



Ripening Tomatoes

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Quality of Tomatoes



Types and varieties
Conventional & ESL
MG & VR stages
Growing areas
Growing seasons

} All Impact Final Quality

Tomato Quality Attributes


- Color**
- Firmness**
- Composition (sugars, acids, volatiles)**
- Ripening physiology**

Tomato Type & Composition, U.S. Retail


Tomato Type	% Soluble Solids	% Titratable Acidity
→ Grape	7.55	0.62
Cherry	6.25	0.67
Orange Cluster	4.70	0.44
Round	4.65	0.33
Roma	4.25	0.31
Round Cluster	4.20	0.35

Tomato Type	% Soluble Solids	% Titratable Acidity
Cherry	7.15	0.77
Campari	6.30	0.58
Romanita	6.30	0.44
→ Grape	5.60	0.51
Round greenhouse	4.50	0.36
Roma	4.30	0.27
Roma	3.75	0.44


Group 1



Group 2

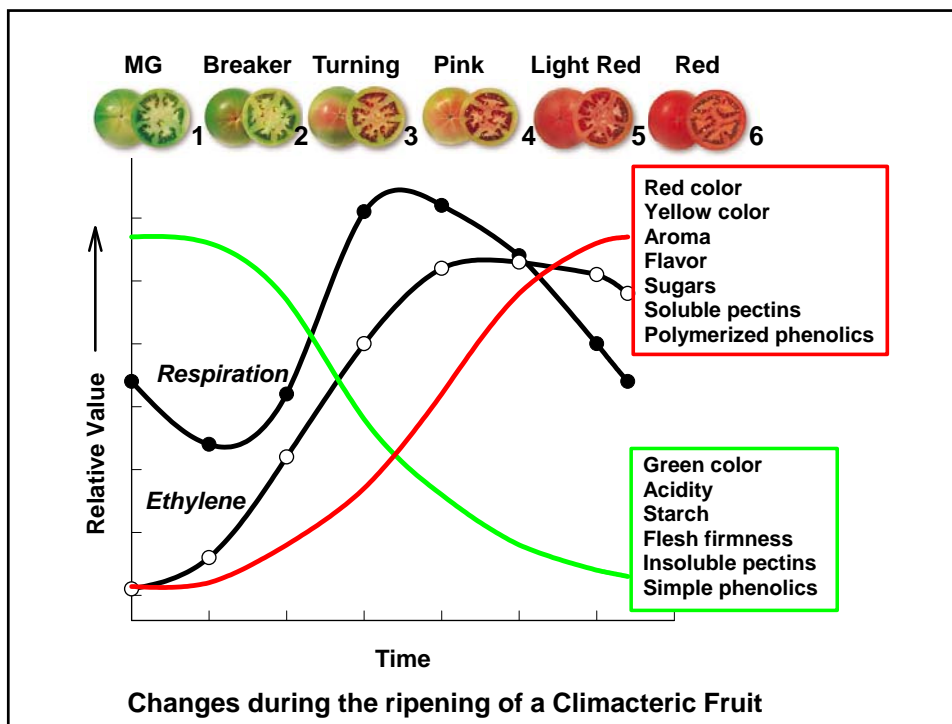


Grape Tomato harvested at 3 stages of maturity and evaluated at full red



Initial Maturity Stage	Weight per fruit, g	Soluble solids, %	Titratable acidity, %	Red color, hue	Firmness, N force
3	4.9	5.9	0.59	35.8	11.5
4	5.7	6.7	0.68	36.3	13.6
5	5.9	7.5	0.67	37.7	13.7

Average 7 cvs, Cantwell, UC Davis



Maturity & Ripening Stages

MG: ethylene and temperature to ripen
VR: manage ripening with temperature

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

VR **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

*VR = vine-ripe

<http://www.ams.usda.gov/AMSV1.0/Grading>

Checker boarding
Should never be a problem
with vine ripe tomatoes!

