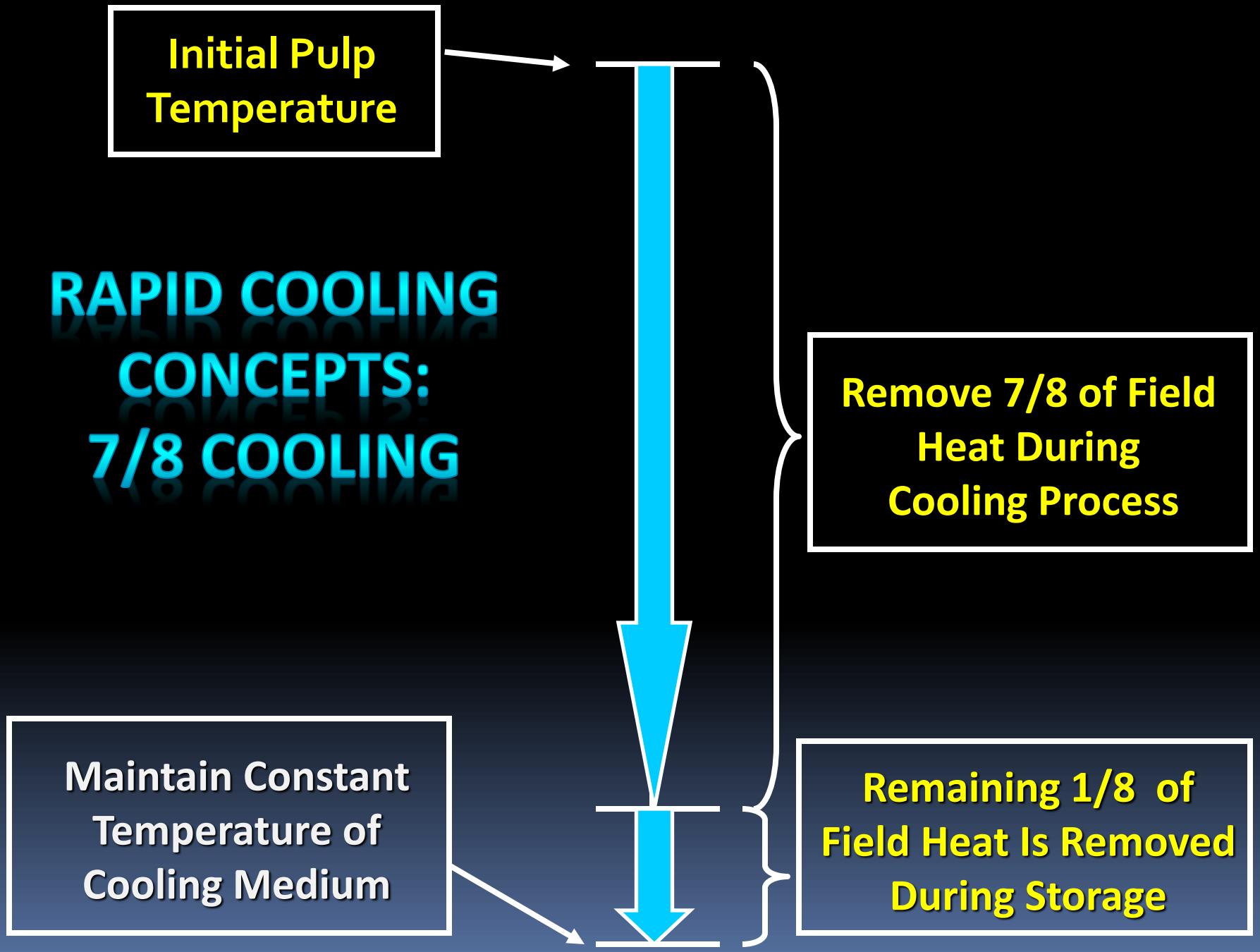
The outside crate held a layer of ice, and the inside crate held the fruit. Dec. 1926.

(Photo courtesy of Gulf Coast Research & Education Center.)

Cooling rate is determined by the 3 T's:

- **T**ime of exposure to the cooling medium
  - Longer = cooler
- **T**emperature of the cooling medium
  - Lower = faster
- **T**urbulence (contact & mixing)
  - Better contact = faster

RAPID COOLING CONCEPTS: 7/8 COOLING



7/8 COOLING CALCULATION

85 °F = Initial Pulp Temperature

Remove 7/8 of Field Heat:
85 – 53 = 32 °F x 7/8
= 28 °F

57 °F

53 °F = Hydrocooling water Temperature

Cool to:
85 – 28 = 57 °F
(remaining 4 °F removed during storage)

Cooling Methods

- Room cooling
  - Slowest – 12 or more hours
  - Loses most moisture
- Forced-air cooling
  - Faster – 1 to 2 hours
  - Less moisture loss
- Hydrocooling
  - Fastest – 20 to 30 minutes
  - Hydrates – no moisture loss. CAUTION: must be sanitary
- Vacuum cooling
  - Fastest process
  - Primarily for leafy crops – moisture loss can be an issue

