



Postharvest Considerations

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Good Postharvest Management is a Very Sustainable Practice

- **32% of harvested products are never consumed**
- **Wastes resources invested in production and packaging**
- **Equal attention should be paid to pre and postharvest activities for sustainability**



Causes of Postharvest Losses from Biological and Environmental Factors

- Improper maturity/ripeness
- Poor initial quality
- Mechanical damage
- Inadequate sanitation
- Decay
- Improper product temperature
- Excessive water loss
- Undesirable levels of O_2 , CO_2 , C_2H_4
- Delays between harvest & market



***Estimated Postharvest Losses (%) of
Fresh Produce in Developing vs. Developed
Countries***

Locations	Developed Countries		Developing Countries	
	Range	Mean	Range	Mean
From production to retail sites	2-23	12	5-50	22
At retail, foodservice, and consumer sites	5-30	20	2-20	10
Cumulative total		32		32

Quality Factors for Strawberries

- Degree of Ripeness
- Presence of Gloss
- Absence of Defects
 - Decay
 - Poorly shaped fruit
 - Unripe fruit
- Firmness
- Flavor



Maintaining Postharvest Quality of Strawberries

- **Rapid cooling to near 0°C**
- **Prevent physical damage**
- **Rapid marketing**

- **Reduce decay development**
- **Reduce water loss**
- **Maintain nutritional quality**

