

# Temperature Management

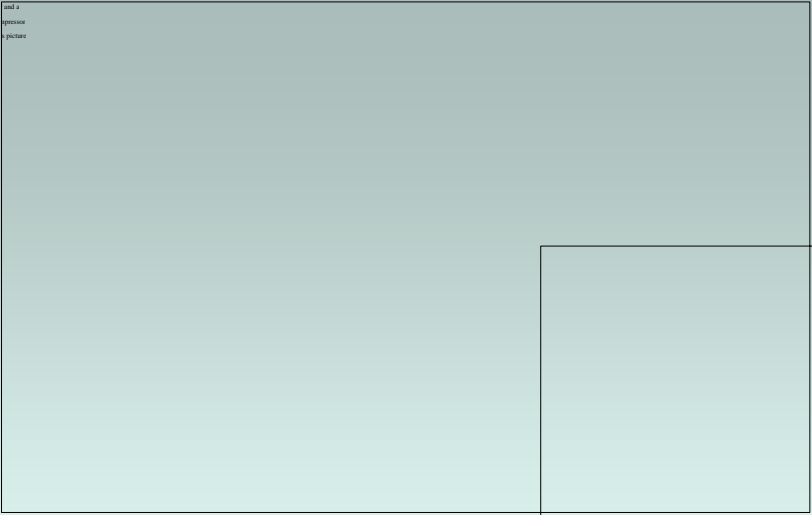
Jim Thompson  
Biological & Agricultural  
Engineering, UC Davis

## Temperature management

- Insures best product quality