At Packhouse

At Distribution

TOV at harvest
and after 4 days
at distribution center
Likely these green
fruit will not ripen

Tomato mature-green and breaker stages; fruit with internal color will ripen well without ethylene treatment. For good eating quality, need at least stage MG3

MG1 MG2 **MG3** MG4 Br








Ethylene Treatment for Ripening MG fruit ↑

- Ethylene concentration: 10-100 ppm
- Temperature: 15-25°C (60 to 77°F)
- Relative humidity: 90-95%
- Duration: 24 to 72 hours ←
- Air circulation: sufficient for distribution of ethylene in ripening room
- Ventilation: sufficient to prevent accumulation of CO₂ over 3%

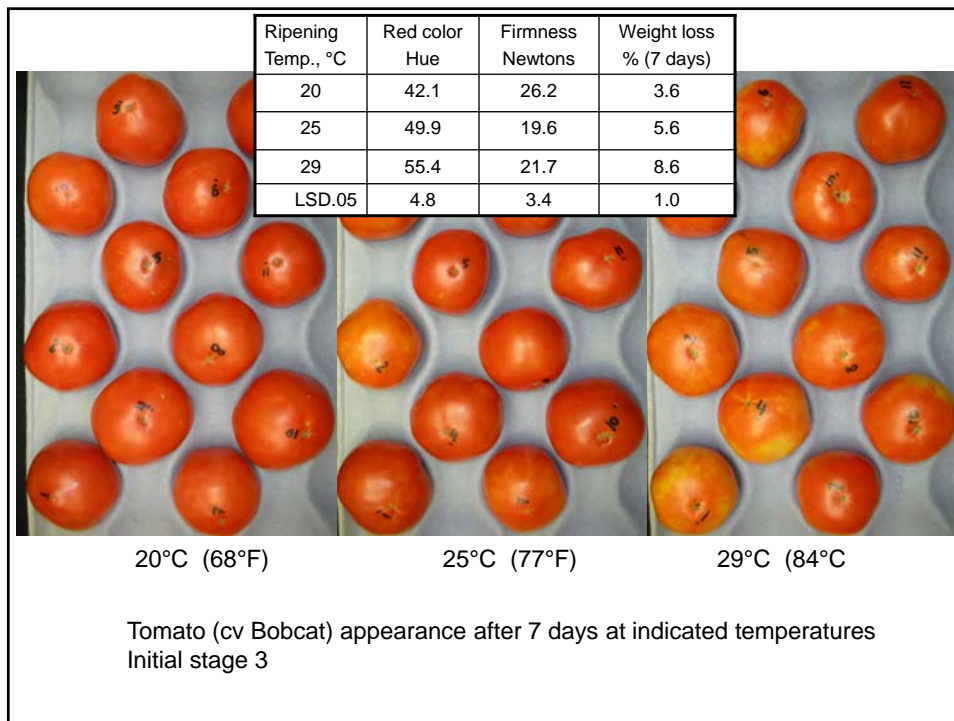
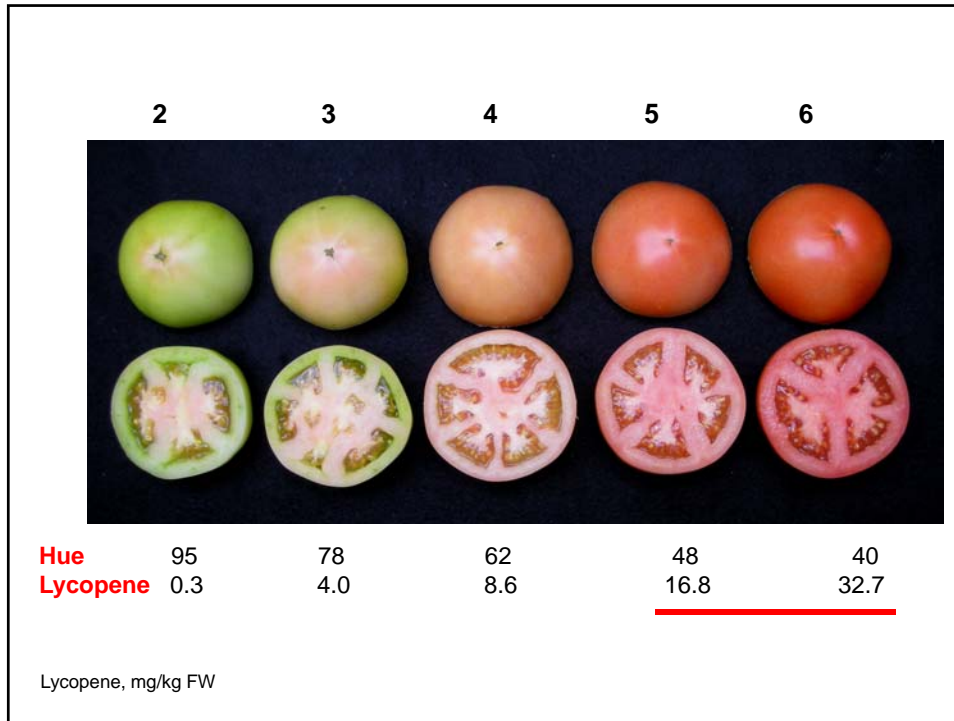


