Avocado Postharvest Handling

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Persea americana Mill.

Family: Lauraceae

3 horticultural races

- Mexican
- Guatemalan
- West Indian (Antillean)

Bul. 743, U. S. Dept. of Agriculture. PLATE XXII.

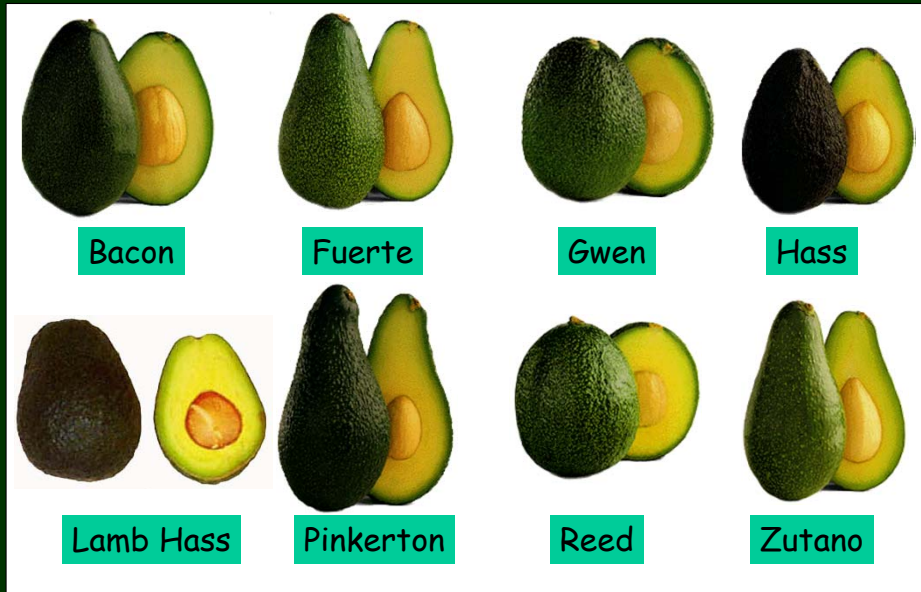
THE TERTOH AVOCADO, ONE OF THE LARGEST GUATEMALAN VARIETIES.

The fruits here shown are not yet fully grown. Good specimens of this variety weigh 3 pounds and are of excellent quality, the flesh being rich yellow in color, free from all discoloration, and of nutty flavor. The seed, as will be noticed in the illustration, is comparatively small. This variety has a considerable reputation in the vicinity of the city of Guatemala, owing principally to its large size. Avocados weighing more than 2 pounds are rare in Guatemala. (Photographed at the city of Guatemala, December 2, 1917; 17760173.)

Avocado

- Most leading avocado producing countries produce Guat/Mx race avocados
- More tropical areas produce West Indian Race avocados
- Leading cultivar worldwide: HASS

California Avocado Cultivars



Hass Seasonality

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
California												
Mexico												
Chile												
Peru												
Dominican Republic												
New Zealand												

Susceptibility to low storage temperatures

External Chilling Injury

Internal Chilling Injury

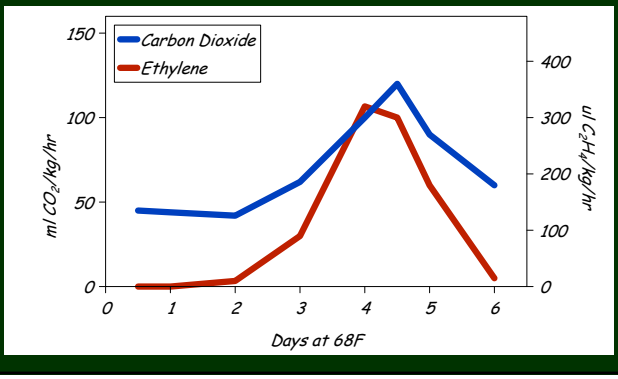
Postharvest Diseases

Stem End Rot

What we know about the avocado fruit

- It is a climacteric fruit showing an increase in respiration and ethylene production during ripening
- Influenced by maturity, time after harvest, temperature and atmosphere

Adapted from Eaks (1978) for 'Hass'