- Longest shelf life
- Reduces microbial growth
- Required for MA packaging.

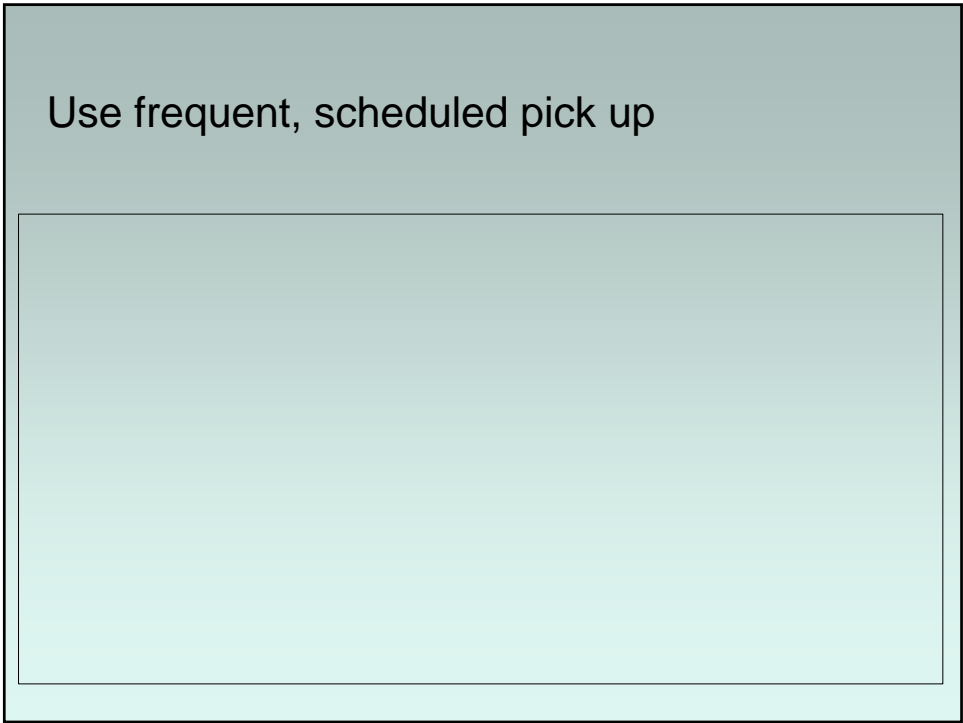
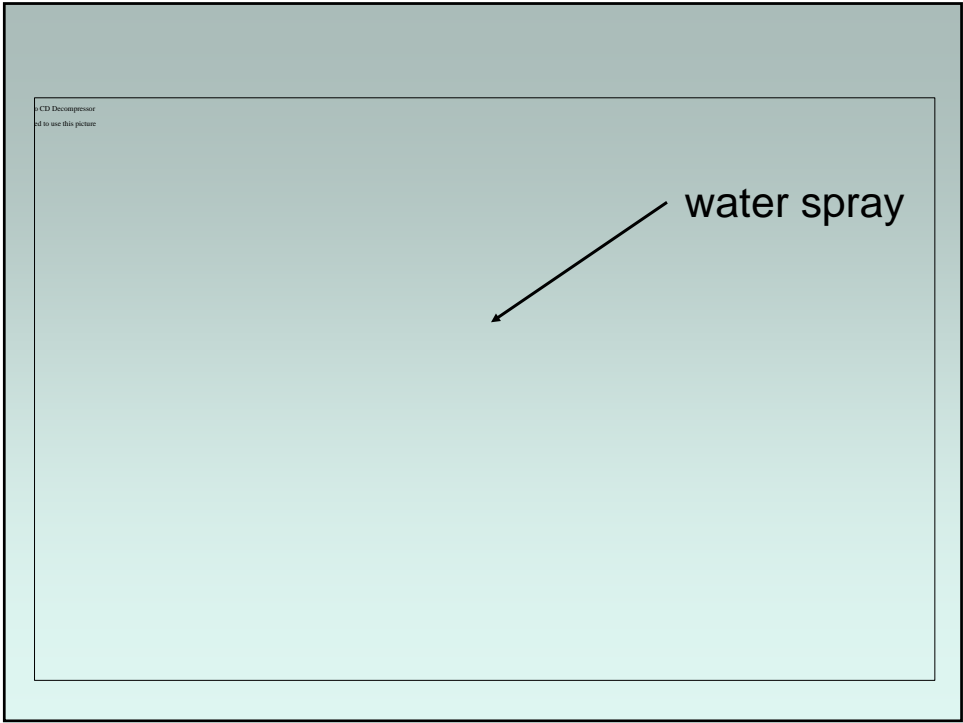
## Cooling Begins in the Field