In-room Cooling & Packing

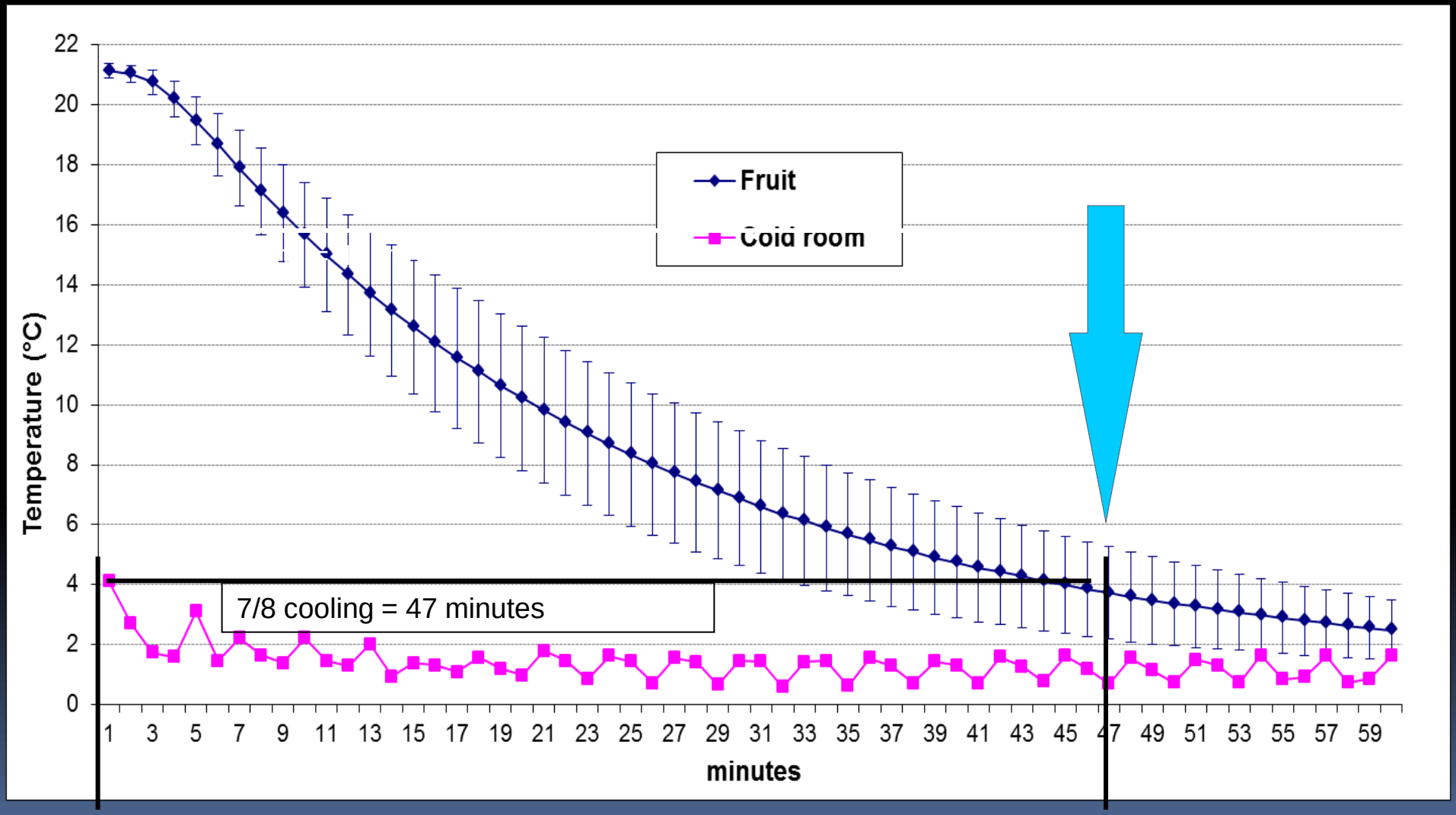
In-room Cooling & Packing

Forced-air cooling tunnel:
Forming the tunnel with pallets

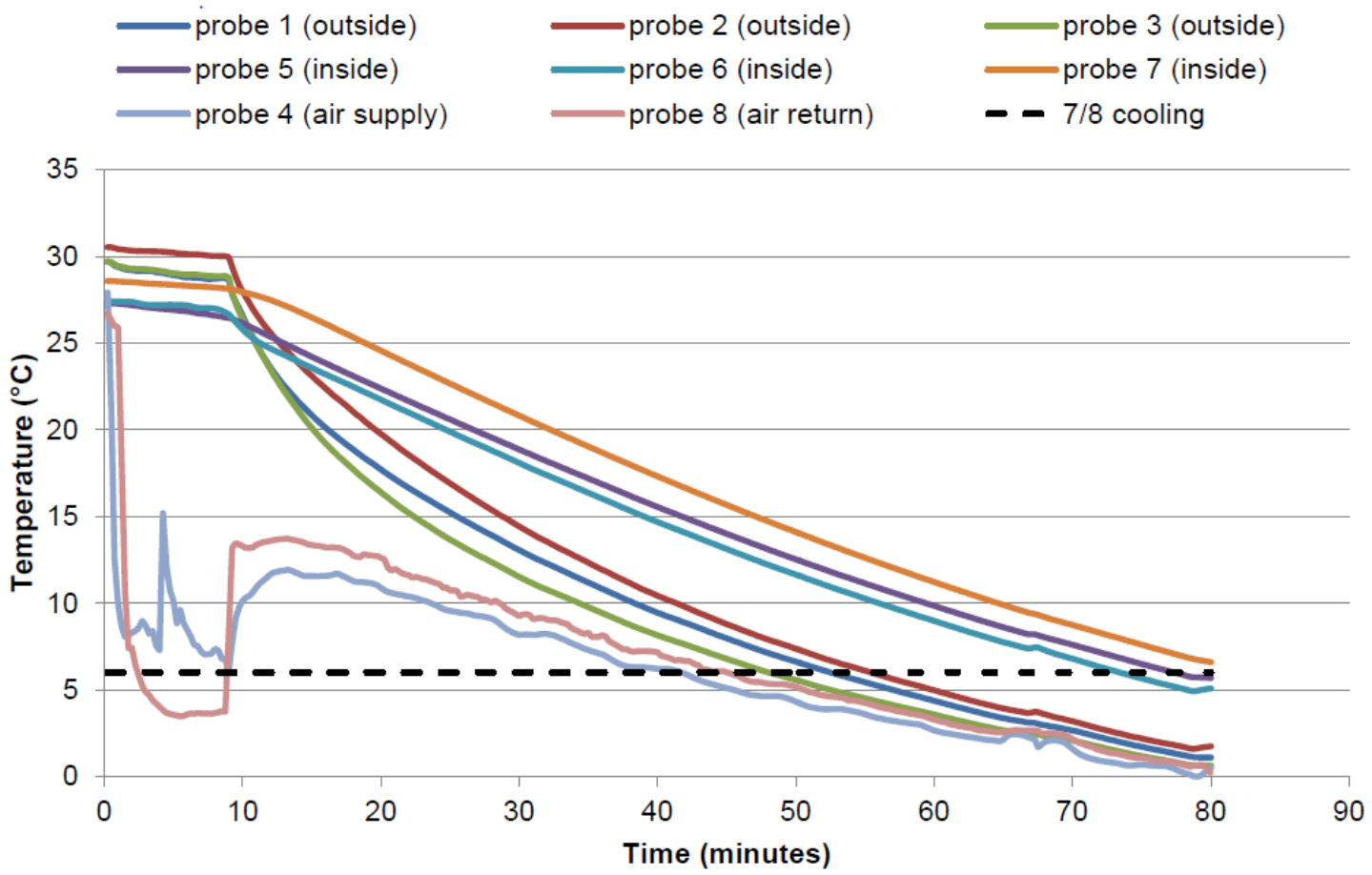

Tarp forces cold air through carton vents
Block openings at pallet bases

Cooling rate for forced-air-cooling of strawberries: lab scale

(Note wide Standard Deviation)