Field Operations

- Minimum Maturity Standards
  - Dry Weight
- Harvesting Methods
- Bin Holding
- Multiple Harvests per year

California switched to Dry Matter in 80's from oil content

Relationship between dry wet and oil

Also "raised" minimum maturity based on sensory evaluation

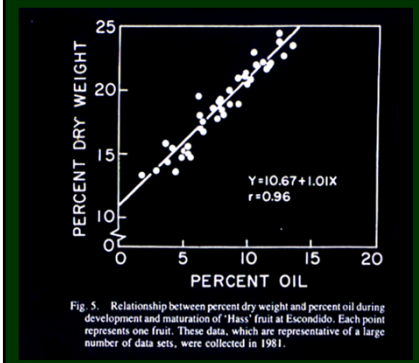


Fig. 5. Relationship between percent dry weight and percent oil during development and maturation of 'Hass' fruit at Escondido. Each point represents one fruit. These data, which are representative of a large number of data sets, were collected in 1981.

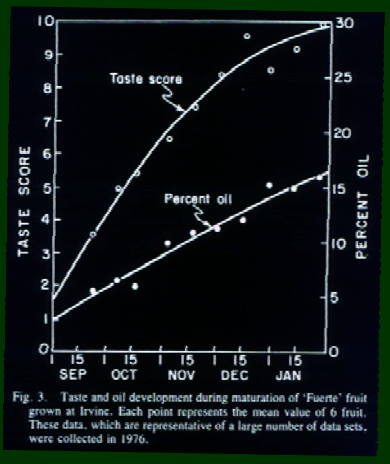


Fig. 3. Taste and oil development during maturation of 'Fuerte' fruit grown at Irvine. Each point represents the mean value of 6 fruit. These data, which are representative of a large number of data sets, were collected in 1976.

Work of Lee et al. (UCR)

Current California Minimum Maturity Standards

Dry Matter (%)	Variety
17.7	Bacon
18.7	Zutano, Reed
19.0	Fuerte
20.8	Hass
21.6	Pinkerton
22.8	Lamb Hass, GEM, Harvest
24.2	Gwen

Date/Size Maturity Releases

- Date/Size maturity releases allow avocados to move in a uniform manner.
- Avocados can still be harvested before the release dates, but they will be tested for minimum maturity standard.
- Regulated by CA Dept of Food and Ag.

Dry matter determination in California

- 5-fruit bulk sample
- Core sample from middle of fruit
- Microwave drying to constant weight

- NIR for the future????

'Hass' size and release dates

size 40 and larger	size 48	size 60	size 70 and smaller
Nov 28	Dec 12	Jan 2	Jan 16

Fruit *clipped*
Trees are tall – ladder work and picking poles required
Bins moved to receiving area

Bins hold approx. 900 lbs

Considerations in the grove

- Avoid picking when temperatures are high especially with late season fruit
- Avoid picking during or shortly after a rain event – more decay
- Keep fruit in a cool place, out of the sun; high temperatures can impact ripening and increase decay
- Minimize delays from time of harvest to cooling

The link between the preharvest environment and fruit quality

Quality does NOT improve after harvest

Increasing body of evidence that many factors influence PH fruit quality and decay development

- Mineral nutrition, most notably N, Ca
- Rootstock via mineral distribution
- Canopy management strategies
- Plant growth regulators such as Sunny and Cultar
- Weather conditions just prior to harvest
- Fruit position on the tree

All contribute to fruit quality; interact with each other
Important to understand interaction with fruit maturity

Packing Operations

- Bins cooled overnight
- Dry dump
- Brushing (waxing)
- Labeling/weight sizing
- Packing

Bin Dump

Labeling and Sizing by weight

Grading


Tray Pack
Volume Fill


RPC
Shrink Wrapped
Bagging
...and all combinations

Box weights calibrated and final quality inspection

Palletization

From US packinghouses often shipped in mixed loads;
Imports either in break bulk vessels or CA containers