- Prevent heating in the field.
- Shorten time before cooling begins.

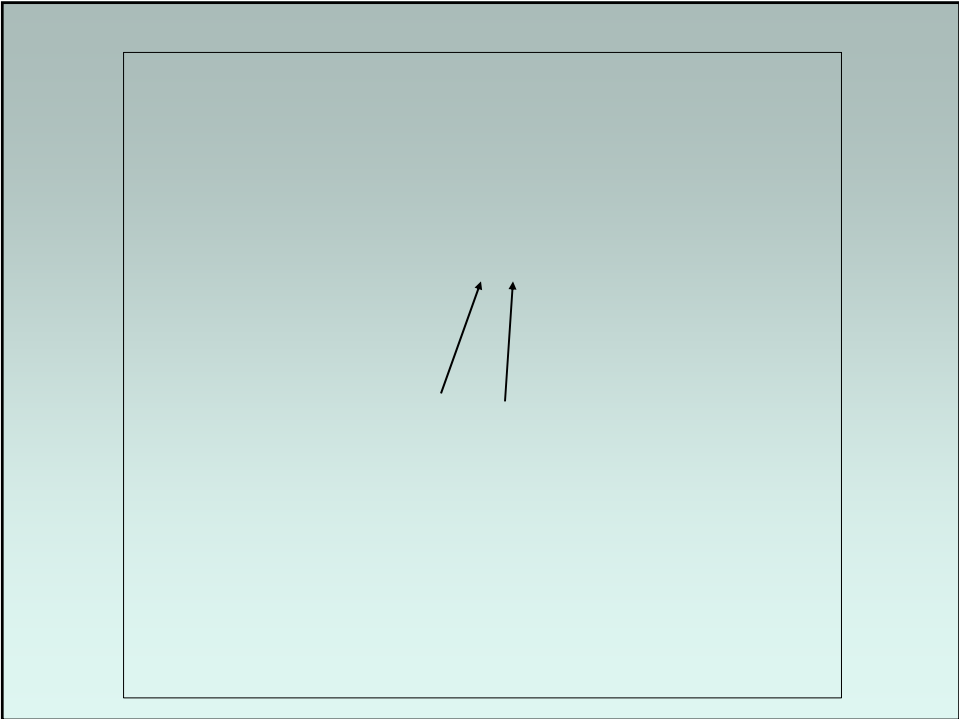
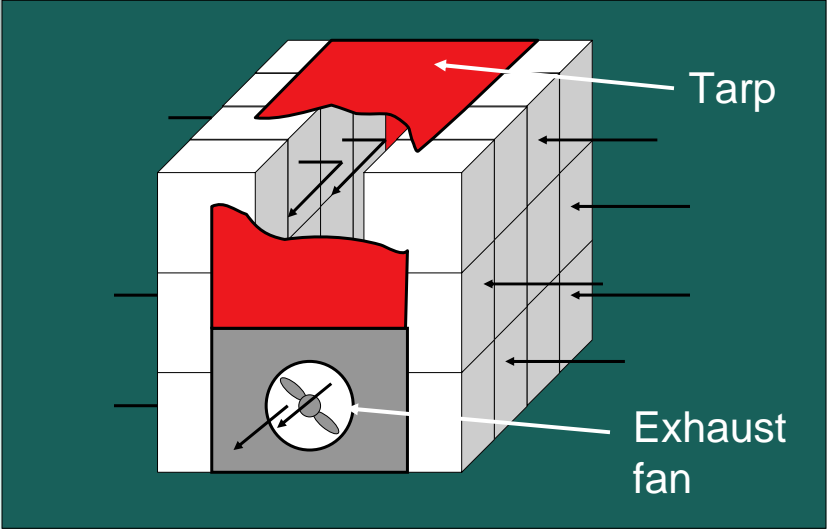


