Considerations for Fresh-cut Fruit Vegetables

- Immature Fruit Vegetables
  - Squash
  - Cucumber
  - Beans
- Mature Fruit Vegetables
  - Peppers
  - Tomatoes

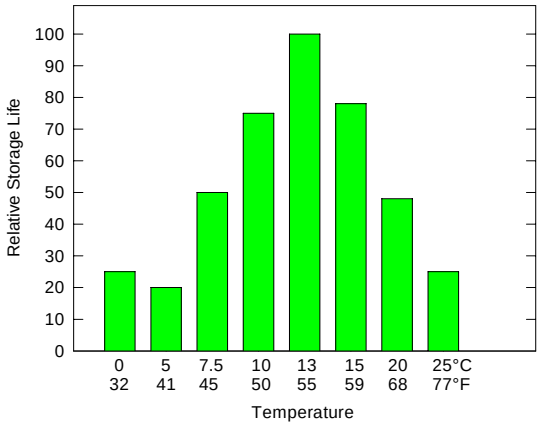
Immature Fruit Vegetables

- **Beans, Peas**
- **Summer squash**
- **Okra**
- **Cucumber, chayote, other cucurbits**
- **Eggplant**
- **Tomatillo**
- **Sweet corn**

- **Maturity**
- **Water loss**
- **Physical damage**
- **Chilling injury**
- **Decay**
- **Internal seed development**

Chilling Sensitive Products: Cucumber

Shelf-life of cucumbers in relation to temperature



Sensitivity
Exposure Time
Temperature

Symptoms:
poor ripening
discoloration
pits and sunken areas
increased weight loss
increased decay

Symptoms of chilling injury

- Surface pitting
- Water soaking
- Browning
- Necrosis
- Rots

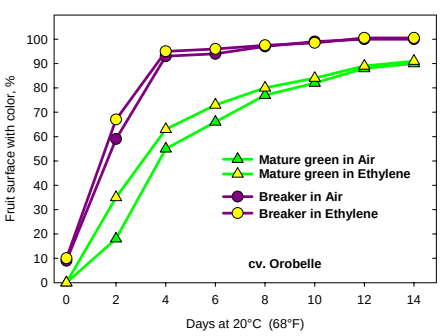
Mature Fruit Vegetables

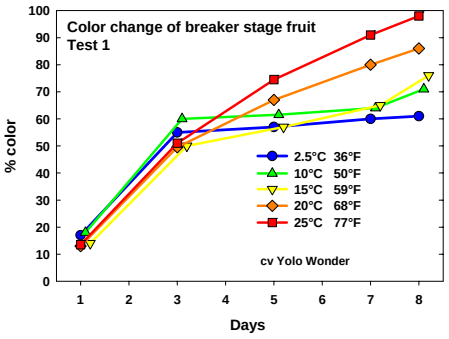
- Peppers, Chiles
- Winter squash, pumpkins
- Tomatoes
- Melons

- **Maturity at harvest critical for quality**
- **Chilling sensitive, but variable in sensitivity**
- **Ethylene can control ripening**
- **Moderate respiration rates; can be stored**

Pepper Ripening

- Bell peppers generally do not respond to ethylene
- Temperature has the greatest effect on color change or ripening.
- Holding at 25-29°C (77-84°F) maximizes rate of color change