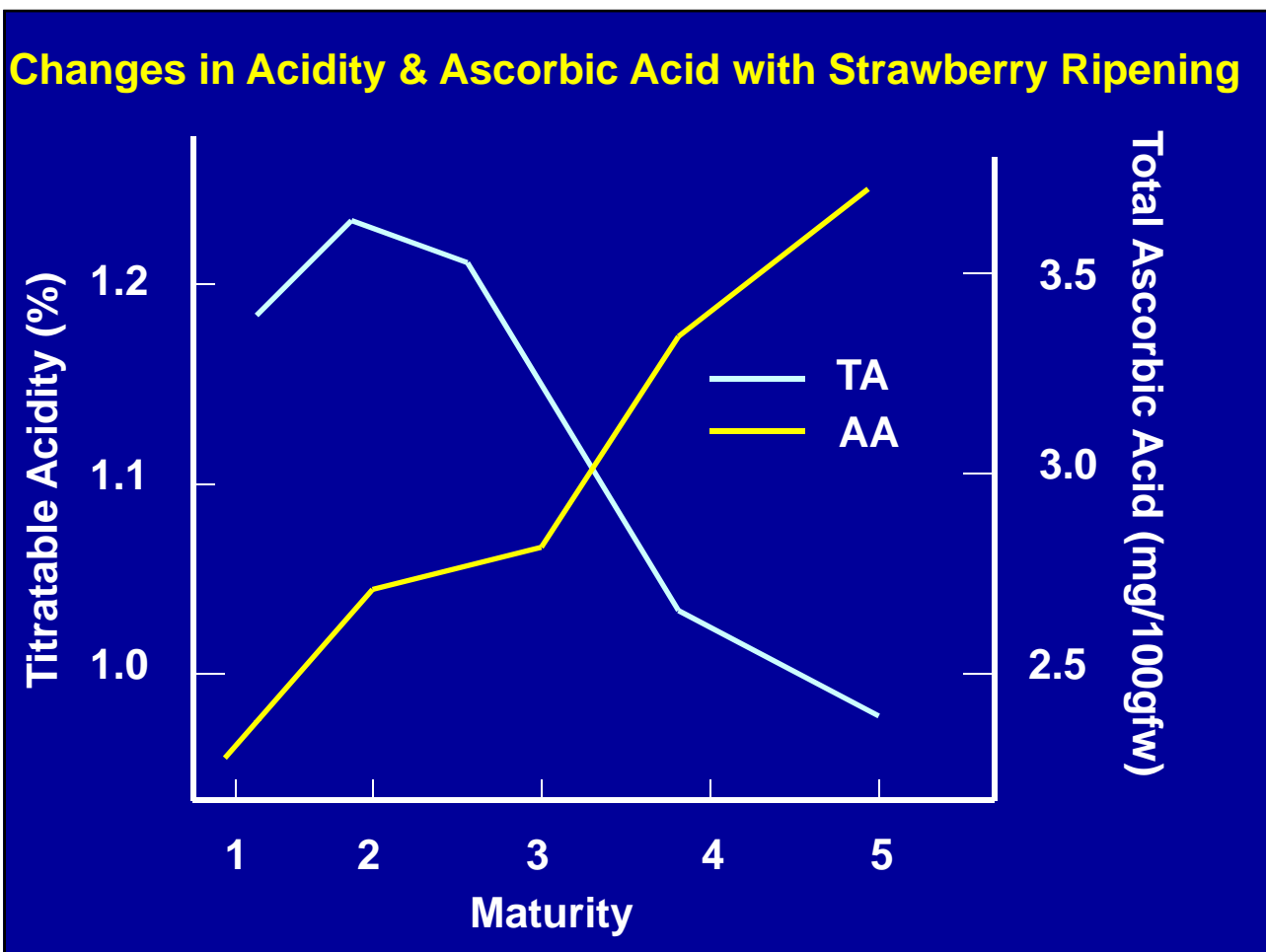


**Stages of
Strawberry
Ripening**

**Harvest near full
ripe for best flavor
quality**

**Sugars accumulate
on the plant only**



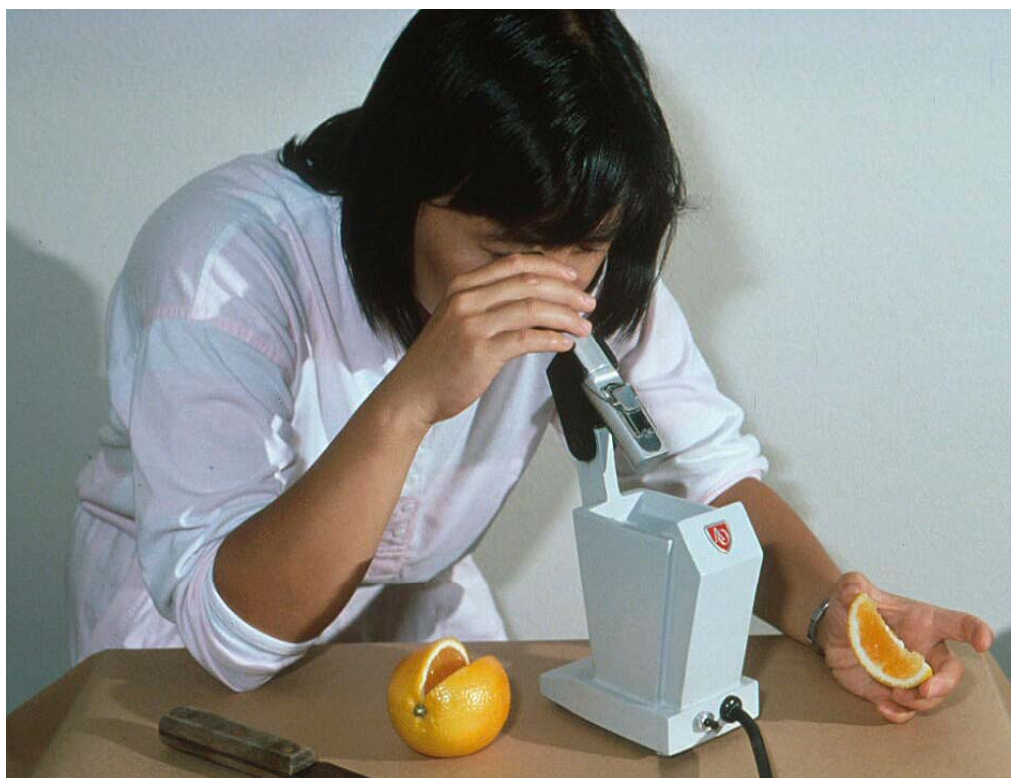


Composition of Strawberry Fruit

- **Total soluble solids** **4.6 to 11.9**
- **Titrateable acidity** **0.5 to 1.9**
- **Total ascorbic acid** **26 to 120**



Measurement of Total Soluble Solids by Refractometer

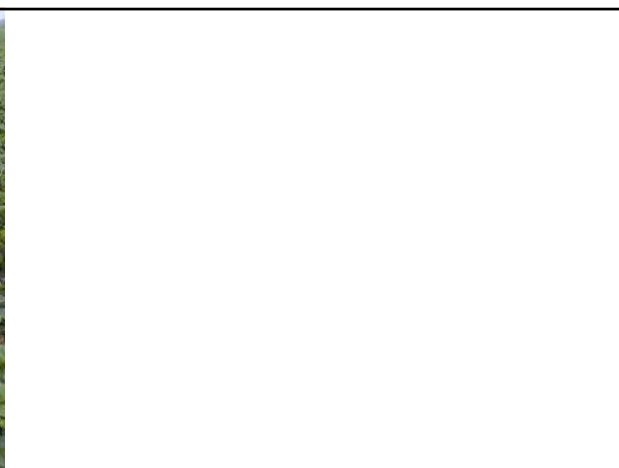


Composition of 'Seascape' Strawberries

Constituent	Mean conc. (%)	Percent of TSS
Sucrose	2.18	23.7
Glucose	1.54	16.7
Fructose	1.56	16.9
Total sugars	5.28	57.3
Citric acid	0.77	8.4
Malic acid	0.20	2.2