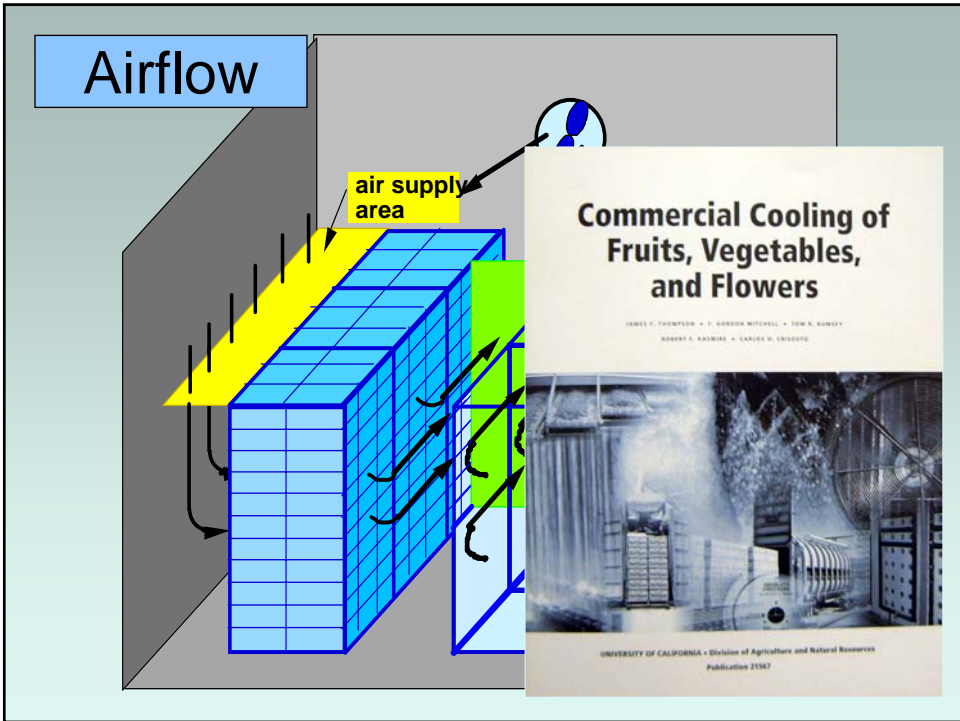
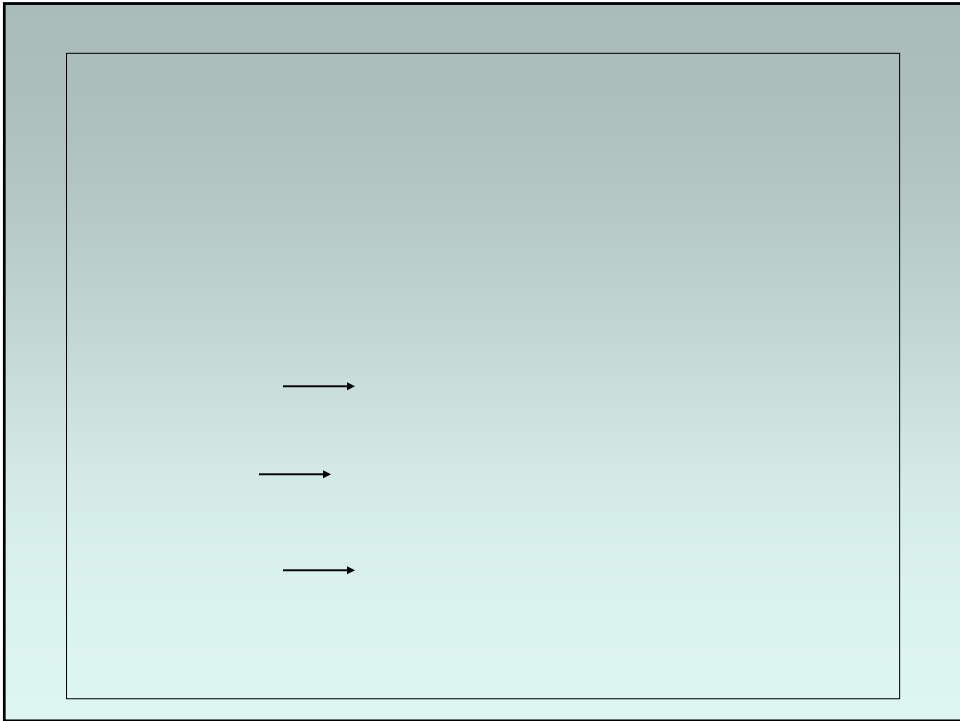
Shade product to  
reduce heat gain and  
moisture loss