Cooling rate for commercial forced-air-cooling of strawberries

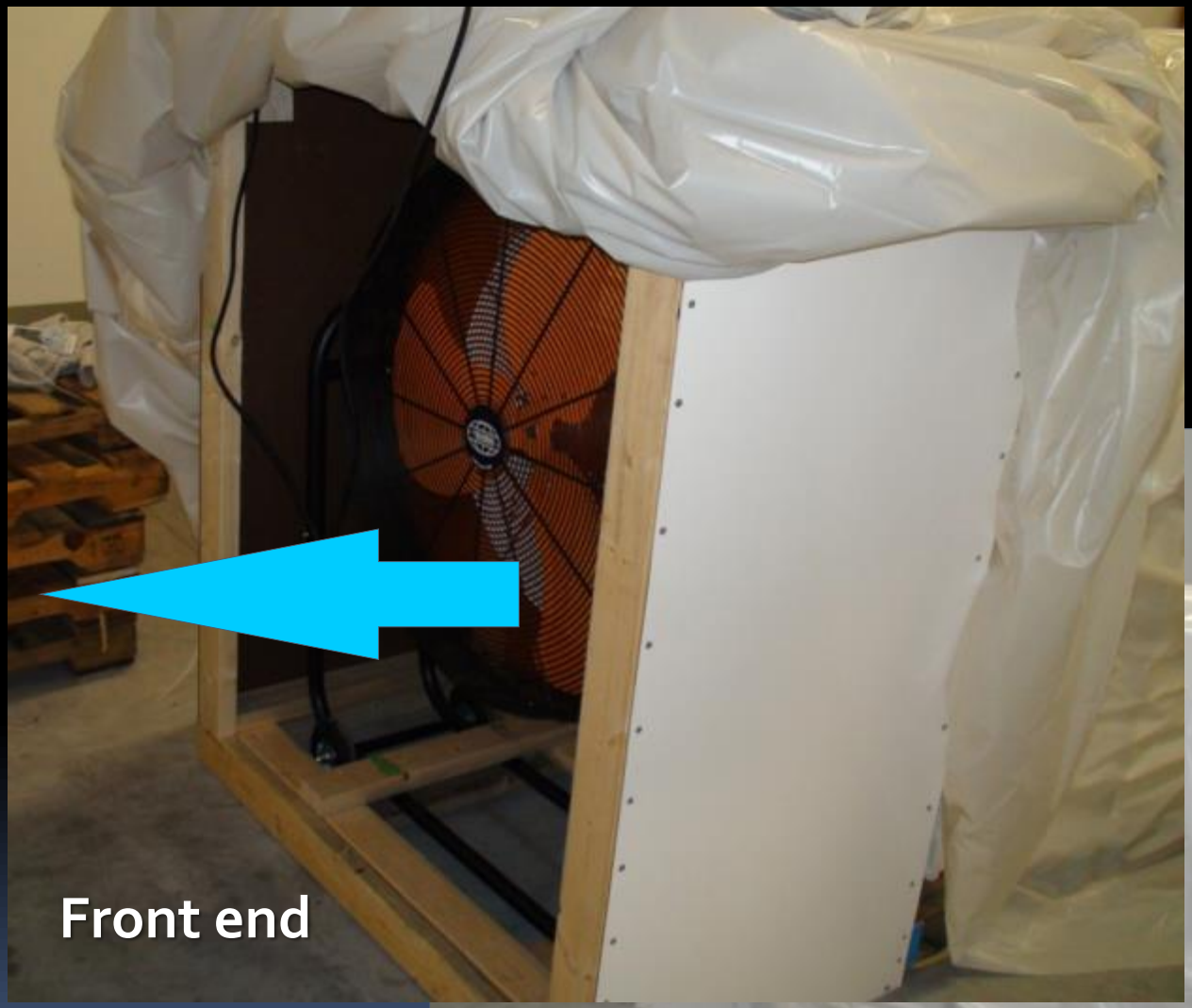


Forced-air cooling – small scale

Portable forced-air cooler In cold room

Portable Forced-air Cooler in Cold Room

Portable Forced-air Cooler in Cold Room



Single-pallet forced-air cooler "cabinet" in cold room