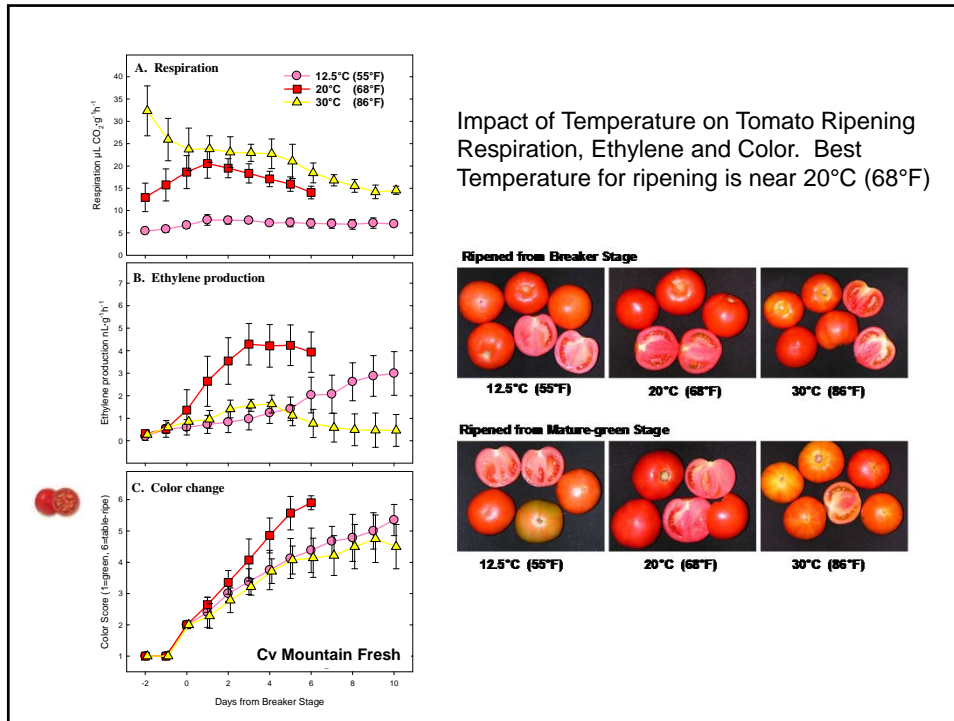
Shelf-life/Storage/Ripening Conditions

Effect of temperature on ripening rates of **conventional tomato cultivars**.