The diagram consists of a large light blue rectangle representing a field. A smaller, darker blue rectangle is positioned in the bottom right corner of the larger rectangle, representing a shaded area for product protection.

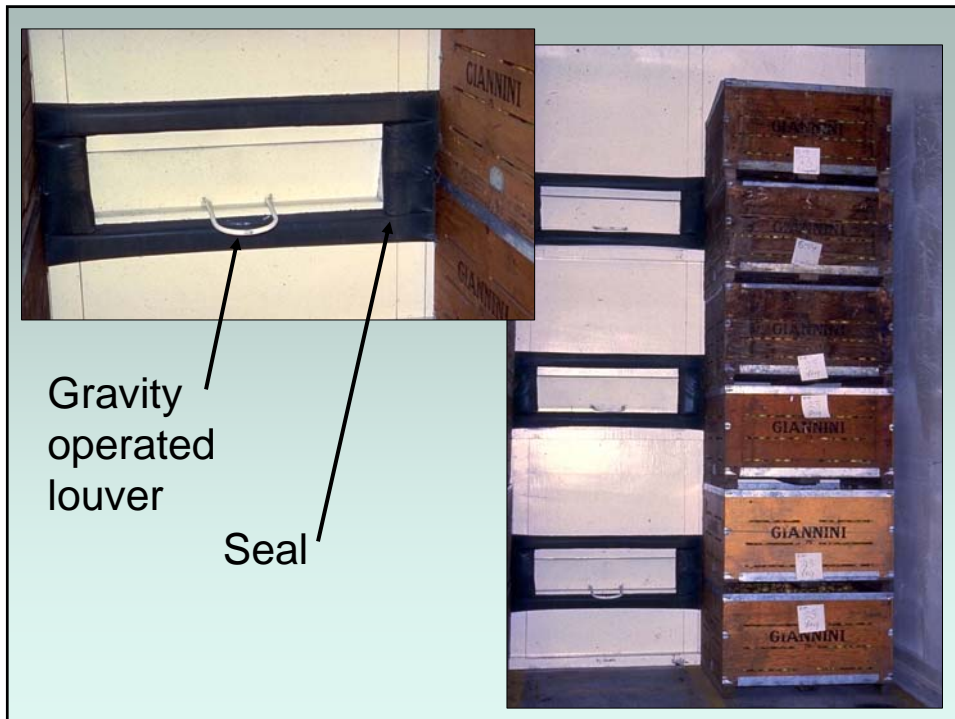
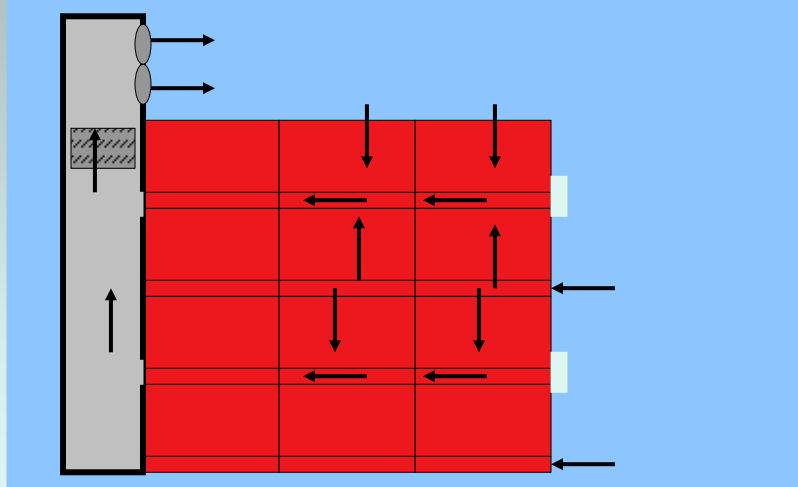