Physical damage and chilling

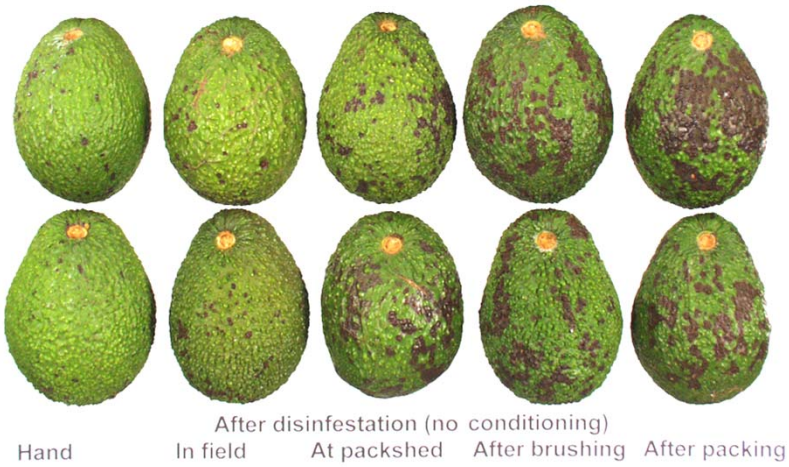
Damage is cumulative;
worse if turgid or wet fruit are harvested

Lenticel damage

External chilling

Source: Hofman, Cutting, Dixon, Pak

Physical damage and chilling



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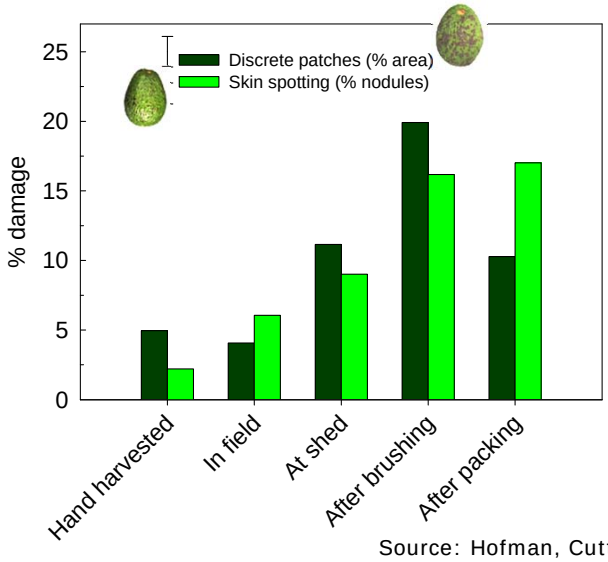
Physical damage and chilling



Source: Hofman, Cutting, Dixon, Pak

Avocado Storage and Transit

- California fruit marketed within 1 – 2 weeks of harvest; storage at 5C
- US imports arrivals vary in time after harvest:
  - <5 days (Mexico)
  - 7 – 10 days Dominican Republic
  - 12 – 28 days (Peru/Chile)
  - approximately 28 days (New Zealand)
- Fruit from Chile and New Zealand may be shipped in Controlled Atmosphere containers
- Fruit quality has been mixed on longer transit times…….
- 1-MCP ?

Can you successfully cold-treat avocado?