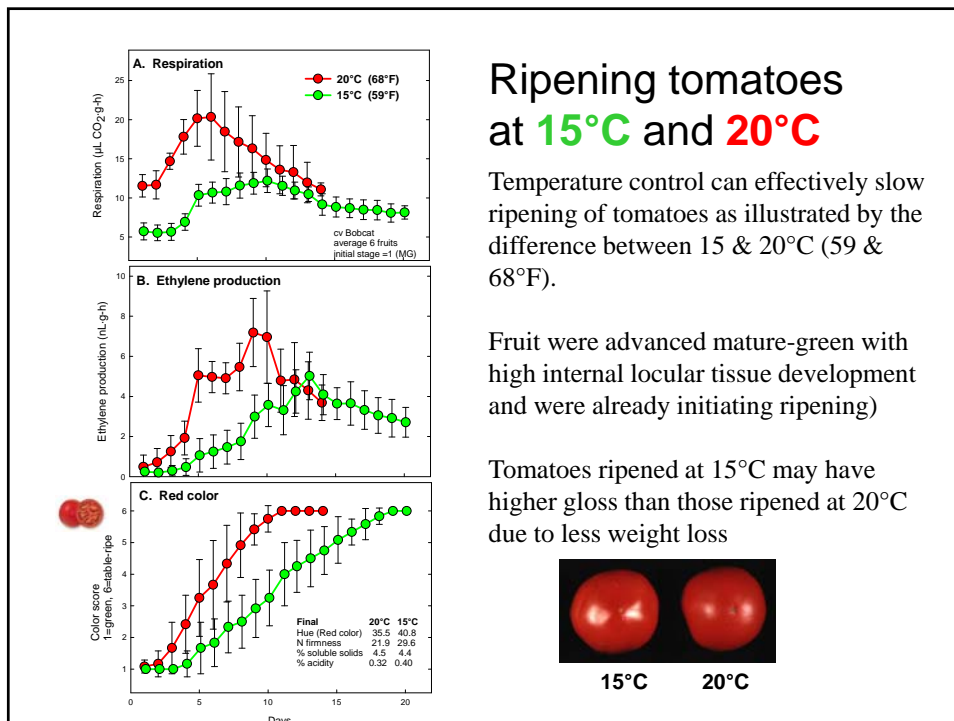
	Days to full red color at indicated temperature 					
Ripeness stage	12.5C 55F	15C 59F	17.5C 64F	20C 68F	22.5C 72F	25C 77F
 Mature-green	18	15	12	10	8	7
 Breaker	16	13	10	8	6	5
 Turning	13	10	8	6	4	3
 Pink	10	8	6	4	3	2

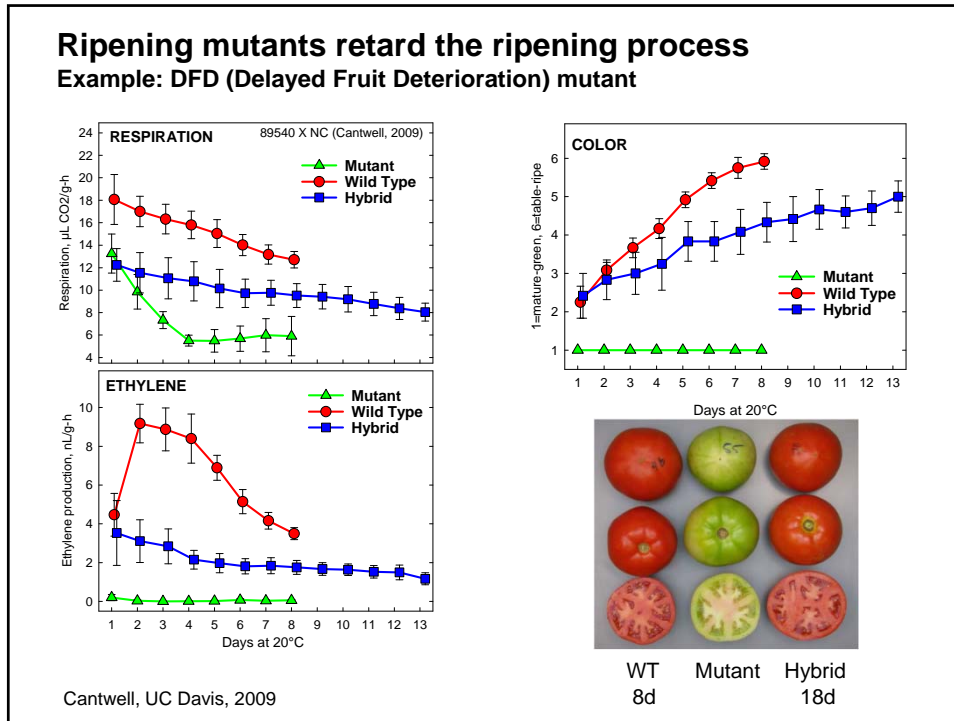
For tomatoes developed with ripening mutants, fruit may require same or longer time to achieve ripening. There is considerable variation in the ripening behavior of different cultivars.