# Forced Air - Tunnel





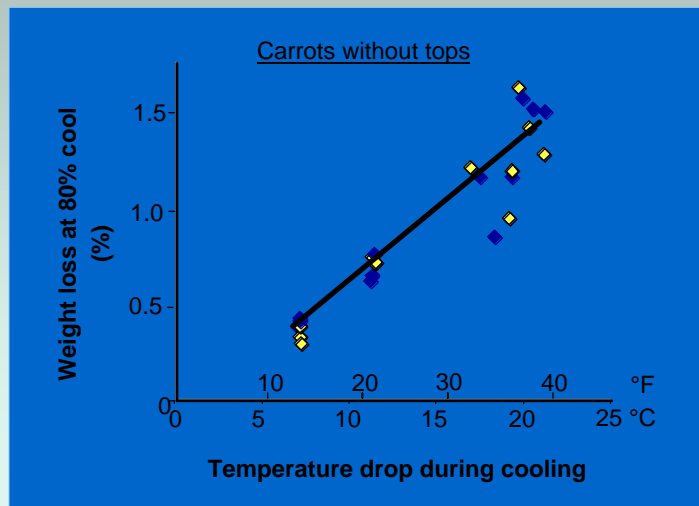
# Forced Air - Serpentine



Operating  
serpentine  
cooler

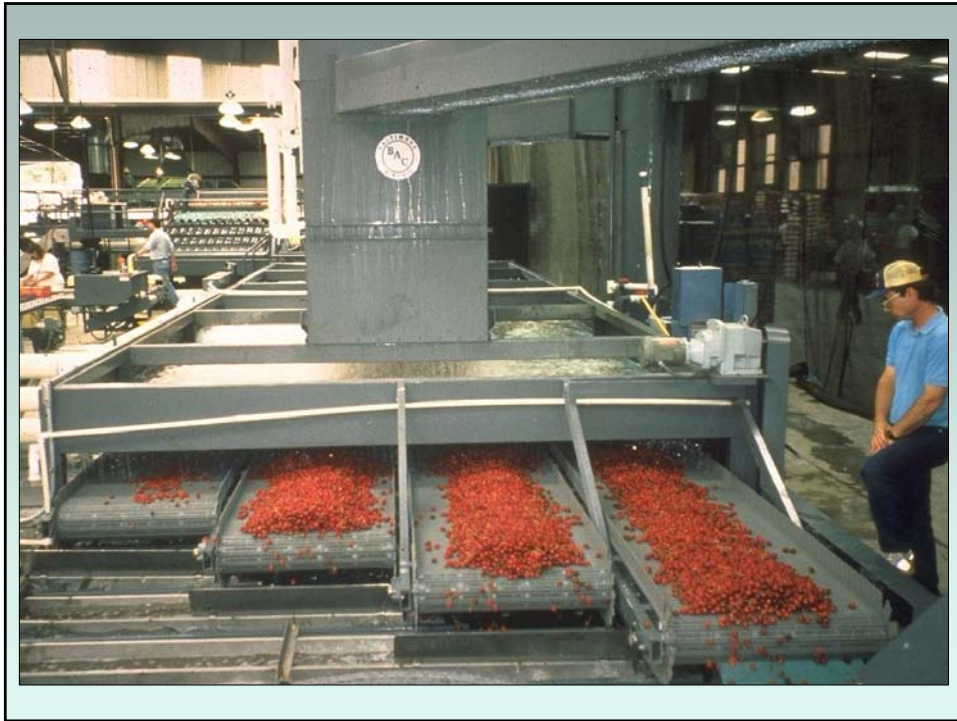


## Moisture Loss in Forced Air Cooling

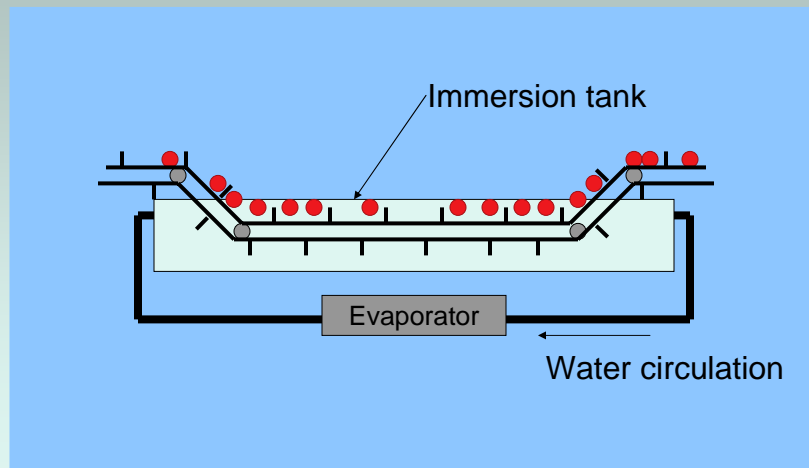


# Hydrocooling

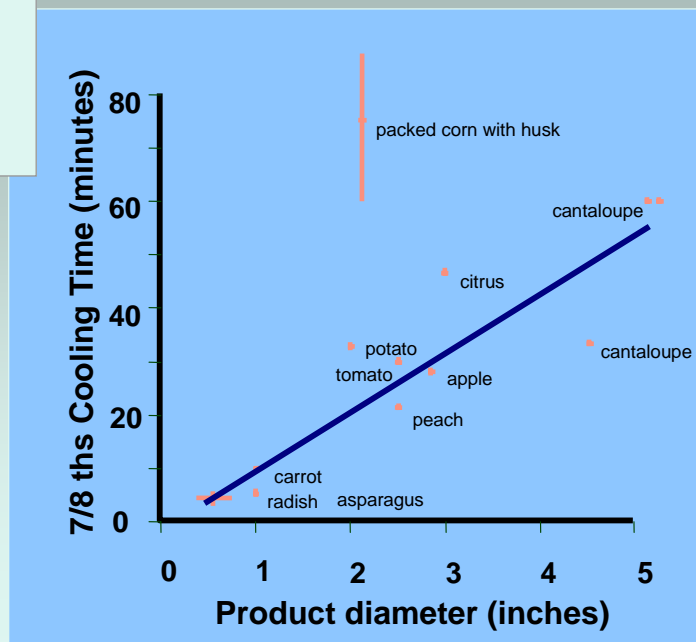




## Immersion Hydrocooler



## Hydro Cooling Time



## Moisture Loss in Hydrocooling

**Gain 0.5 % to lose .05%**

## Water Beating Damage



## Control pH and Chlorine Levels

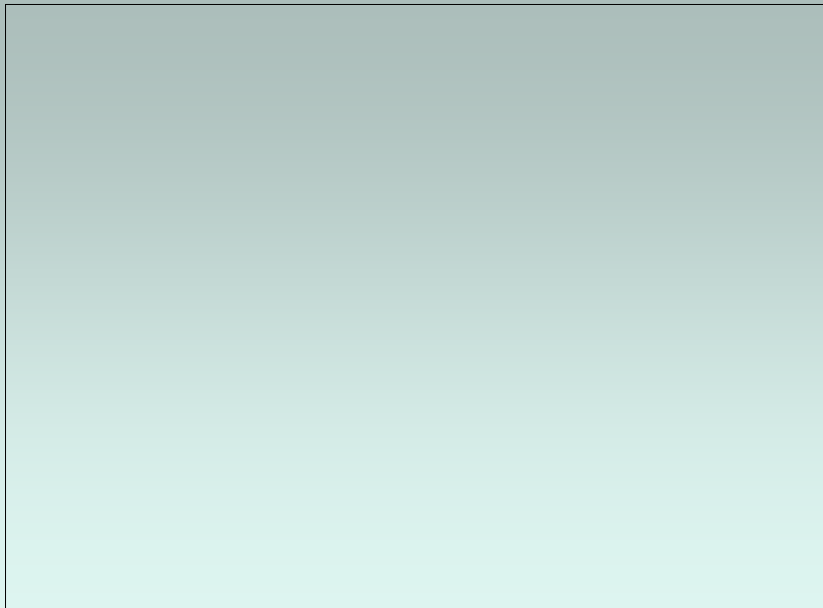


## Package Icing



Ice solidifies &  