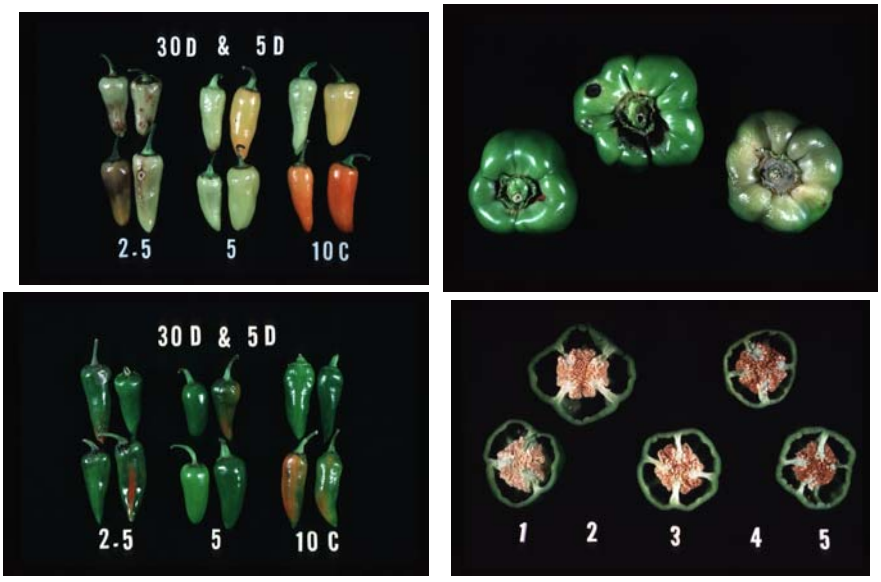




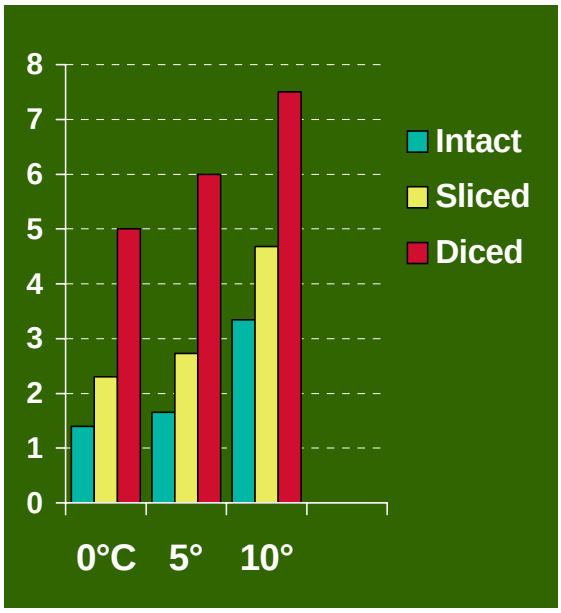
Storage Conditions for Peppers

- High RH reduces water loss but may increase superficial decay on stems
- Avoid condensation, will favor bacterial decay on damaged areas
- Temperature: 5-10°C (41-50°F); 7.5°C (45°F) is best
- Shelf-life: 2-3 weeks
- CA not provide much benefit; low O2 retards color change

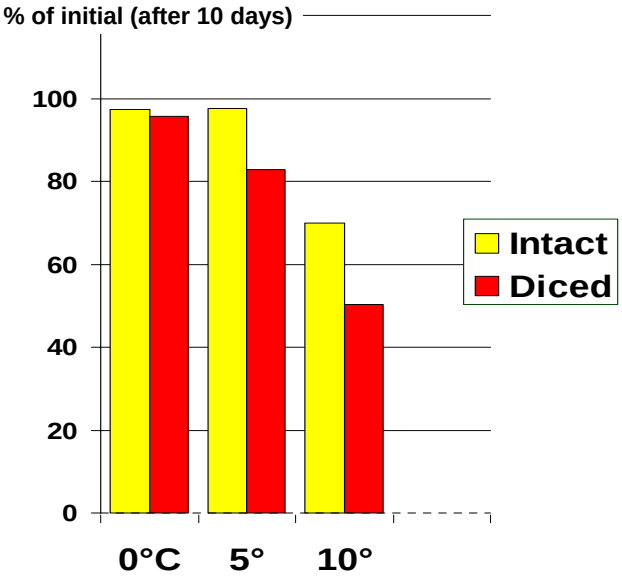
Chilling Injury Symptoms on Peppers and Chiles