Room air should be humidified to minimize water loss from the fruit

Mobile forced-air cooler

Shower Hydrocooling

Single-layer tunnel

Pallet tunnel

Immersion Hydrocooling - lychees

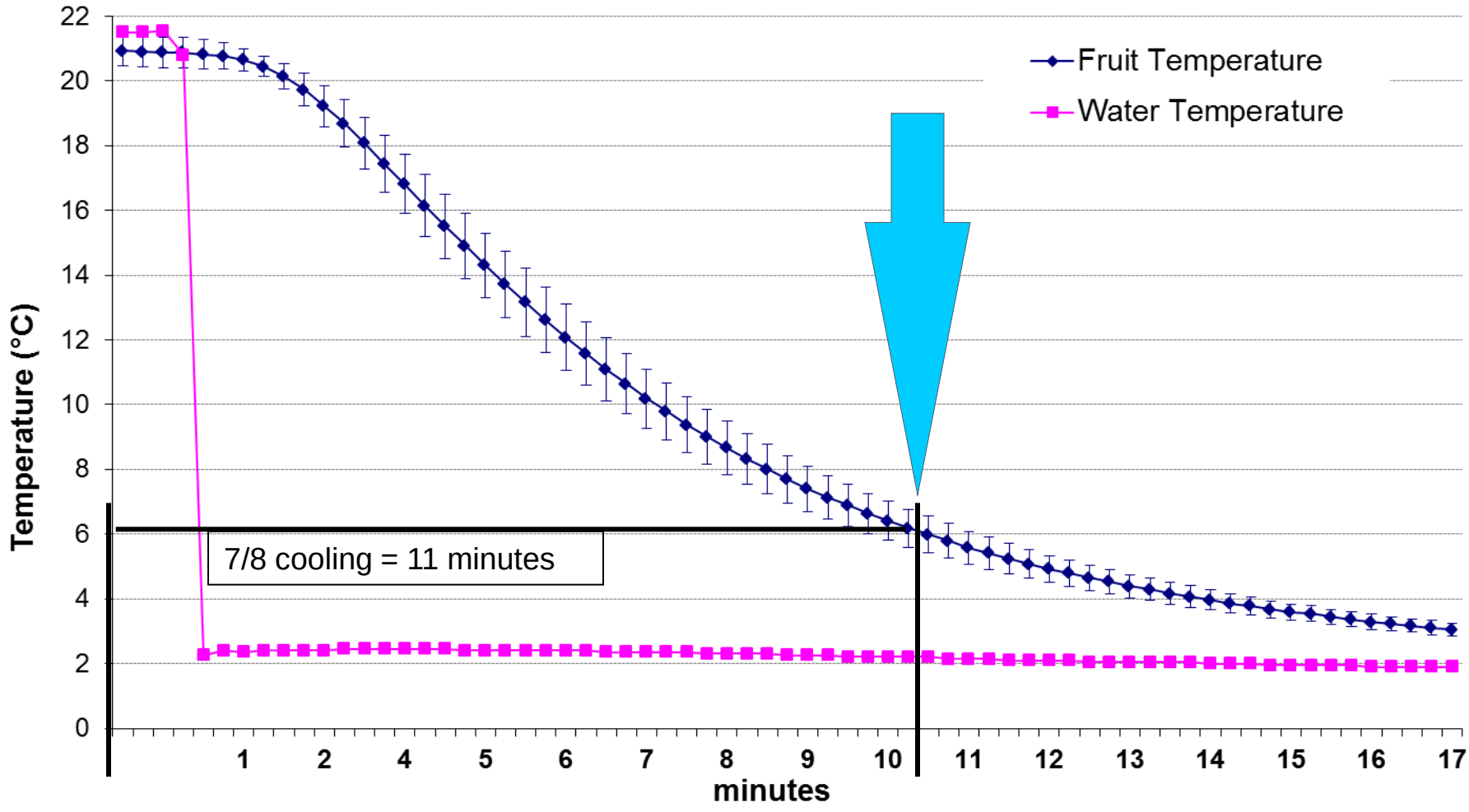
Immersion Hydrocooling - lychees

Immersion Hydrocooling: strawberries