Impact of Temperature on Tomato Ripening Respiration, Ethylene and Color. Best Temperature for ripening is near 20°C (68°F)













Storage of Tomatoes

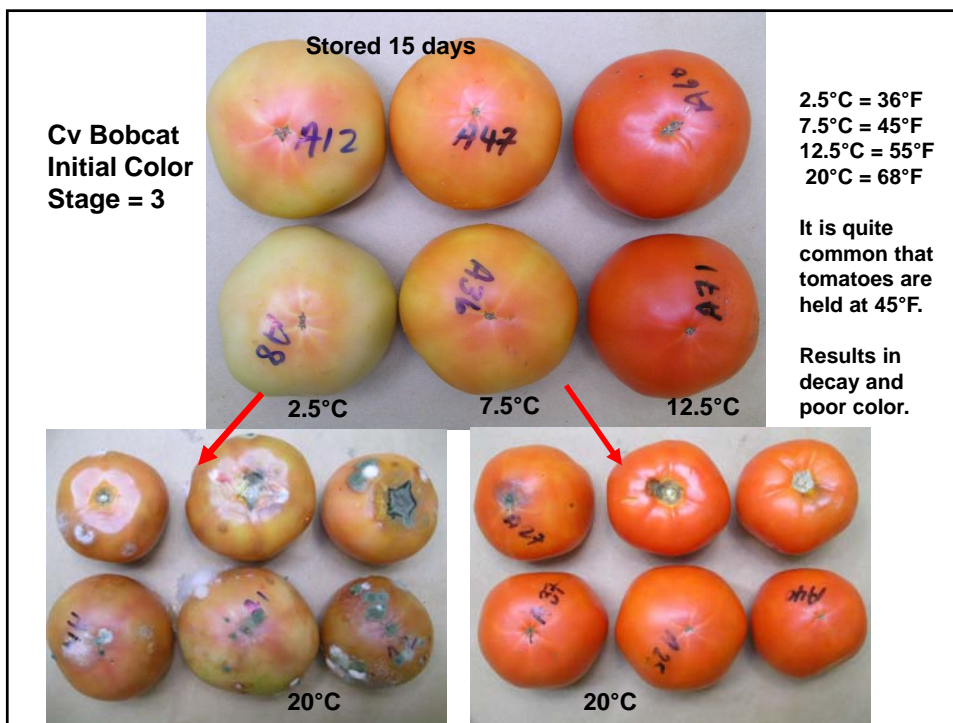
- 12.5°C (55°F)- will continue to ripen slowly
- No lower than 10°C (50°F)
- 2-3 weeks
- Controlled atmospheres
 - 3% O₂, <3% CO₂
 - Relative humidity ~85%