melts away  
from product

# Liquid Ice Machine



## Vacuum Cooling

At 25mm Hg water boils at 20°C



Cools product that can release moisture quickly



## Moisture Loss in Vacuum Cooling

**Lose 2.0 to 4.0 %**

**1%moisture loss for each  
11°F (6°C) of temperature drop**

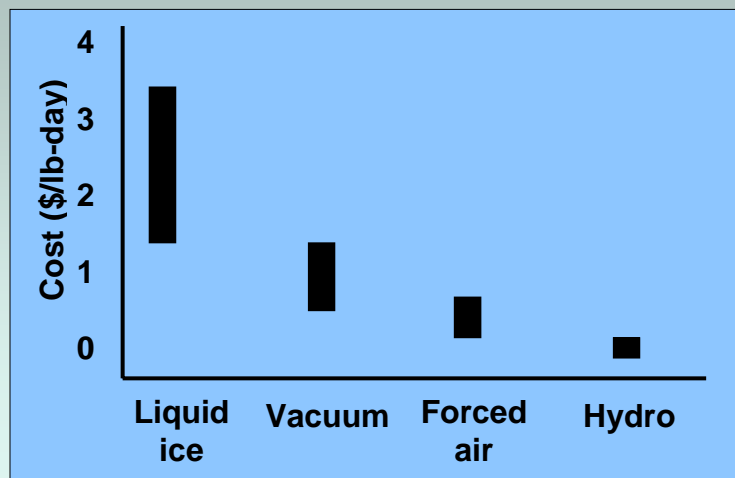
## Water Spray Vacuum Cooling



## Selecting a Cooling System

- Product requirements.
- Product mix.
- Temperature requirements.
- Cooler cost.

## Capital Cost



What is the temperature of the packing operation?



What is the temperature of the packing operation?