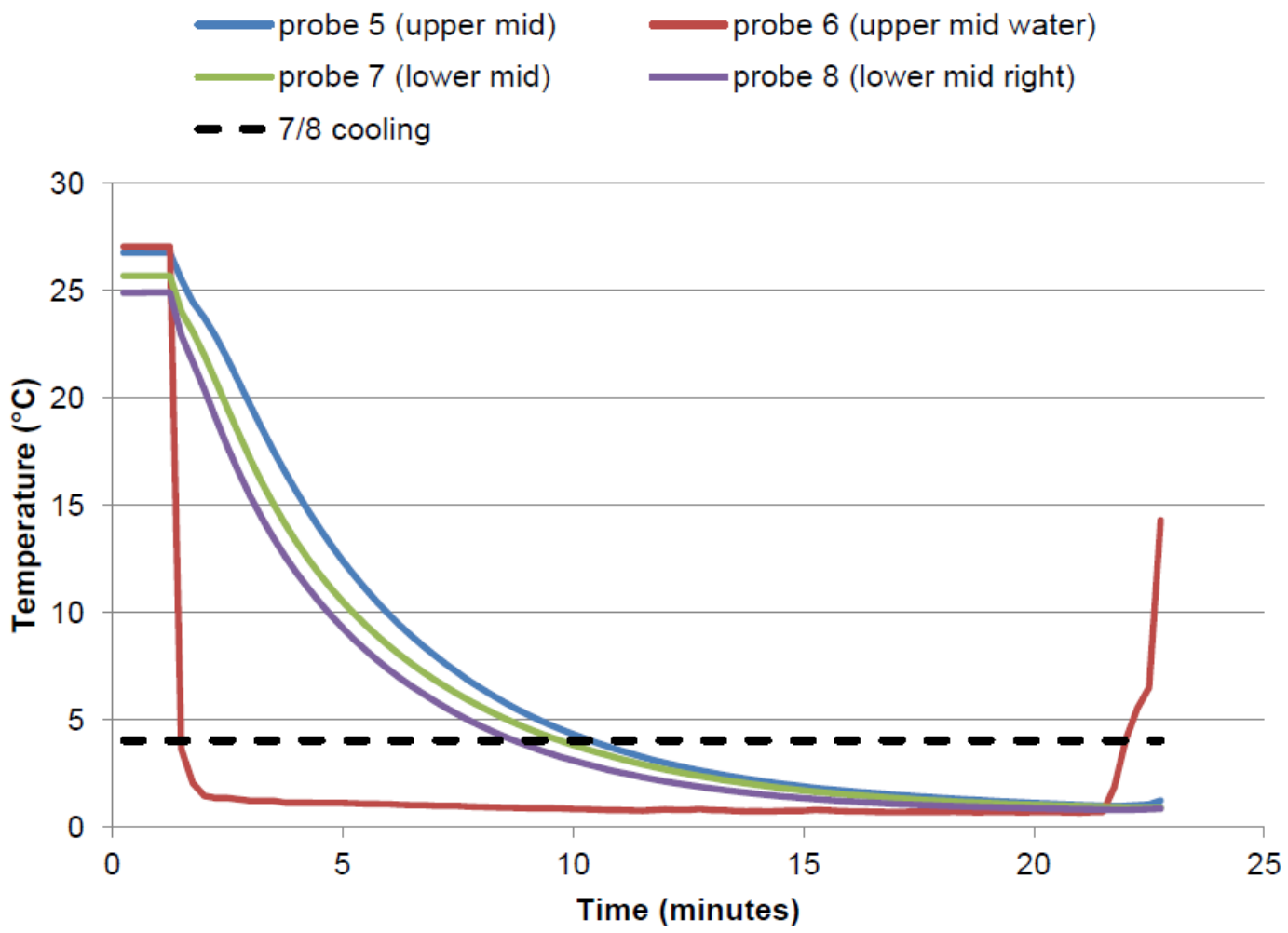

Dole
STRAWBERRIES
0.8
ON/FAST
OFF/AUTO OFF
QUARTZ
digi-thermo

Cooling rate for strawberry hydrocooling: lab scale

(Note narrower Std. Dev.)

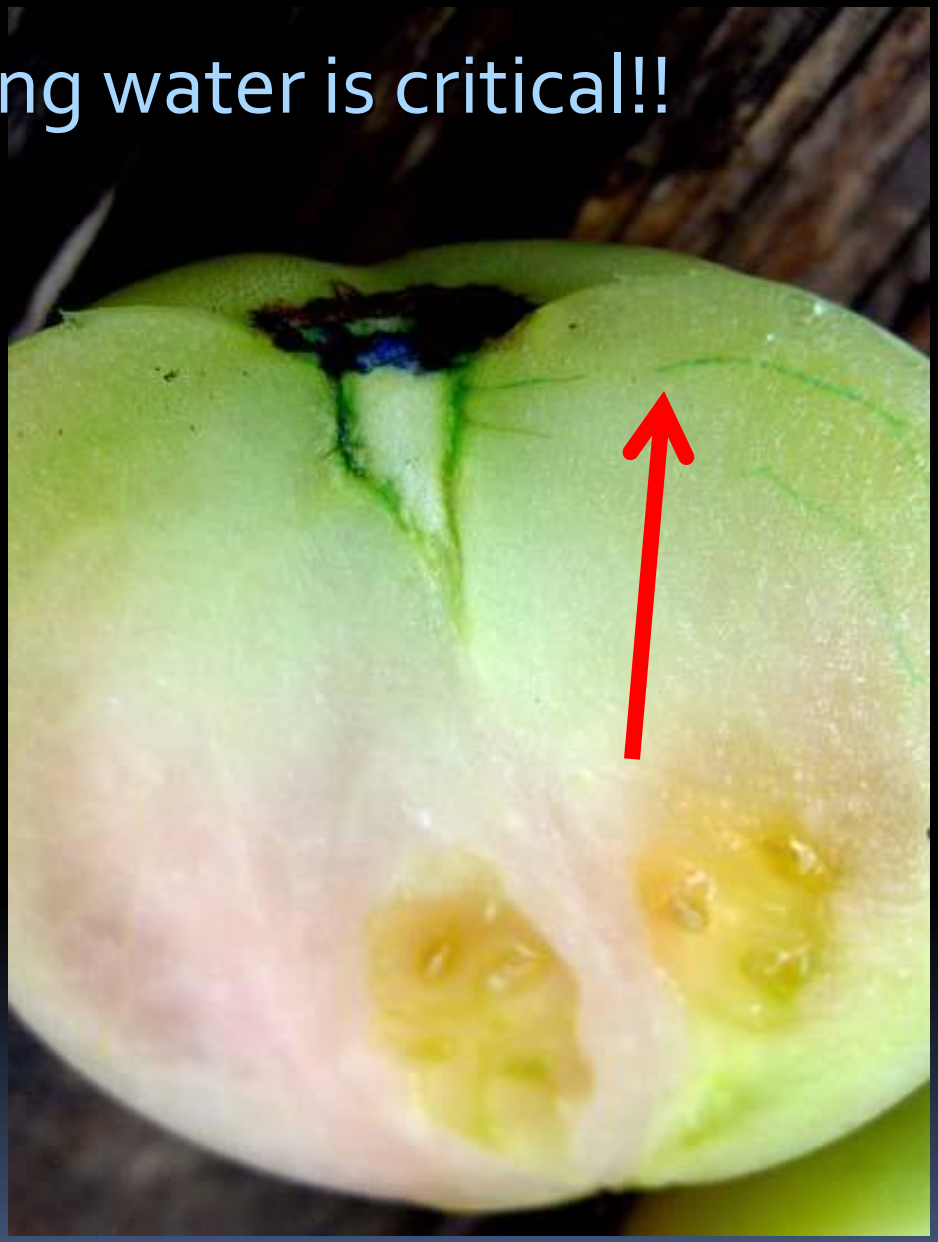


Cooling rate for commercial hydrocooling of strawberries



Sanitation of cooling water is critical!!