The fruit will respond positively to intermediate low temperature conditioning

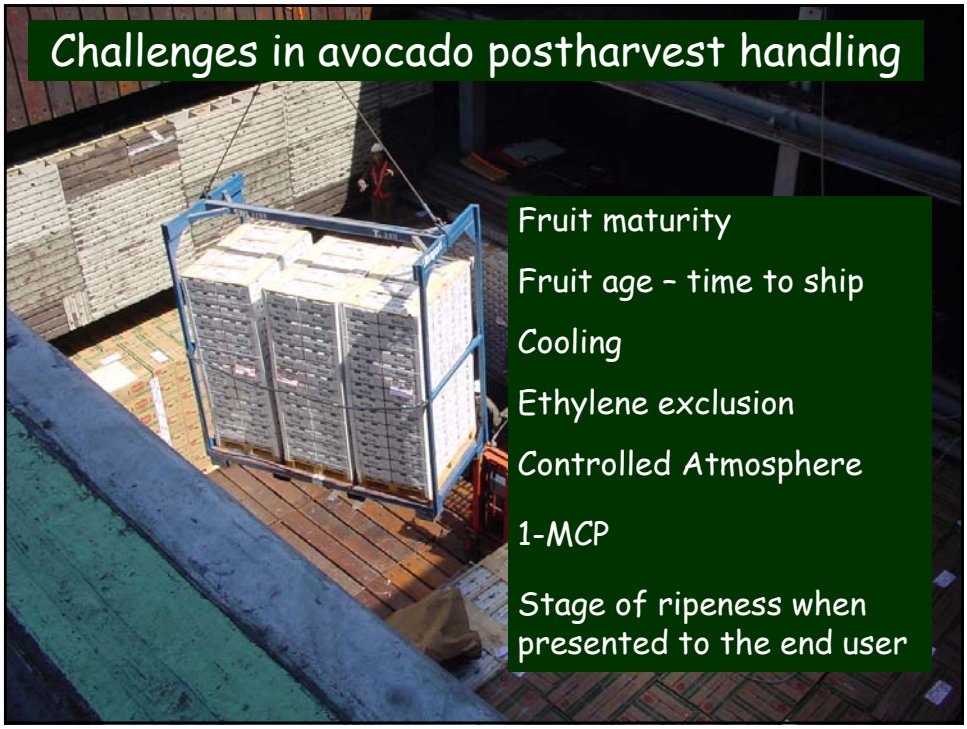
Work published by Hofman et al (2003) PBT and Woolf et al (2003) PBT demonstrated that following several days at 6-8C will provide protection against peel damage during subsequent low temperature storage.

Success of conditioning is dependent on temperature (don't want softening) and duration.

Temperature Range: 5-10C

Duration: 3-5 days

Challenges in avocado postharvest handling



- Fruit maturity
- Fruit age – time to ship
- Cooling
- Ethylene exclusion
- Controlled Atmosphere
- 1-MCP
- Stage of ripeness when presented to the end user

Ethylene - hastens deterioration

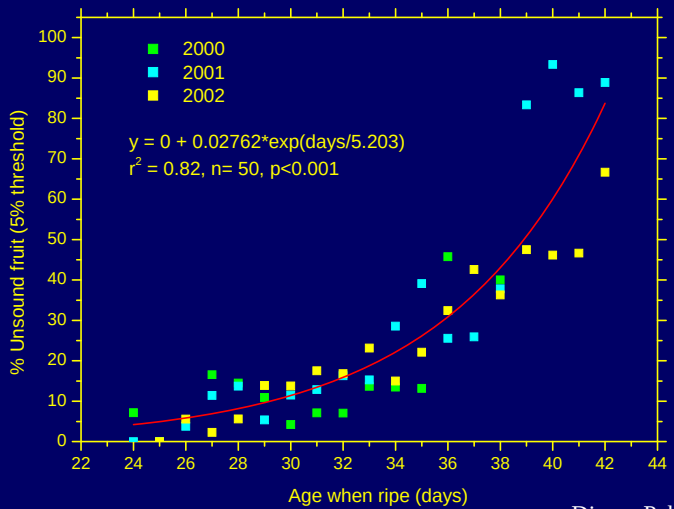
Ethylene contamination
- Softening
- Physiological disorders

Use of CA
- High CO_2 counteracts ethylene
- Slows softening

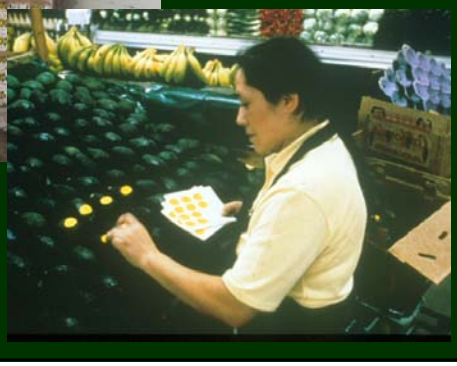
Use of 1-MCP
- Can slow softening
- Development of disorders
- Risks – overdose fruit; ripening

There are problems with fruit arrivals

Relationship between fruit age and unsound fruit



Dixon, Pak and Cutting



"RIPE FOR TONIGHT"

- Increasing importance for both domestic and imported fruit
- Ethylene treatment can occur at packinghouse, distribution points or specialty handlers

Why Ripen Avocados?