Total acids	0.97	10.6
Others	2.95	32.1
Total SS	9.20	100.0

What are the Other Constituents?

Constituent	Contribution to refractometer reading	% of TSS
Anthocyanins	1.95	21.2
Soluble pectins	0.60	6.5
Ascorbic acid	0.21	2.3
Phenolics	0.19	2.1
Total	2.95	32.1



Harvest, Sort, and Pack in the Field



Nesting of Botrytis Rot

One Bad Berry can Destroy the Whole Basket



Inspect and remove decayed berries before packing

Harvest Operation Pick, Pack, and Palletize in the Field





Packaging Characteristics

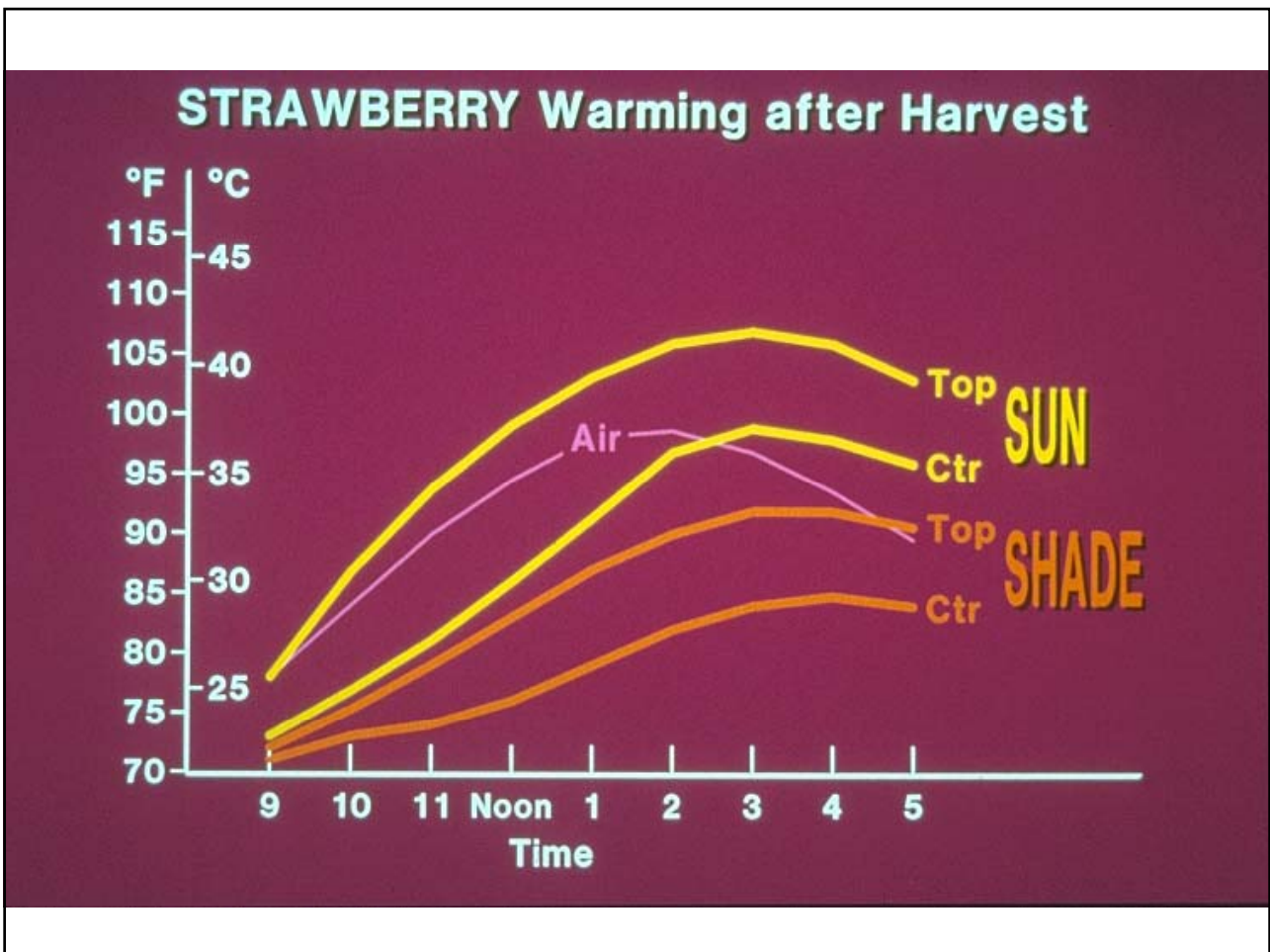
- Protect berries from damage
- Allow for rapid cooling
- Reduce water loss
- Allow for effective marketing