- Surrounding water can infiltrate into the fruit .
- Note blue dye infiltrated into tomato stem scar.



J. Bartz

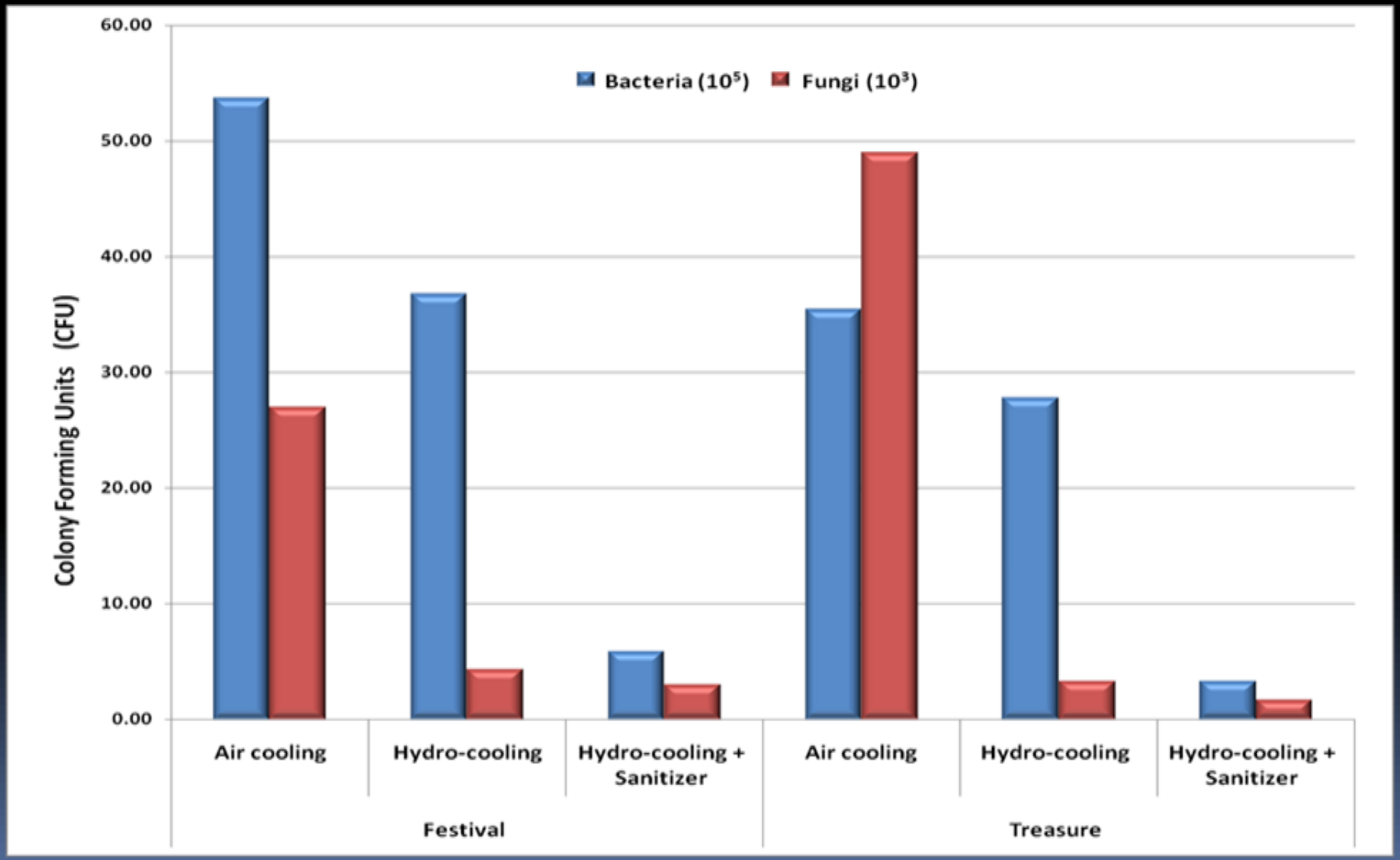
Non-sanitized vs. sanitized water rinse

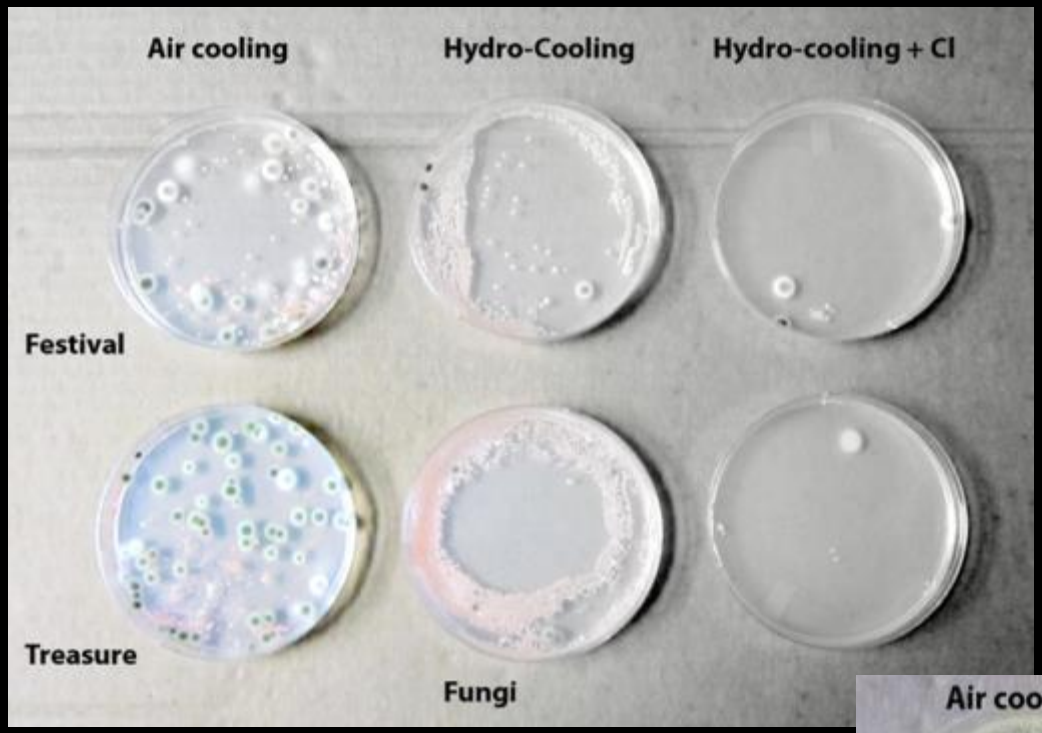
Water rinse only

Water + Chlorine (80 ppm)

J. Bartz

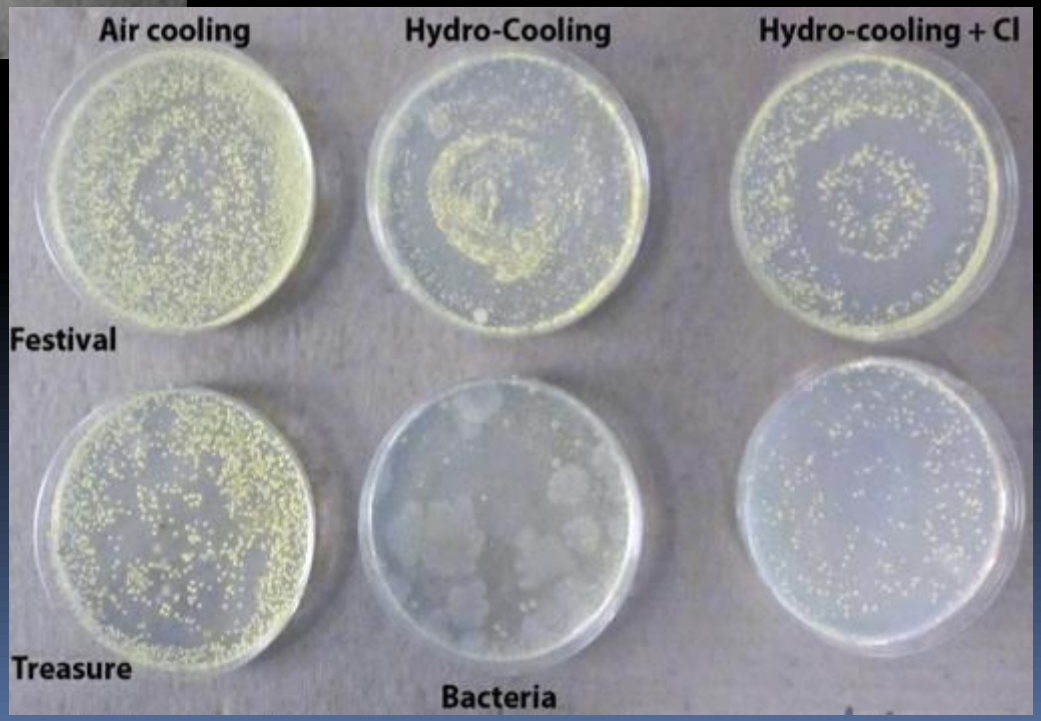
Effect of Cooling Method on Microbial Load - strawberry (Colony Forming Units)





Fungi

Bacteria



Top Icing – must be tolerant to freezing temps

Package Icing

Top Icing in loaded trailer

Vacuum cooling

Transportation

Floating Market Rachaburi, Thailand


WAUCHULA
FARMERS'
STATE
MARKET

Shipping Operations

Maintain the "cold chain"

The "Cold Chain":

- Following cooling maintain crop temperature/RH during each shipping and handling operation: no breaks in the Cold Chain
- Consists of a series of critical points which should be implemented according to Good Manufacturing Practices (GMPs) and vigilantly maintained