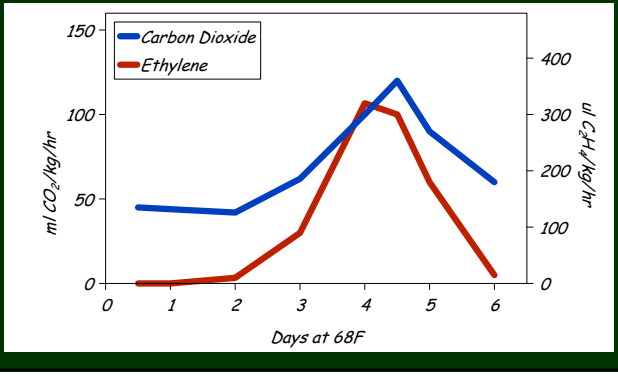
Untreated, fruit ripening may range from a few days to even weeks within a carton

Increase Uniformity
Decrease Checkerboarding

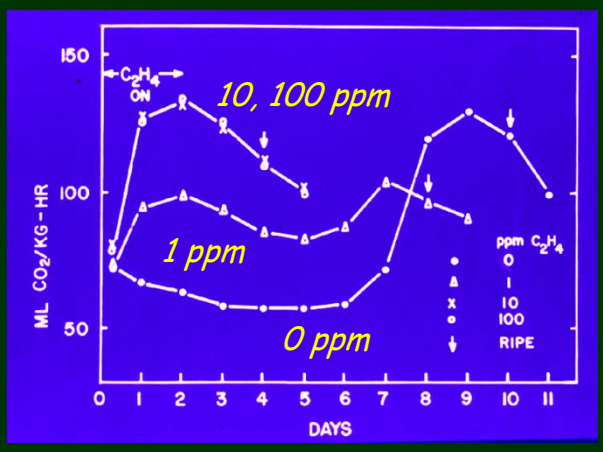
Why will avocados respond to ethylene?

- It is a climacteric fruit showing an increase in respiration and ethylene production during ripening
- Influenced by maturity, time after harvest, temperature and atmosphere

Adapted from Eaks (1978) for 'Hass'



How much to apply?



- *Short exposures to ethylene can trigger ripening*
- *Threshold is believed to be around 10 ppm*
- *Commercial application of 20 - 100 ppm is recommended*

Source: I. L. Eaks, UC, Riverside

Ethylene dose considerations

- Ethylene concentration
  - >20 ppm; no more than 100 ppm
- Fruit Maturity
  - Less mature; longer treatment
- Time after Harvest
  - With increasing time after harvest; shorter durations needed

Ripening Management
When do you turn off the gas?

- You don't need the gas until ripe; a short duration treatment will "trigger" ripening
- Fruit may soften but may not color – maturity and other factors involved
- The best way to gauge the rate of softening is with a penetrometer…not your fingertips or buttons "popping"