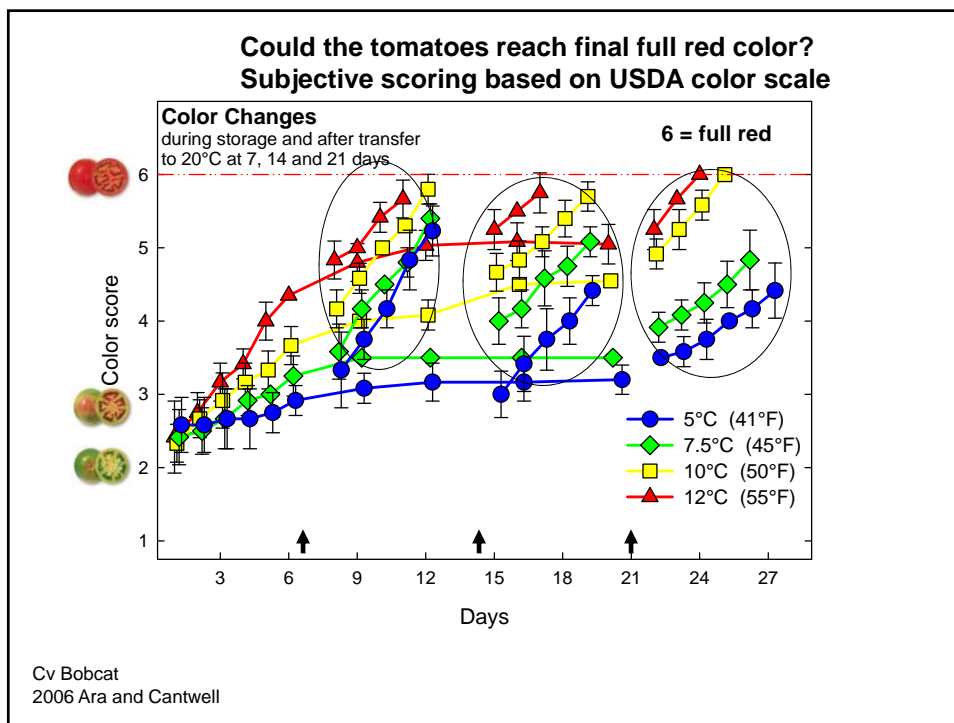
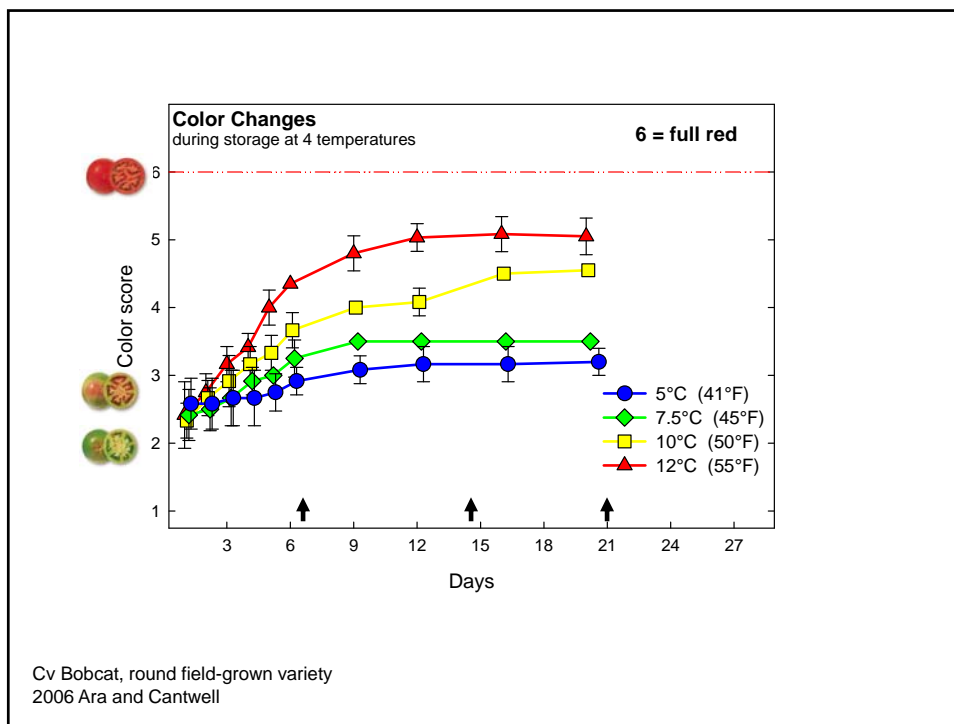