Harvest Operation Pick, Pack, and Palletize in the Field



Covered Receiving Area





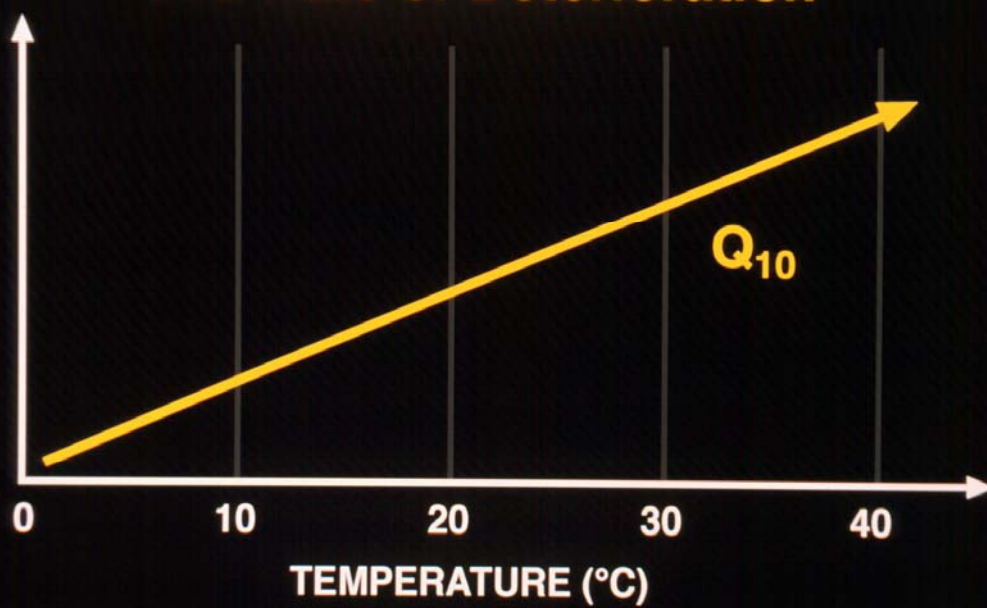
Quality Control at the Cooling Facility

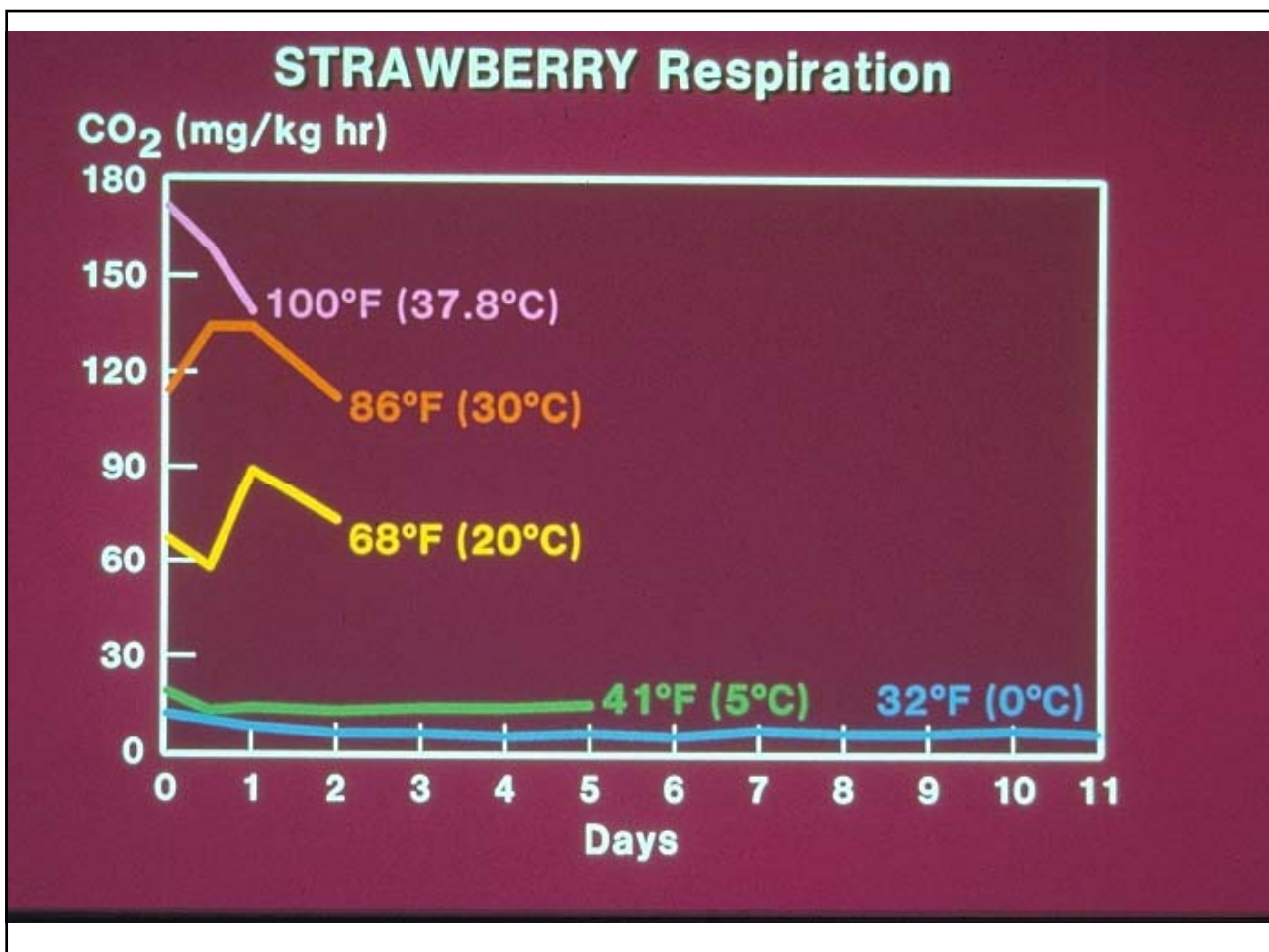


Cooling and Cold Storage Forced-Air Cooling is Best!

- **Cool fruit to 0°C as quickly as possible, 90 – 95% RH**
 - Reduce water loss
 - Reduce decay
 - Reduce respiration rate and extend postharvest life