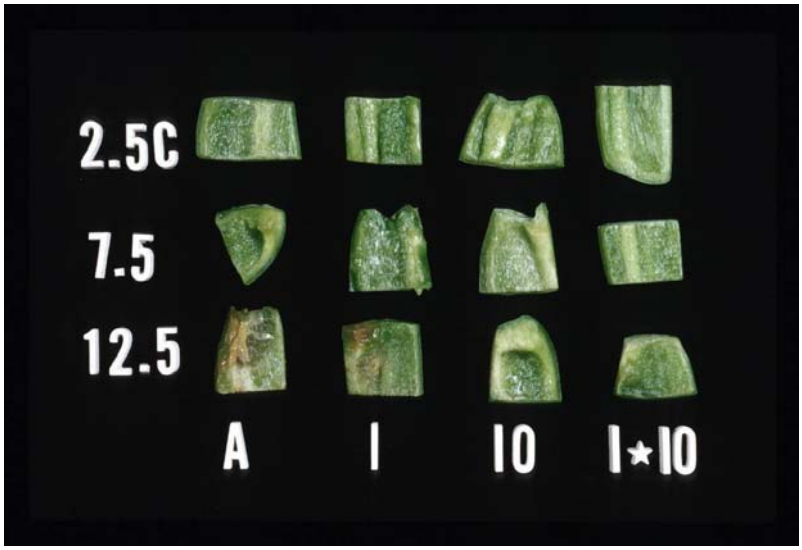
Respiration rate (ml CO2/kg-h) of fresh-cut MG peppers



Changes in sugar content of fresh-cut MG pepper



Temperature and CA effects on MG bell pepper



Temperature and CA effects on MG bell pepper

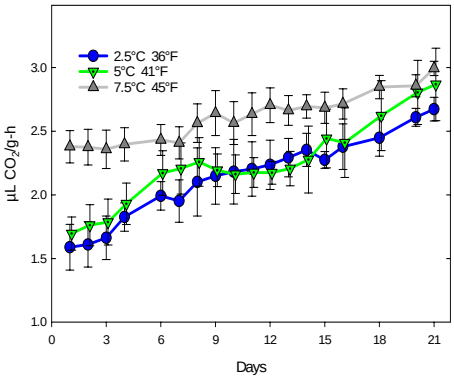
Raw Material Quality

Peppers are chilling sensitive. What happens to fresh-cut quality if intact peppers have been stored at temperatures below that recommended (7.5°C, 45°F)?

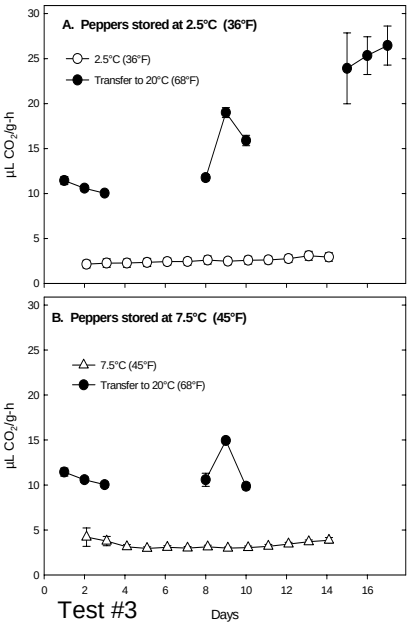
Conclusions to date:

Peppers are chilling sensitive and storage below 7.5°C (45°F) results in chill-induced increases in respiration. However, the impact of storing high quality summer-harvested peppers up to 14 days at lower than recommended temperatures (2.5 or 5°C, 36 or 41°F) on the quality of fresh-cut pieces was small.

Peppers: Preprocessing Storage Temperature



Test #2



Test #3

Fresh-cut tomato products

Maturity & Ripening Stages

1 
GREEN The tomato surface is completely green. The shade of green may vary from light to dark.

2 
BREAKERS There is a definite break of color from green to bruised fruit Tannish-yellow, pink or red or 10% or less of the tomato surface.