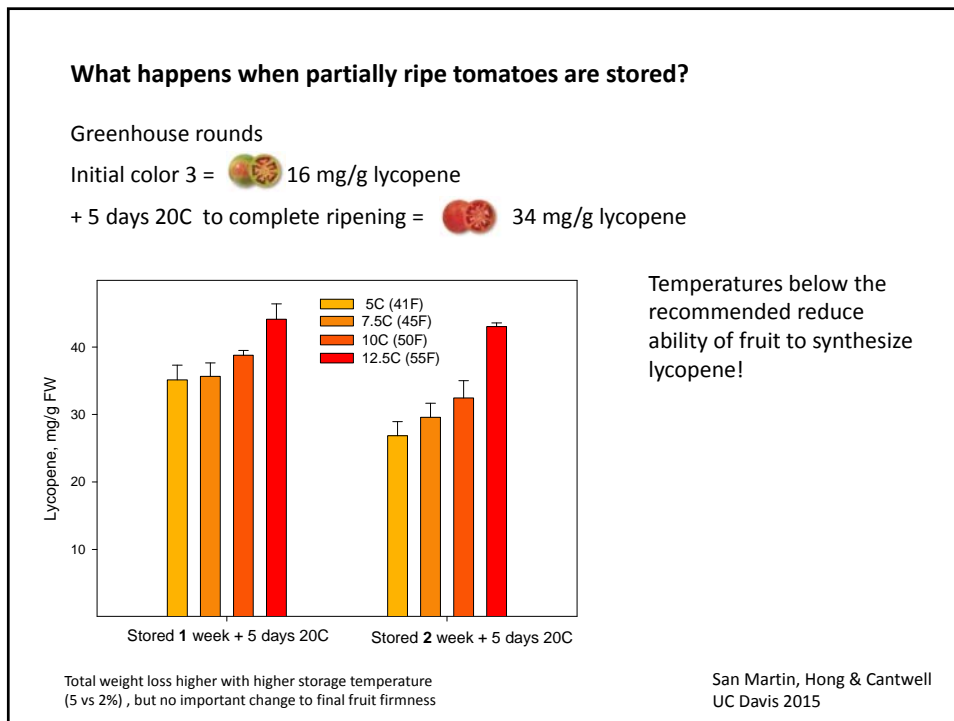
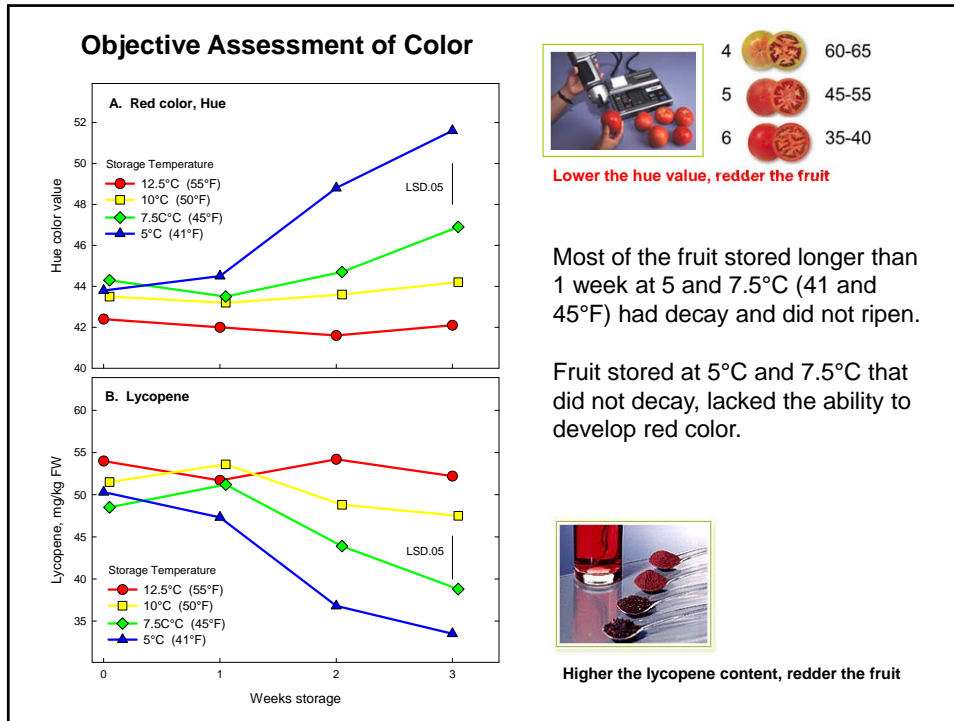
Tomatoes ripen into similar quality in temperature range from 12.5-20°C