Relationship Between Temperature and Rate of Deterioration





Postharvest Life

0°C	5°C	10°C	15°C	20°C
7	5	3	2	1 days

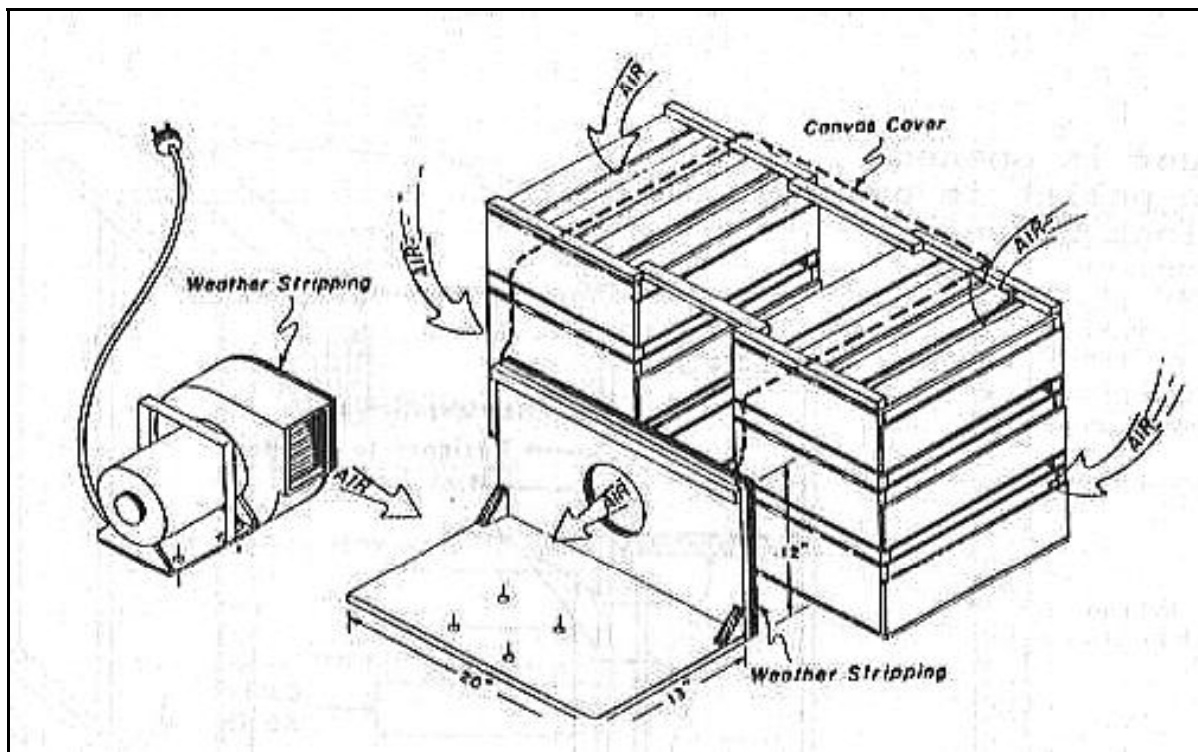


Nunes et al., 2002

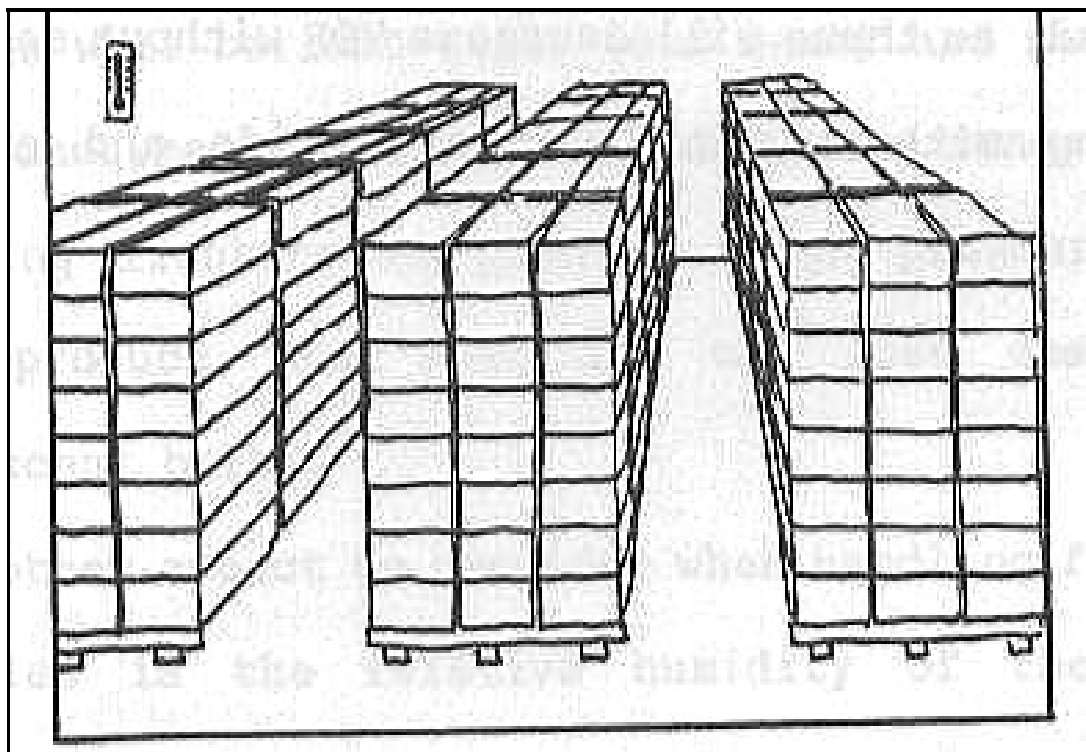
Forced-Air Cooling of Strawberries



PORTABLE FORCED AIR COOLER



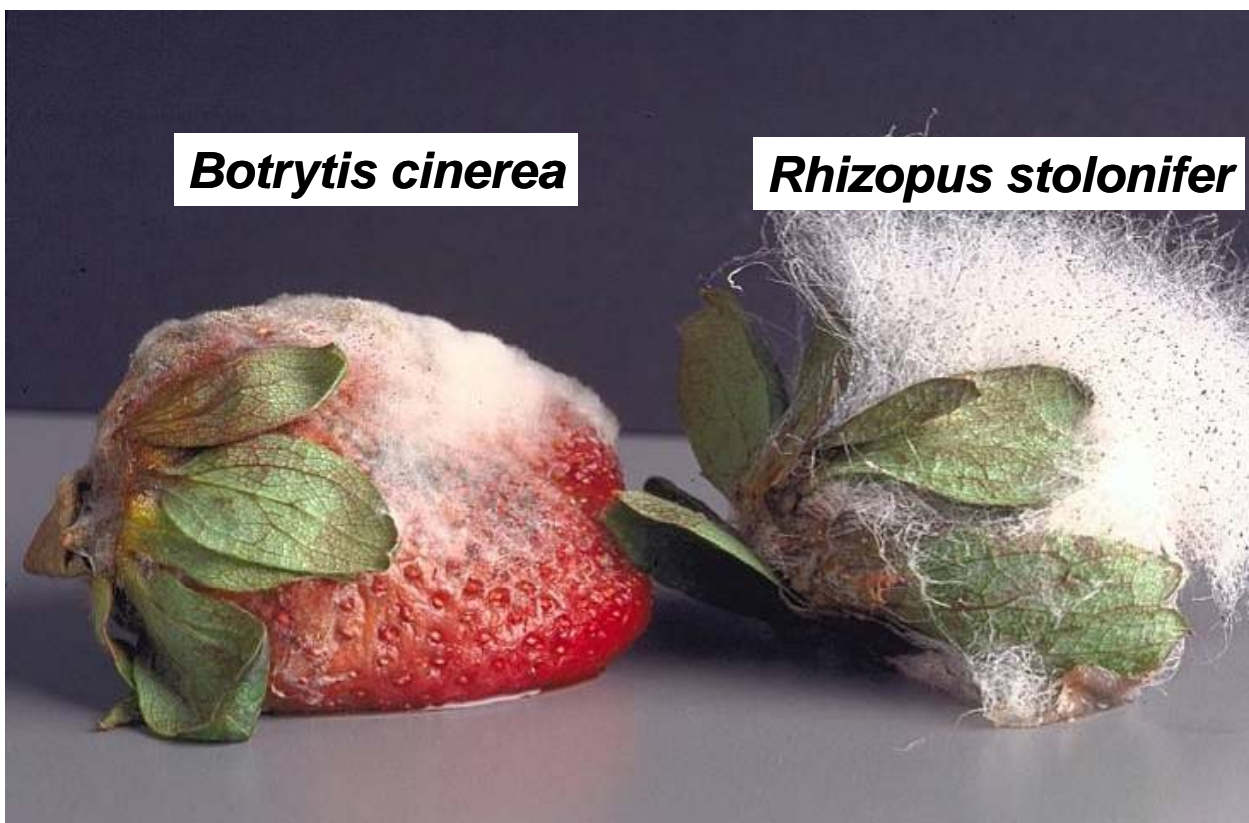
ROOM COOLING SETUP



Postharvest Decay of Strawberry

Botrytis cinerea

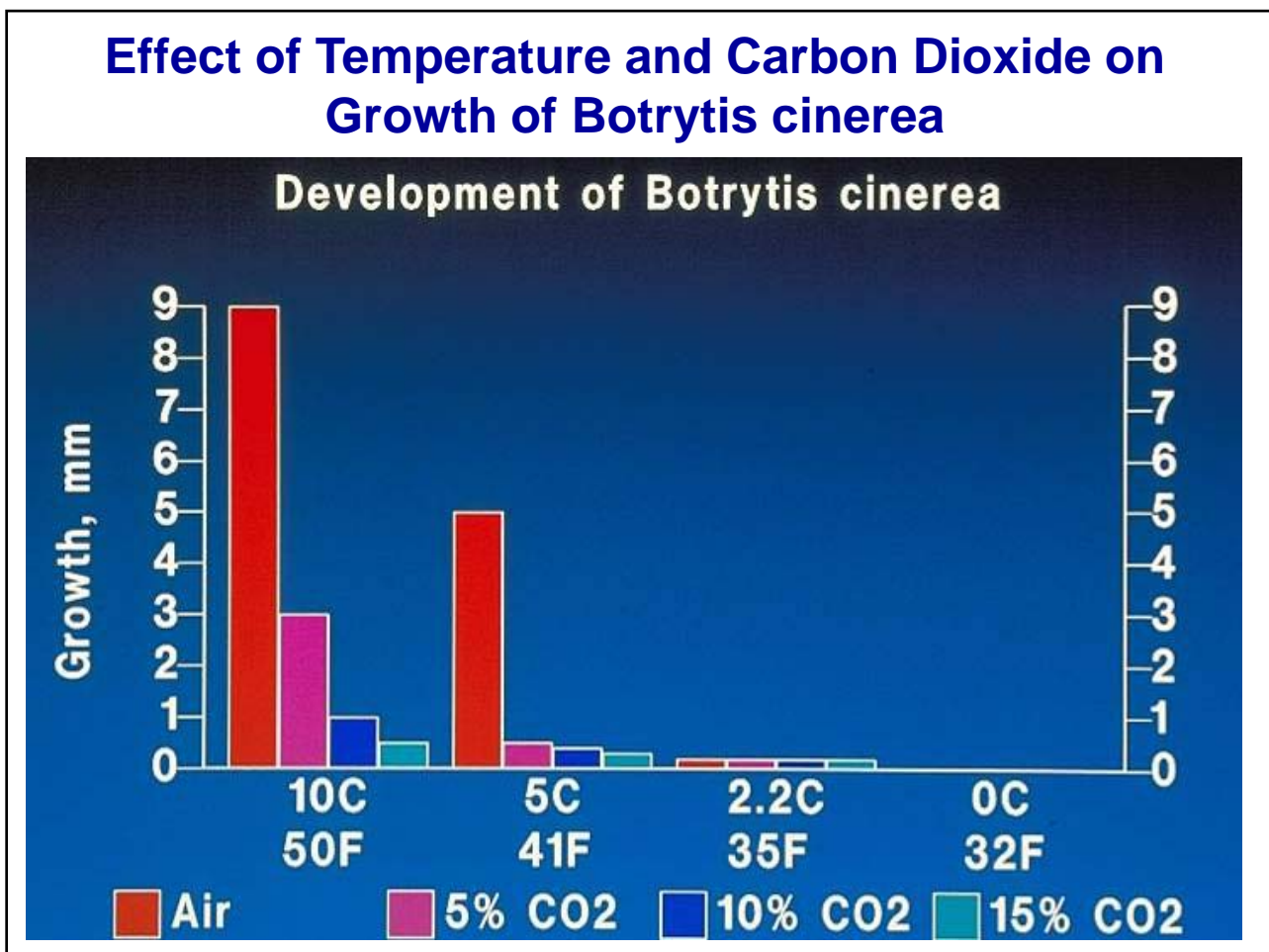
Rhizopus stolonifer



Pallet Covers for Carbon Dioxide Treatment of Strawberries during Transport



Effect of Temperature and Carbon Dioxide on Growth of *Botrytis cinerea*



Comparison of Pallet Cover Systems to Maintain Strawberry Fruit Quality



University of California, Davis
University of Florida, Gainesville



Pallet Cover Setup in California

- 🍓 'Albion' fruit in clamshells were packed into flats and palletized