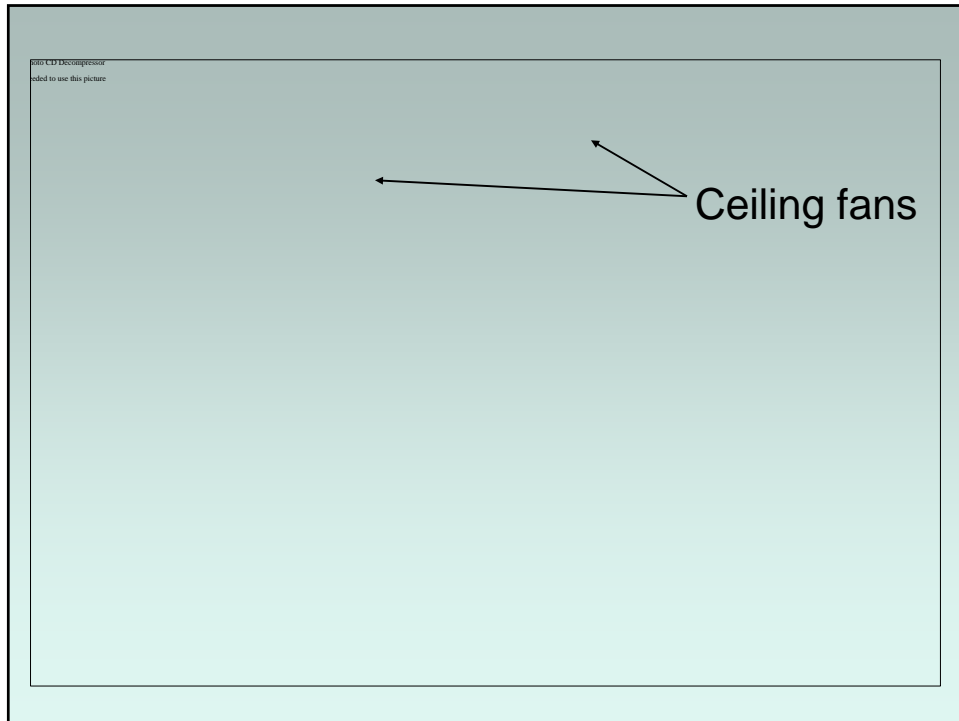
## Room Cooling

For finish cooling after packing.



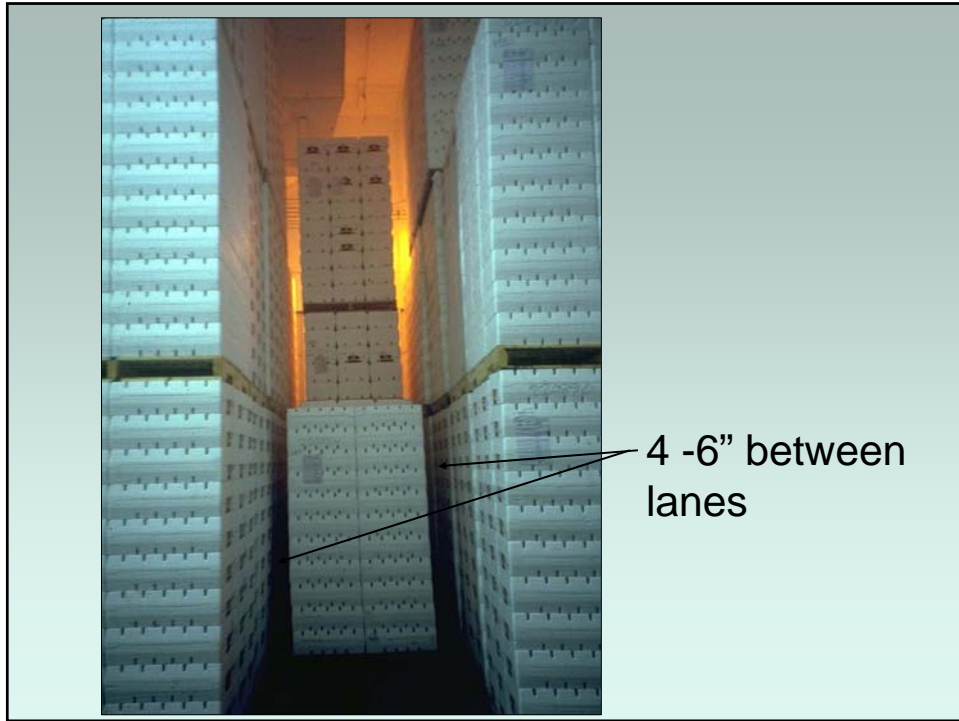
## Room Cooling

- 100 cfm per ton of product.



## Room Cooling

- 100 cfm per ton of product.
- Space stack product.



## Room Cooling

- 100 cfm per ton of product.
- Space stack product.
- Well vented boxes.

Sloped sides  
Vents



## Room Cooling

- 100 cfm per ton of product.
- Space stack product.
- Well vented boxes.
- Lowest possible air temperature.

## Highest Freezing Temperature

Apples	29.3°F
Cherries	28.8°
Pear	29.2°
Asparagus	30.9°
Lettuce	31.7°
Cauliflower	30.6°

## Room Cooling

Pallets of tight fill plums in corrugated boxes			
Vents	Box spacing	Stacking	Longest cooling time (hr)
none	none	cross	84
4%	1"	register	22
4%	1"	register	18

# Transport Cooling

Product temperature drop is rare in trailers.



Slow cooling in marine transport