The penetrometer is a tool to judge the relative stage of ripeness

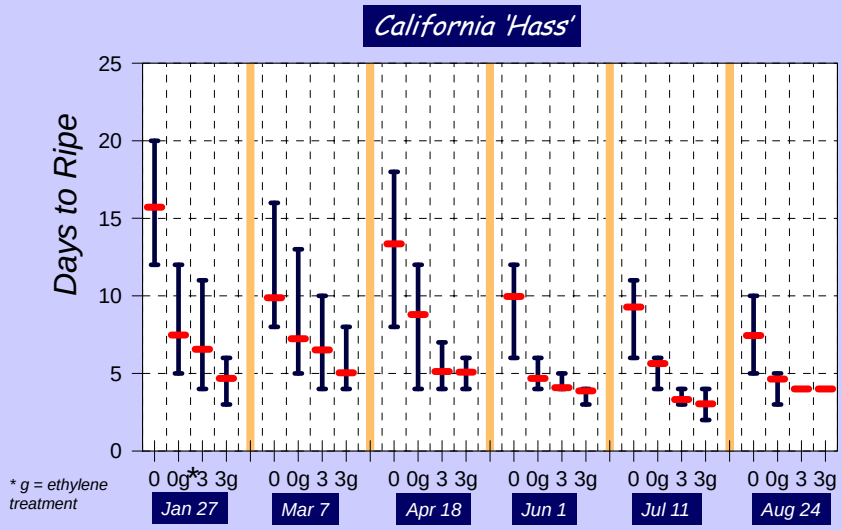
Ripening Management

- Uniform heating and cooling is ABSOLUTELY ESSENTIAL
- Refrigeration needs to control the heat (6000 BTU/pallet)
- Forced air ripening is critical (1000 cfm/pallet)
- Venting (preferably flow through, keep CO_2 below 1%)
- Source of Ethylene – as low as possible; physiologically you only need ~10 ppm)
- Fruit needs to be easily accessible in ripening room for monitoring; especially if fruit is of varying arrival condition or multiple lots of fruit
- Keep good records

Time after harvest

- Ethylene has maximum benefit within 1-2 weeks of harvest
- Imported fruit (i.e. Chile) if conventional shipment will need less time (24 hours or less)
- Imported fruit if CA shipped or 1-MCP treated may need longer treatment times

*Note the affect of **maturity**, **storage** (3 wks @ 41F) and **ethylene** (50ppm) on the amount of days to ripe to <1.5 lbf at 68F as well as the variability of the data (checkerboarding)*

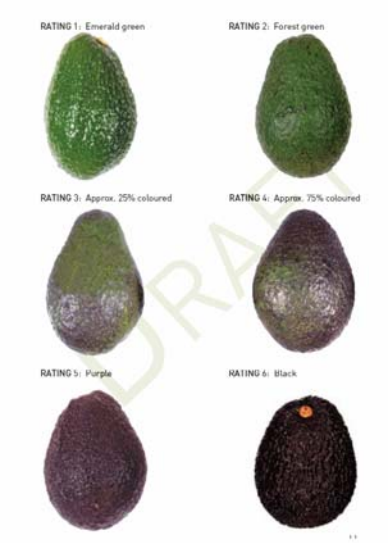


LH2000 - 25 fruit; San Diego fruit

Suggested treatment times for California 'Hass' avocados

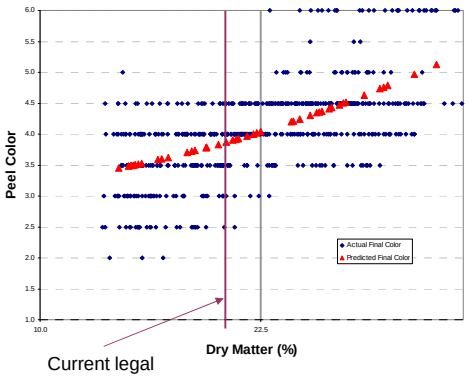
- Early season fruit (November – February) *36 – 72 hours*
- Mid-season fruit (March – June) *24 – 36 hours*
- Late season fruit (July – October) *8 - 24 hours*

California ‘Hass’ Avocado



Relationship between dry matter and final peel color

Final Peel Color = 3.06261- 0.00264DW +0.0020DW^2
where DW = Dry weight
R^2 = 0.621 ***

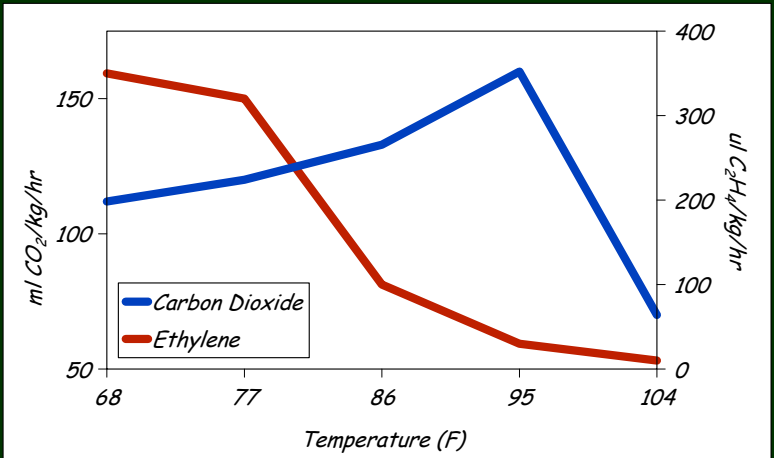


Management Issues

Temperature
Ventilation/Air exchanges

- ✓ *Careful Monitoring*
- ✓ *Prompt Movement of fruit*
- ✓ *What is the proper stage of ripeness?*
- ✓ *Where do you ripen the fruit?*

High Temperature Effects on 'Hass' Fruit Respiration and Ethylene Production (Eaks, 1978)



Peak respiratory rate and ethylene production. Fruit held continuously at temperature.