- 🍓 Fruit were forced-air cooled to a pulp temperature of 35°F
- 🍓 Different cover systems were then placed over pallets

- **Tectrol®**

Cover was sealed to the pallet and CO₂ was injected inside

- **CO2 West**

Cover was open at the base and pads release CO₂ inside

- **Peakfresh®**

Cover was open at the base

- **PrimePro®**

Cover was open at the base

- **Uncovered control**

- 🍓 Pallets were shipped by truck to Florida in 4-5 days





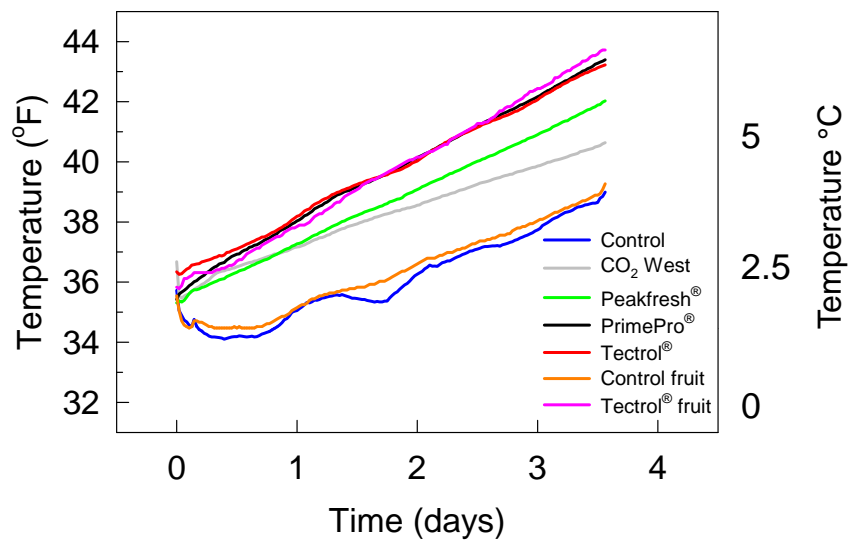
Tectrol System



CO₂ West
Active Pad

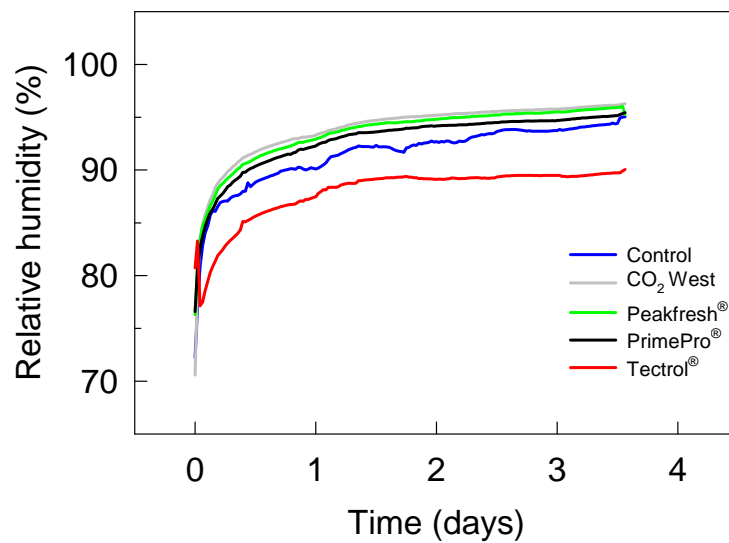
Key Results

- Temperatures within covered pallets steadily increased during shipment, while the air temperature in non-covered control pallets fluctuated with the truck refrigeration



Key Results

- 🍓 The average relative humidity inside clamshells during shipment was highest in most of the covered pallets, and lowest in the Tectrol[®] pallets