Shipping Operations

Avoid using unrefrigerated loading dock

Temperature Management during Shipping Operations

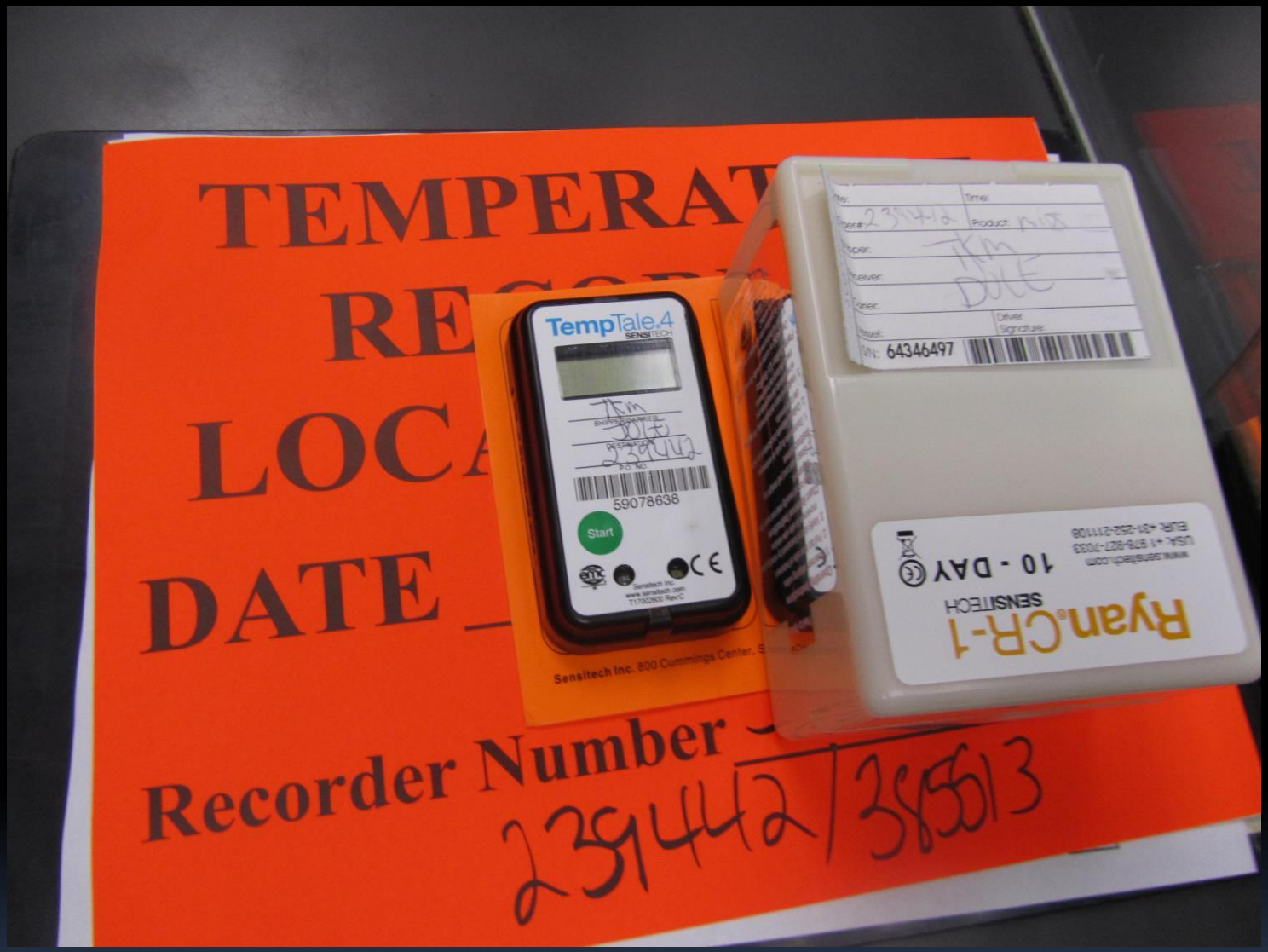
Load and unload directly from the cold room

Temperature Management during Shipping Operations

Load and unload directly from the cold room

Proper loading in the trailer is critical

Proper loading in the trailer is critical



Portable recorders in trailer track air temperature

- *Keep cool as long as possible*
- *Avoid having to re-cool*

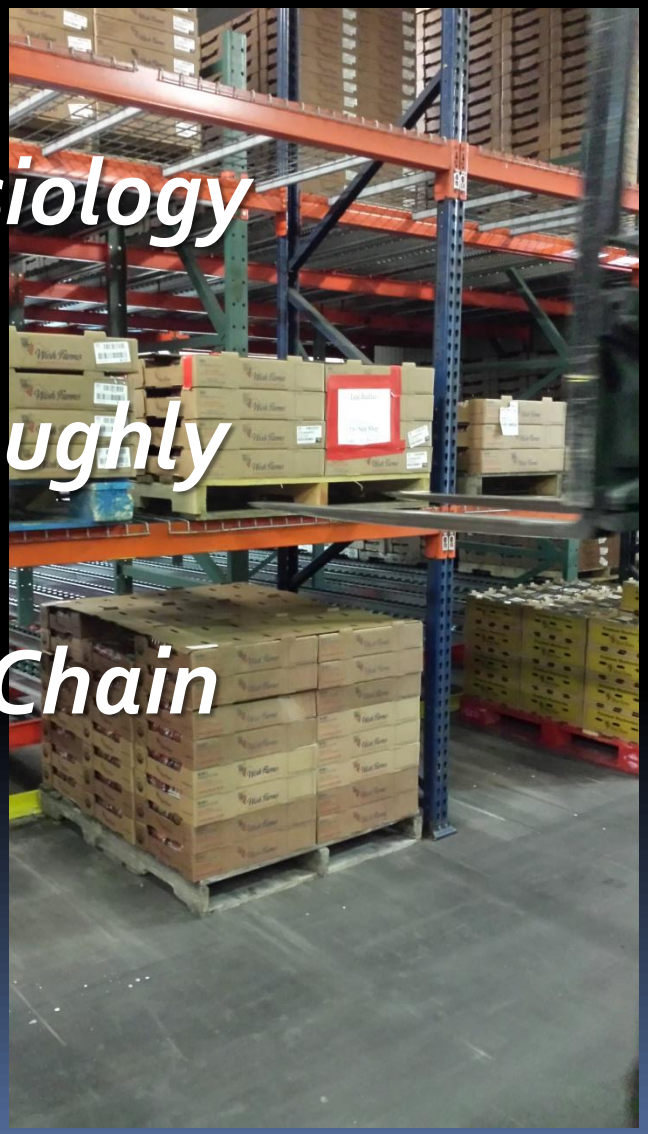
Breakbulk Cargo Shipping: "lift-on, lift

Looking down into the hold of the ship

Container Shipping

Temperature Maintenance

- *Consider crop physiology*
- *Cool quickly, thoroughly*
- *Maintain the Cold Chain*



Questions??