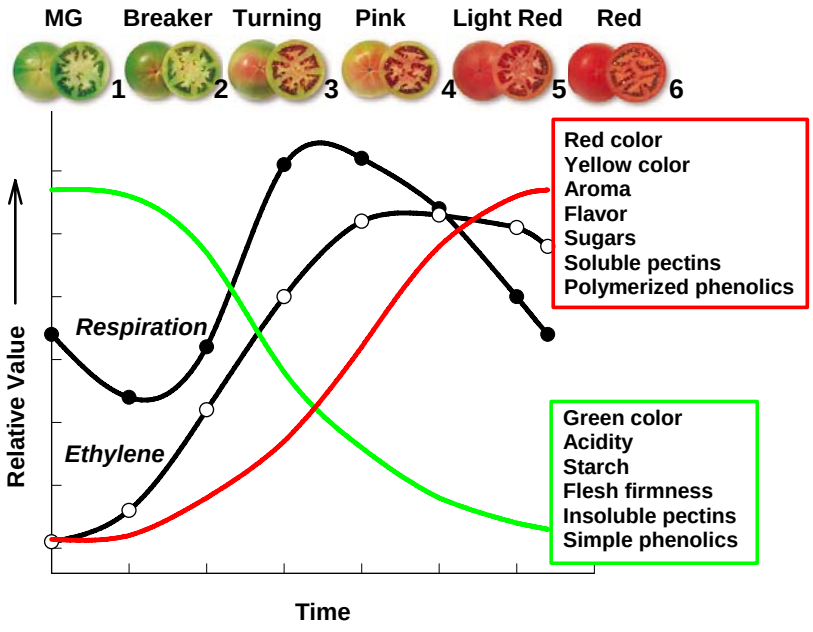
3 
TURNING Tannish-yellow, pink or red color shows on over 10% but not more than 30% of the tomato surface.

4 
PINK Pink or red color shows on over 30% but not more than 90% of the tomato surface.

5 
LIGHT RED Pinkish-red or red color shows on over 60% but red color covers not more than 90% of the tomato surface

6 
RED Red means that more than 90% of the tomato surface, in aggregate, is red

http://www.tomato.org/
http://www.floridatomatoes.org/

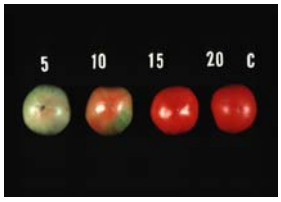


Tomato photos: http://www.tomato.org/food/color.html

Tomato Color

Carotenoids

- β– and other carotenes
- Lycopene (90%)

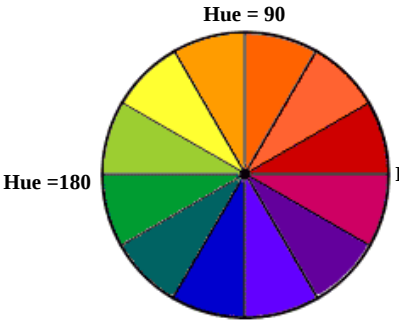


Lycopene extraction and spectrophotometric determination
Fish, W. W., P. Perkins-Veazie, J.K. Collins. 2002. A quantitative assay for lycopene that utilizes reduced volumes of organic solvents. J. Food Composition Analysis 15: 309-317.

The Functions of Tomato Lycopene and Its Role in Human Health
2004. HerbalGram, J American Botanical Council; Issue: 62 Page: 49-56

Tomato Color

Simplified Color Wheel



Minolta Color Meter

Good red color in tomatoes:

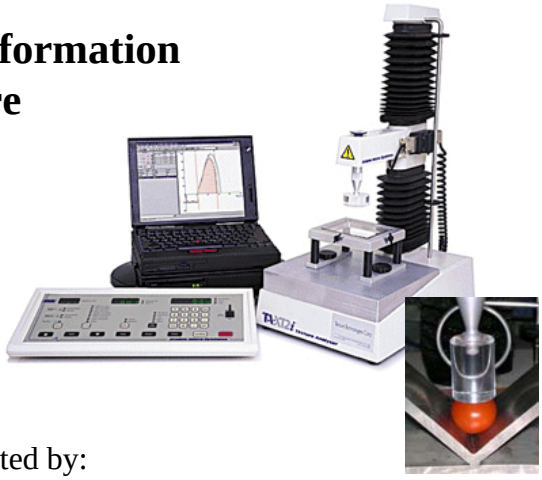
Hue less than 40

http://www.scribbleskidsart.com/generic.html?pid=84

#	L	a	b	C	H
1	54.4	12.0	23.2	26.1	62.7
2	48.5	19.9	21.1	29.0	46.7
3	45.6	25.1	17.8	30.8	35.4
4	41.1	24.9	13.0	28.1	27.6

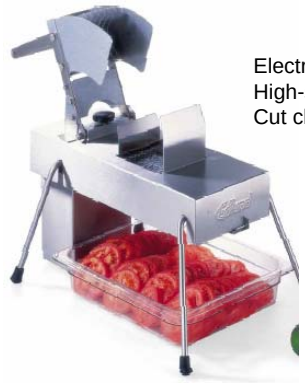
Tomato Texture

Compression, deformation
Force to puncture
Slice integrity
Mealiness



Tomato texture is affected by:
Variety, maturity, temperature, mechanical injury

Tomato Slice Integrity



Electric tomato slicer; 1/16, 1/8, ¼ inch slices
High-speed reciprocating stainless steel serrated blades
Cut cleanly with minimum pressure

	Juice Loss
Very firm	0-2%
Firm	2-5%
Moderately firm	5-8%
Moderately soft	5-8%
Soft	8-10%
Very soft	>10%

http://www.edlundco.com/pdf/kiElecSlicers.pdf

Firmness measurement

- Computerized texture analyzer
- Less expensive portable testers
- In-line nondestructive firmness testers, Sinclair Intl.
- Human as instrument; calibrate with spheres
  - USDA inspectors

Commercial Experimental

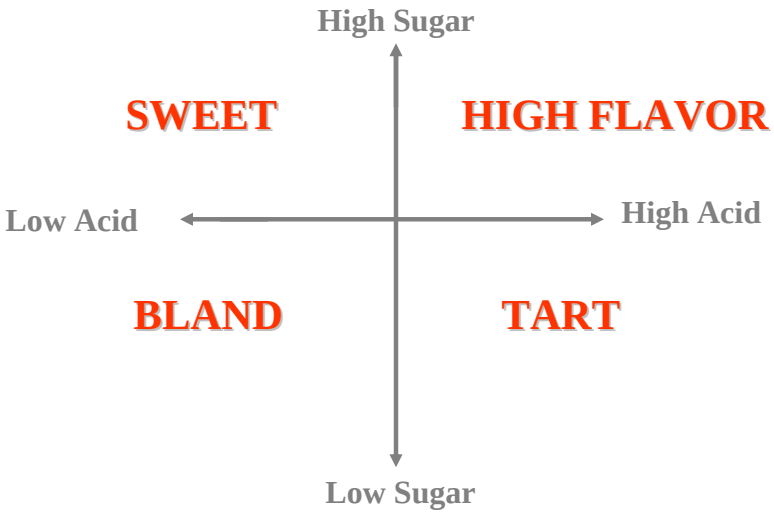
Tomato Flavor

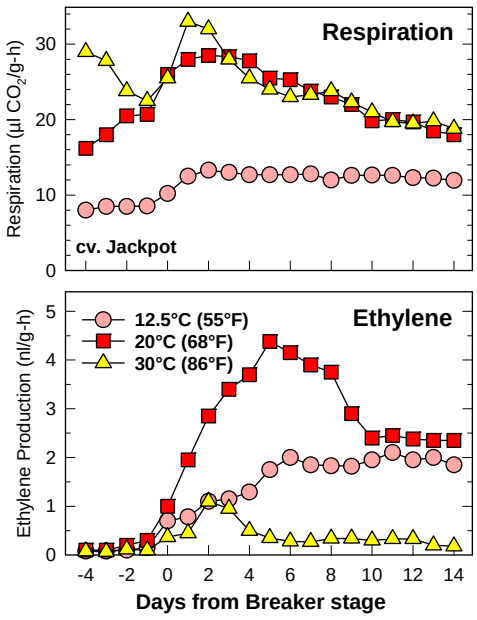
Depends on content of:

- Sugars (4-6%)
- Acids (0.2-0.6%)
- Aroma volatiles (ppm)

We estimate flavor by measuring sugars (soluble solids) and acids (titratable acidity)

Tomato Composition & Flavor





Effect of temperature on Tomato fruit ripening

Good temperature range: 15-25°C (59-77°F)

Best temperature: 20°C (68°F)