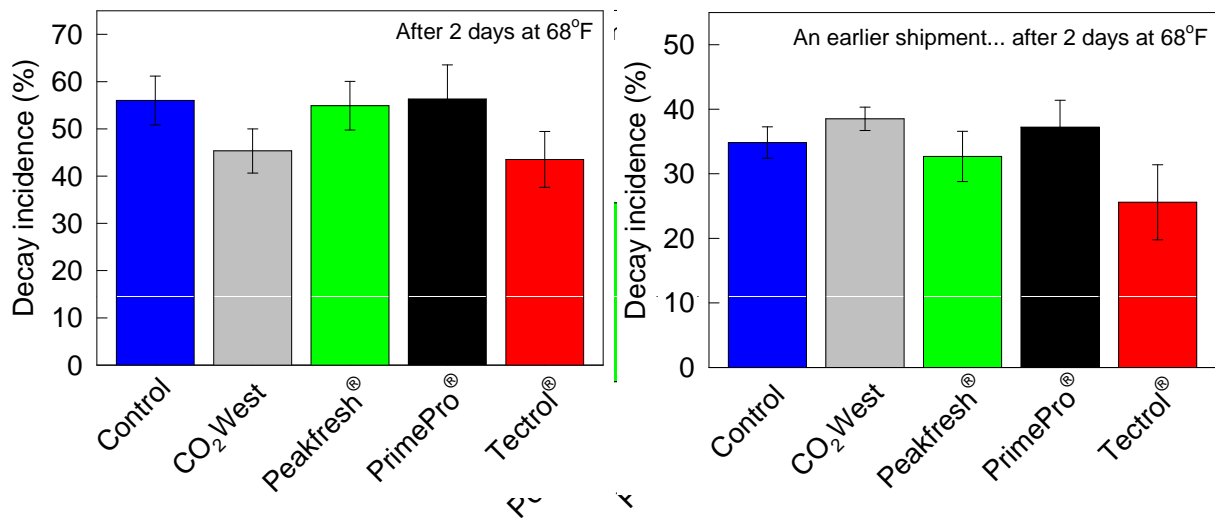
Key Results

- CO₂ concentrations were highest in the Tectrol® pallets at the beginning (13.2-34.4%) and end (2.8-24.8%) of shipment
- CO₂ concentrations in the other covered pallet systems were relatively low at the beginning and end of shipment

Pallet cover	Initial CO ₂ (%)	Final CO ₂ (%)
Control	0.03 ± 0.00	0.18 ± 0.00
CO ₂ West	0.06 ± 0.02	0.32 ± 0.06
Peakfresh®	0.04 ± 0.02	0.37 ± 0.05
PrimePro®	0.05 ± 0.01	0.30 ± 0.03
Tectrol®	16.00 ± 3.54	12.23 ± 3.76

Key Results

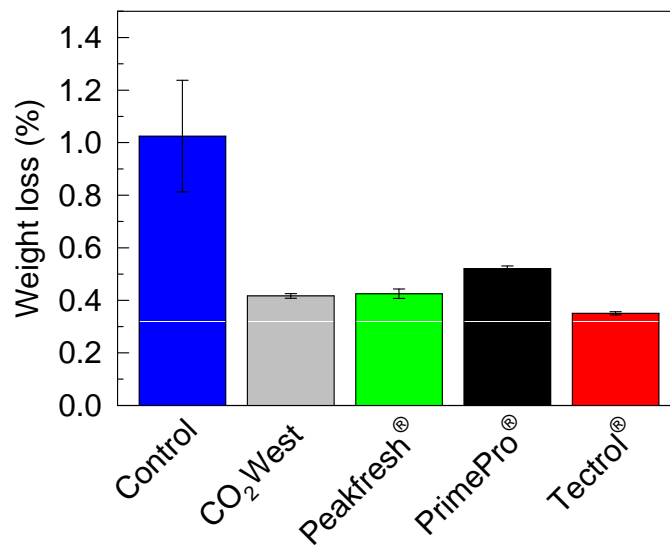
- 🍓 The incidence of decay was 0.5-1.7% for fruit from all pallets immediately after shipment
- 🍓 Fruit decay incidence increased considerably after a 2-day shelf life at 20°C



Key Results

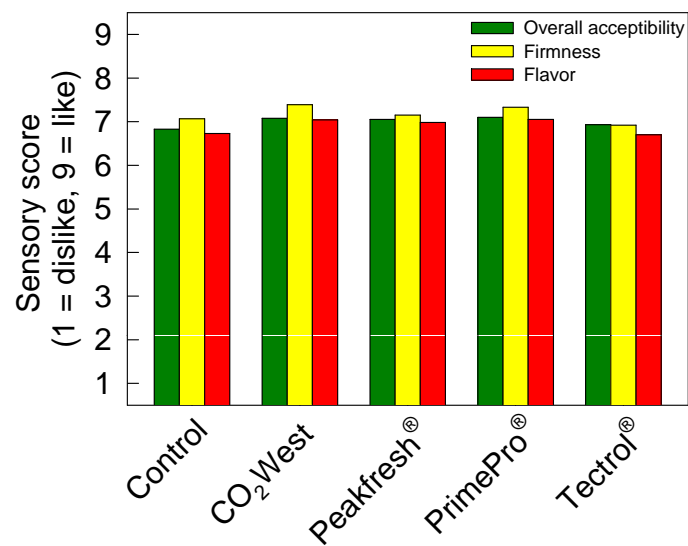
- 🍓 Relative to non-covered pallets which lost 1% of fruit weight during shipment, covering pallets with the different shrouds reduced transport-related weight loss by 49-66%.

Fruit were packed in covered clamshells



Key Results

- There were no discernable differences in the eating quality of fruit sampled from the different pallet systems as judged by a 100-person consumer taste panel



Handling times & temperatures during simulated handling from the grower to the retail display (chosen as representative of our measurements at each handling step and taken over a 5-year period)

Handling simulation	Time (h)	Temperature (°C)	
		Semi-constant	Fluctuating
Harvest	0	-	-
Warehouse (grower) + Truck	17	3	3
Tarmac	2 (19)	3	10 (1h) + 20 (1h)
Airplane	7 (26)	3	20
Tarmac	1 (27)	3	RT*
Truck + Warehouse (distribution center) + Truck	24 (51)	3	3
Backroom (supermarket)	24 (75)	8	8
Retail display	15 (90)	20	20
Retail display	9 (99)	20	20
Total time	99 (4 days + 3h)		