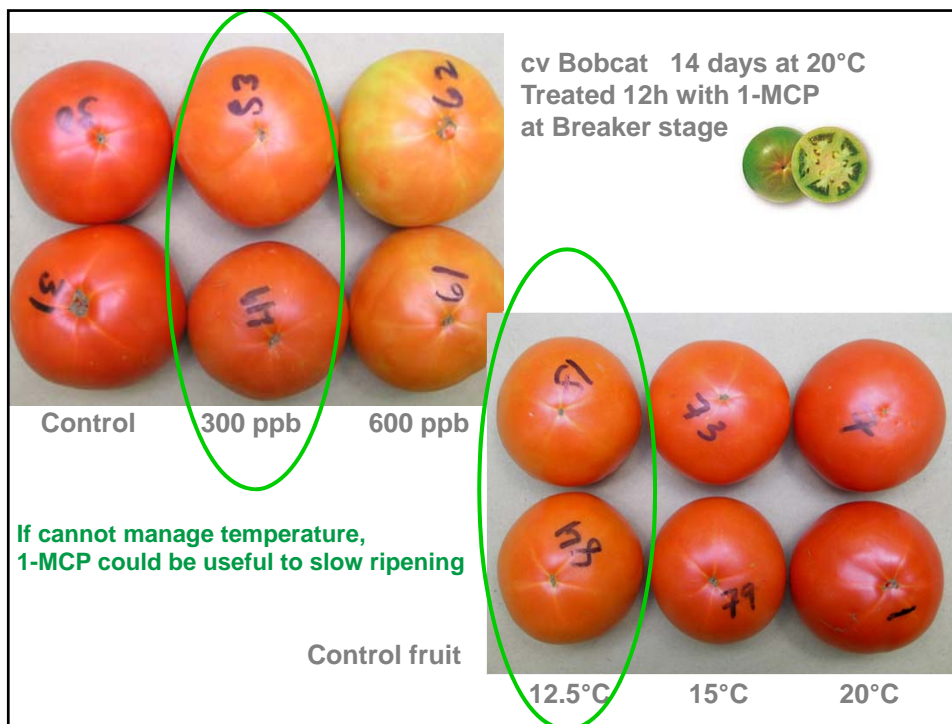
Temp. °C	Initial color	Days to TR	Weight loss %	Firmness N	Red color Hue	SS %	Sugar mg/ml	TA %	Vit. C mg/100ml	
20		2	13	4.3	27.0	35.0	4.0	18.3	0.26	21.8
12.5		2	32	4.2	28.2	38.3	4.0	17.8	0.26	24.3
20		3	11	3.4	23.0	35.9	4.0	20.8	0.26	27.4
12.5		3	22	3.0	28.5	39.4	4.2	19.5	0.28	29.9
20		4	7	2.2	25.5	37.2	4.0	20.2	0.29	26.6
12.5		4	18	2.2	26.3	37.6	4.1	19.9	0.27	30.3
20		5	5	2.0	23.0	39.7	3.9	19.4	0.28	27.4
12.5		5	18	2.3	20.5	37.5	4.2	22.7	0.26	29.3
Average 20C		9	3.0	24.6	37.0	4.0	19.7	0.27	25.8	
Average 12.5C		22	2.9	23.4	38.2	4.1	20.0	0.27	28.4	
LSD.05			0.5	3.7	1.8	0.2	2.9	ns	3.5	

Cantwell, 2003 MCP#7; cv Bobcat Tomatoes were handled very carefully; therefore minimal decay









Tomatoes and 1-MCP (SmartFresh™)

- 300ppb 1-MCP at 20°C \approx 12.5°C Storage
- 1-MCP is a powerful regulator of tomato fruit ripening
- Easy to overdose and have poor final quality (red fruit)
- Important to determine where 1-MCP can add value to the tomato category

Effect of 1-methylcyclopropene on tomato flavour components, shelf life and decay as influenced by harvest maturity and storage temperature.
E. Baldwin et al., 2011. J Sci Food Agric 91: 969–980.



Aroma and Sensory

- Harvested tomatoes green, breaker, turning and pink +/- treatment with 1-MCP
- Ethylene turns on aroma synthesis in tomato
- Stored/ripened 18 or 13 °C; better aroma profile at 18°C
- Found no real difference between breaker, turning and pink, but aroma volatiles and sensory scores generally higher for fruit harvested with more color
- Minimal effect on flavor due to 1-MCP, slightly less aroma volatile development

from work of Elizabeth Baldwin, USDA, Florida
SCRI workshop, Feb 2011



Ripened Tomato quality

- Variety and maturity at harvest
- Minimize physical injury
- Storage: temperature & duration
 - 12.5°C (55°F), No lower than 10°C (50°F)
 - 2-3 weeks
- Ripening conditions
 - Temperature 15-20°C
 - High humidity (85%)
 - If MG fruit, 100 ppm ethylene 3 days
 - Once ripening is initiated, use conditions that allow color to continue to advance—keep going slowly, but not interrupt the process.