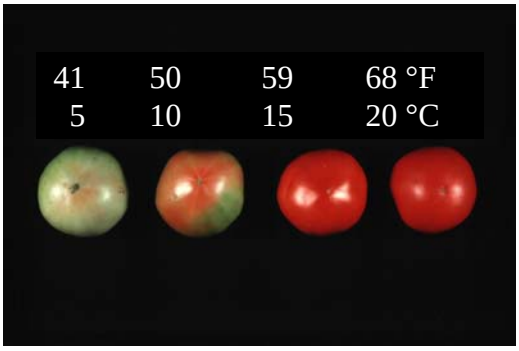
Ripened from Breaker Stage

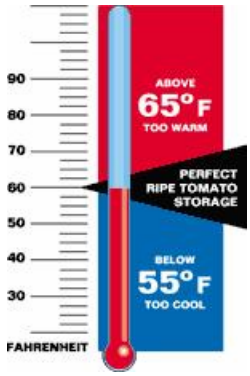
12.5°C (55°F) 20°C (68°F) 30°C (86°F)

Ripened from Mature-green Stage

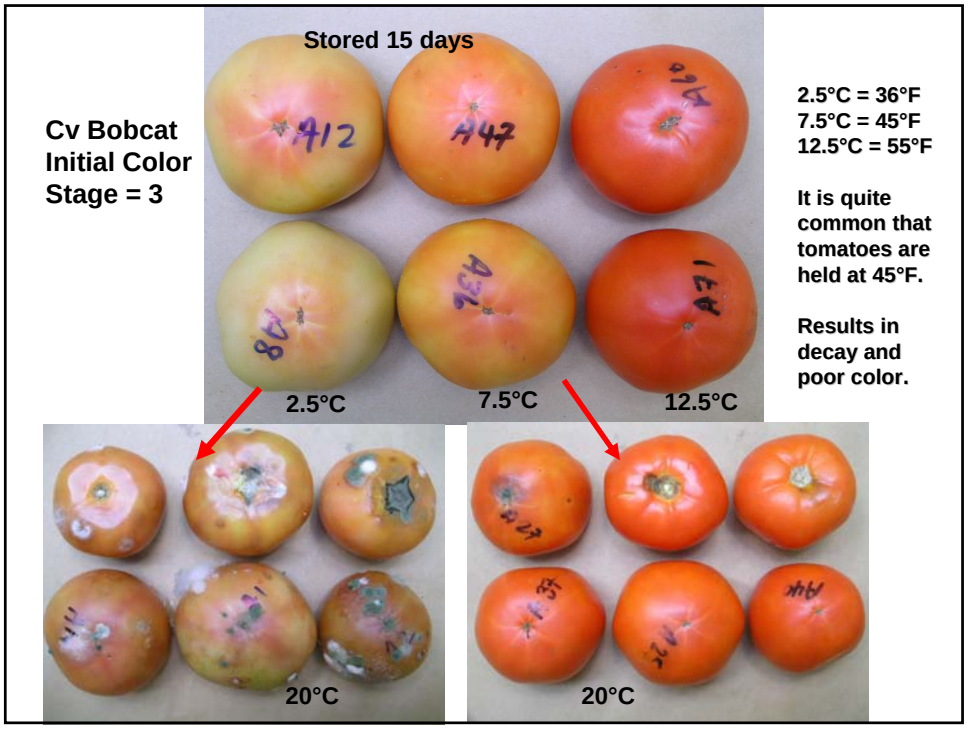
12.5°C (55°F) 20°C (68°F) 30°C (86°F)

Avoid chilling temperatures for tomatoes



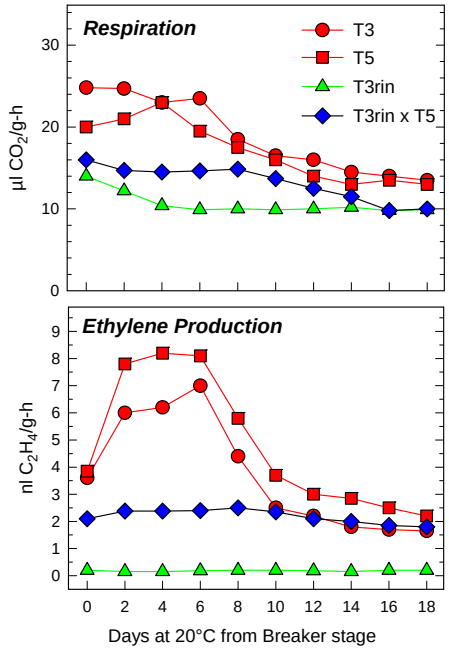


Too low temperature (<10°C <50°F)
Reduces flavor
Affects ability to ripen
Increases decay