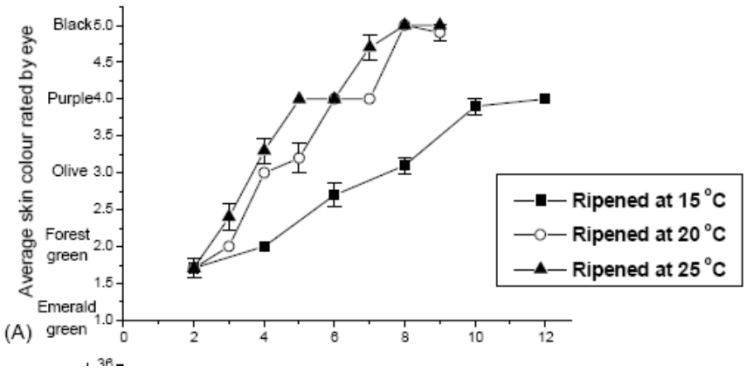
Temperature Management

- Efficient warming/cooling of fruit essential
- Airflow essential to maintain proper pulp temperature (20C, 68F) and CO_2 < 1%

Impact of high temperatures

- Delayed/uneven ripening
- Increased decay

'Hass' Avocado



Ripening temperature influences final peel color

Cox et al, 2004, PH Biol. Tech.

Ventilation

- Buildup of carbon dioxide (inhibits ethylene action)
- Airflow essential to maintain proper pulp temperature (68F)

Preliminary data suggests that short durations of high carbon dioxide (up to 3 -5%) can be tolerated but need to remember OSHA requirements

Postripening Management

- Temperature and softening rate
- Know your customer
- Chilling injury susceptibility
- Move fruit as quickly as possible to end user
- Periodically visit your end user to assess fruit quality and how you are doing

The outcome of “ripe” fruit

Ripe fruit at retail level has greatly increased consumption,

HOWEVER…..

- Greater challenge in temperature management
- Fruit sensitivity to damage greatly enhanced
- A problem NO MATTER the source – an opportunity to work with other industries

Example of fruit shriveling

Example of an overripe fruit with stem end rot, body rot and internal

Example of a stem end rot

Example of body rots

A. *Fruit with no bruising under the peel.*
B. *Fruit which is very overripe and is exhibiting bruising under the peel.*

A. *Very ripe fruit compressed by other fruit on display.*
B. *Example of internal bruising.*
C. *Very ripe fruit showing severe internal damage.*

Considerations for successful avocado ripening

- Temperature management is CRITICAL
  - Too high; ripening inhibited and increased decay
  - Too low; ripening is slowed and lose benefit
- Fruit Maturity
  - More mature; less time
- Time after Harvest
  - After storage; less time
- Avoids delays in marketing
- Minimize fruit handling

CONSUMER/MARKET Education

Checklist

Quality; don't use stressed fruit

Standardize fruit size and maturity

Uniform warming and cooling

Careful monitoring; don't overripen

Limitations to avocado postharvest handling

- Fruit maturity and quality at time of ripeness
- Time after harvest (fruit age)
- Stage of ripeness – more difficult to handle "ripe" fruit

Trends for the future

- 1-MCP
  - –Prestorage/preshipment
  - –Post-ethylene to slow ripening
- Alternative packaging for conditioned fruit
  - –Protecting the fruit during transportation
  - –Protecting the fruit from the consumer
- Ripening closer to end user
- Alternative storage methodologies and understanding O_2 and CO_2 requirements
- **Gene sequencing of avocado will open new doors for research**

Additional information

- California Avocado Commission
  www.avocado.org
- Hass Avocado Board
  avocadocentral.com
- Information on avocados in general from around the world
  www.avocadosource.com