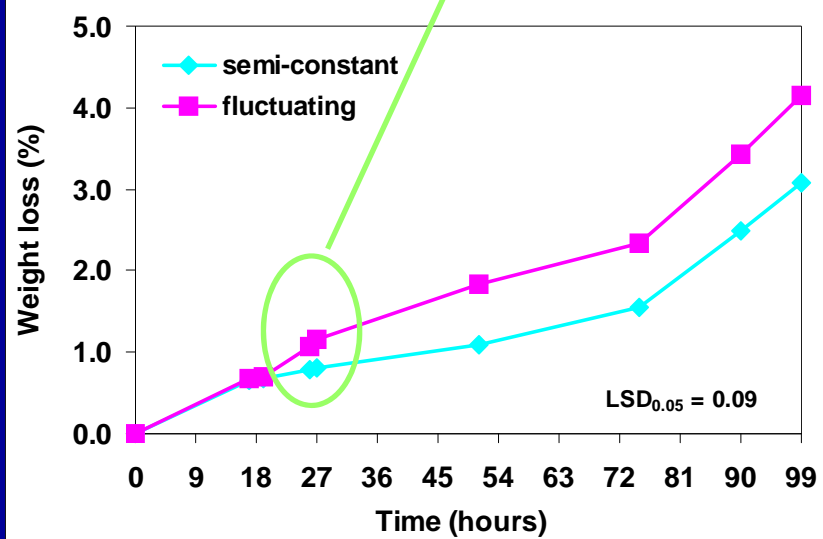
*RT room temperature 23-24°C

10h

Results

Higher weight loss

Tarmac – flight - tarmac



**Appearance of Strawberries
After Simulated Air Shipment
At Semi-Constant or Fluctuating Temperatures**



Higher anthocyanin content (more dark red)

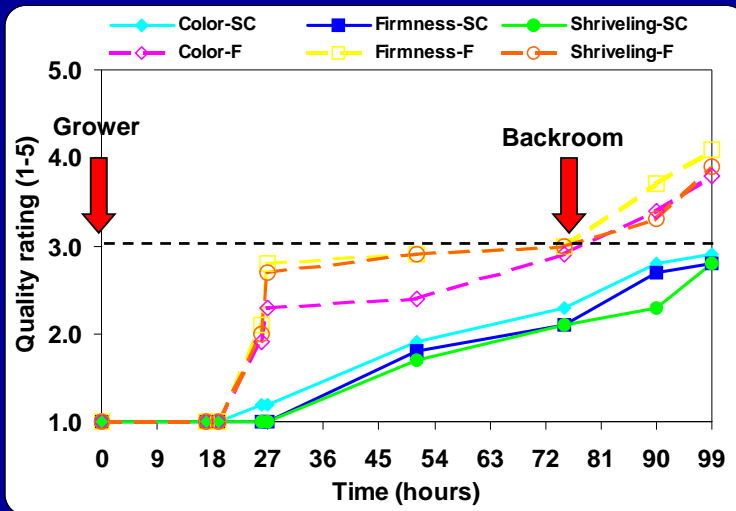
Lower ascorbic acid content

Time	Anthocyanin (mg PGN · 100g ⁻¹ FW)*		AA (mg·100g ⁻¹ FW)	
	SC	Fluctuating	SC	Fluctuating
<i>First harvest</i>				
At harvest	0.165	0.165	75.25	75.25
Retail	0.141	0.162	65.35	63.33
LSD _{0.05}		0.02		1.95
<i>Second harvest</i>				
At harvest	0.103	0.103	60.13	60.13
Retail	0.093	0.135	57.27	53.93
LSD _{0.05}		0.02		0.98

*PGN = Pelargonidin-3-glucoside

Nunes et al., Univ. Florida

Limiting quality factors



Color
Firmness
Shriveling
Bruising

Limited the shelf life of the strawberries handled under fluctuating temperature to 75h

Never would have reached the consumer

Nunes et al., Univ. Florida

Advanced Fresh Air Management

- A feature of marine containers manufactured by Thermo King Corp.
- AFAM, or Automated Fresh Air Management, uses a small motor to set the fresh air exchange of a container thru the microprocessor controller.
- AFAM+ adds a gas analyzer to the unit to vary the air exchange based on CO₂

J. Brecht, Univ. Florida

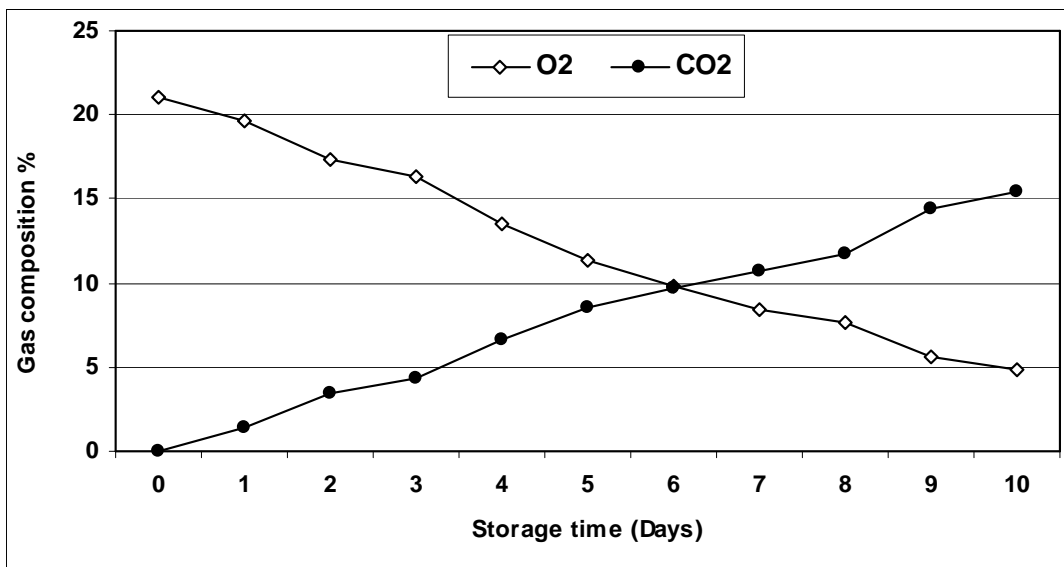


Fig. 5. Respiratory gas composition in a closed strawberry container stored at 2°C. After 10 days of storage, the gas composition was about 5% O₂ + 15% CO₂.





Questions?

<http://postharvest.ucdavis.edu>