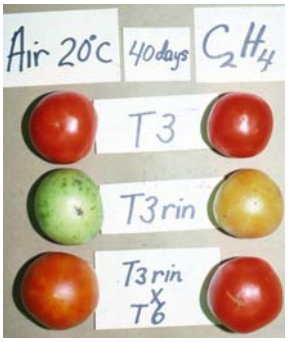
Storage of Tomatoes

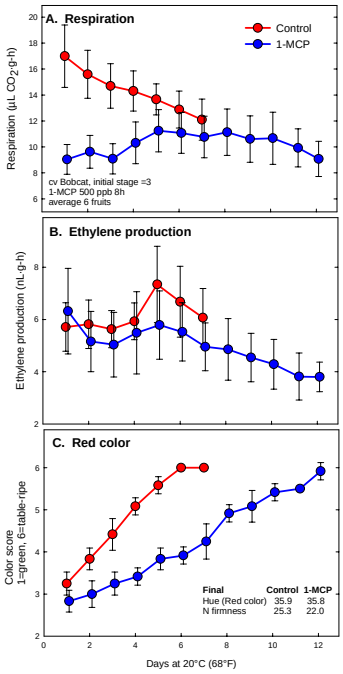
- 12.5°C (55°F)
- No lower than 10°C (50°F)
- 2-3 weeks
- Controlled atmospheres
  - 3% O2, <3% CO2
  - Relative humidity ~85%



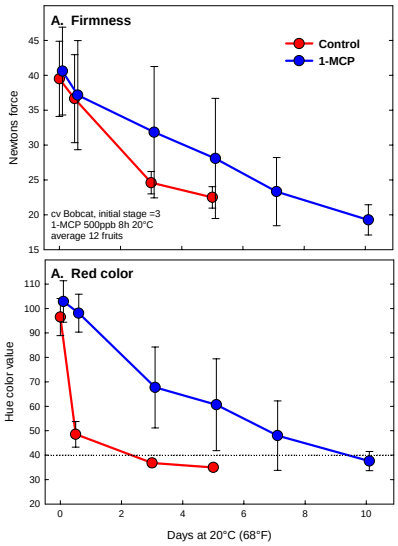
Ripening mutants retard the ripening process

