Refrigerated Trailer Transport

Cherry Life

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Respiration Rate</th>
<th>Life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>60</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>70</td>
<td>35</td>
<td>3</td>
</tr>
</tbody>
</table>
Before Loading Trailer

• Equipment is in good condition

Clean floor & walls

Chute attached, Seals intact
Before Loading Trailer

- Equipment is in good condition
- Cooled to transport temperature
Before Loading Trailer

- Equipment is in good condition
- Cooled to transport temperature
- Reefer off when doors are open

Loading Product

- Product is well cooled
- Pallet loads are unitized
- Keep an air space around load
Trailer Heat Gain

Airflow in Trailers

- evaporator
- fan
- chute
- product
- bulkhead
Airflow in Trailers

- head space
- intact chute

Airflow in Trailers

- wall channel
Centerline vs Staggered Loading

- In 7 loads - no significant difference in average load temperature.
- Other tests show about 1°F increase in product temp loaded next to wall vs away from wall.
Stone Fruit & Table Grapes

Product warming in 3.5 days transport, average of 7 loads

<table>
<thead>
<tr>
<th>Temp 1</th>
<th>Temp 2</th>
<th>Temp 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2°F</td>
<td>1.8°</td>
<td>1.4°</td>
</tr>
<tr>
<td>4.1°</td>
<td>3.2°</td>
<td>1.1°</td>
</tr>
</tbody>
</table>

- Solid bulkhead, full air chute, loaded on palettes, staggered or centerline loaded.
- Average air temp = 31°F

Centerline Air Bags
Staggered Load Offsets

Airflow in Trailers

Product

Rear door channel
Airflow in Trailers

Horizontal Air Supply

Carrier: Smart-Air system
Horizontal Air Supply

No gaps between pallets
Brace load
Boxes vented on 48” side of pallet

Rear Brace
Loading

- Fruit is well cooled.
- Pallet loads are unitized.
- Keep an air space around load.
- Meet highway weight limits.

Single Pallet

Front  Rear

air bag
Single Pallet

Single pallet allows air to bypass load

Set Thermostat Temperature

- For stone fruit and grapes = 34°F
Temperature Recorders

Mixed Load Problems

- Blocked air flow
- Crushed ice on floor
- Hand loaded boxes
- Load dividers
Mixed Load Problems

- Blocked air flow
- Warm produce

Mixed Load Problems

- Blocked air flow
- Warm produce
- Temperature, ethylene, odor compatibility
Produce Compatibility

Vibration Damage
Prevent Vibration Damage

Marine Containers
Airflow In Containers

- High capacity fan
- Product
- Evaporator
- Deep channel floor

Break-Bulk Ships
Package

- strength for 3 weeks at high humidity
- vertical venting

Pallet

- deck boards must support box corners
- no box overhang
- stabilize with netting or corner boards & straps
- 4-way pallet
Package & Pallet Design

- Vents for vertical airflow.
- Pallet is secured.
- Box vents align.
- Boxes maintain strength in high humidity.
- Boxes extend to edge of pallet.
- Deck boards allow vertical airflow.

Precooling

- cool stone fruit and grapes to 32°F
Before Loading

- precool container.
- turn off refrigeration when doors are open.
- do not load with trash in floor or damaged walls or door seals.

Air Flow In Containers

- high capacity fan
- product
- evaporator
- deep channel floor
Uncovered Floor

Air bypasses product

Loading

Do not load above limit line

Block exposed pallet openings and cover floor to deflectors
Loading Patterns

- 18 Pallets
- 20 Pallets
- 19 Pallets (Problem Load)

Single Pallet in Front

Air bypasses load

Air supply area
Loading Patterns

Horizontal airflow

After Loading

• set supply-air temperature control
• set thermostat to ≤ 34°F
After Loading

- set supply-air temperature control
- set thermostat to ≤ 34°F
- adjust air exchange to:
  - 45 cfm for stone fruit
  - 15 cfm for grapes

Automatic vent control

- CO₂ & O₂ measurement
- lower ventilation rates
- faster cool down

Thermoking: AFAM+
Air Freight

Pre & Post Flight Handling

Often more than 50% of trip
Product Temperature

Cool product to lowest possible temperature.

Strawberry Quality

<table>
<thead>
<tr>
<th>Temperature Pattern</th>
<th>°C</th>
<th>Sound Fruit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>51</td>
</tr>
</tbody>
</table>

0 12 24 36 48 Hours
Air Freight
Protect from heating

Temperature Gain in 8 hr (°F)

No wrap  Wrap  Wrap + coolant

Refrigerated Containers

Nippon Cargo Airlines
## Food Miles

<table>
<thead>
<tr>
<th>Method</th>
<th>travel w/ equal energy use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship</td>
<td>3800</td>
</tr>
<tr>
<td>Railroad</td>
<td>2400</td>
</tr>
<tr>
<td>Highway truck</td>
<td>740</td>
</tr>
<tr>
<td>Air</td>
<td>43</td>
</tr>
<tr>
<td>Car w/5kg of produce</td>
<td>1</td>
</tr>
</tbody>
</table>