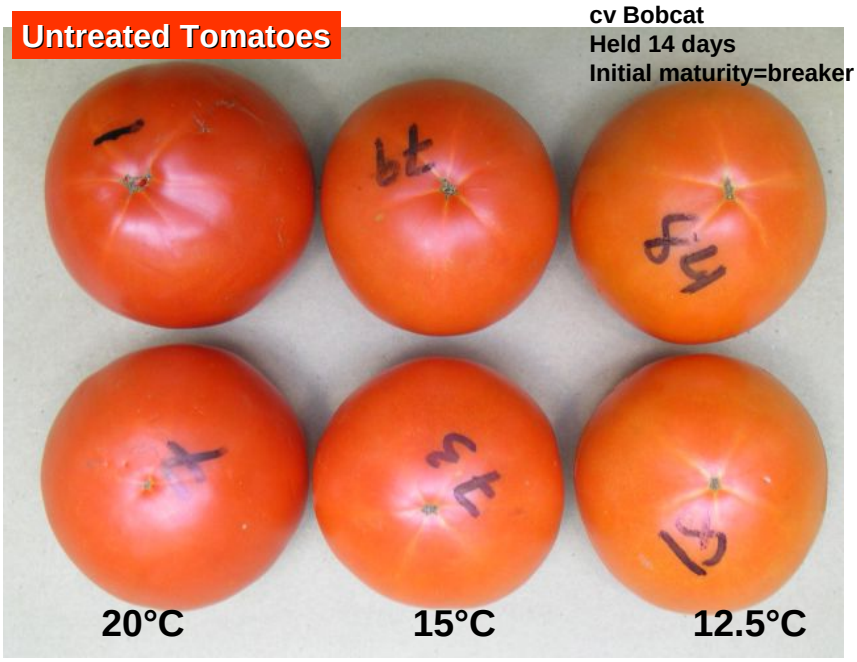
Example:
Tomato *rin* mutant



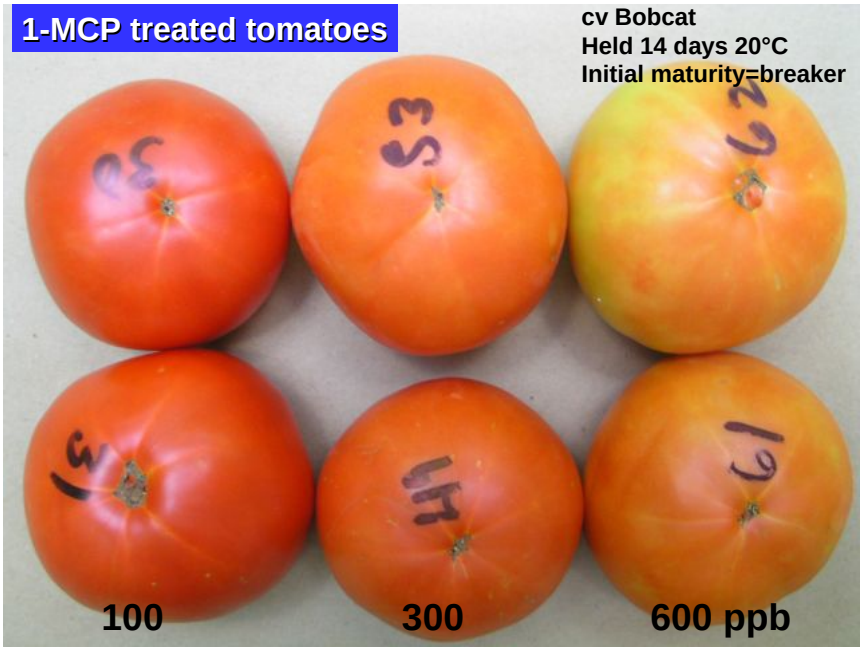


Ripening Tomatoes:
Impact of 1-MCP





Cantwell, 2003 Tomato MCP#6



10h 20°C

Cantwell, 2003 Tomato MCP#6

Ripe tomato quality (MCP#6, 2003, cv Bobcat)

Treatment	Days to Ripe	Firmness, N	Red color, Hue
1. 20°C Control Stage 2	8.8	23.5	36.3
2. 20°C Control Stage 3	6.0	19.5	36.5
3. 20°C Control Stage 5	3.4	20.1	36.3
4. 20°C 100ppb MCP Stage 2	8.9	22.8	36.2
5. 20°C 100ppb MCP Stage 3	6.0	19.1	36.8
6. 20°C 100ppb MCP Stage 5	3.5	20.8	36.1
7. 20°C 300ppb MCP Stage 2	13.9	18.6	35.0
8. 20°C 600ppb MCP Stage 2	18.0	20.6	35.9
9. 20°C 600ppb MCP Stage 3	13.5	20.2	36.0
10. 15°C Control Stage 2	13.1	27.7	38.5
11. 12.5°C Control Stage 2	16.4	27.8	38.9
LSD.05	0.6	4.3	2.0

Postharvest Tomato Quality

- Variety
- Maturity at harvest
- Minimize physical injury
- Storage: temperature & duration
- Ripening conditions

Fresh Market Tomatoes
Potential Decay &
Sanitation Problems

NOW
Additionals concerns about
Salmonella & other
human pathogens

A hot water dip at 125-125°F (52-53°C) was completely effective in controlling *Botrytis* if treatment occurred within 6 hours of wounding. Decay control was good but not complete with a 10 hour delay.