UCDAVIS POSTHARVEST TECHNOLOGY
Maintaining Produce Quality & Safety

Water Loss and Postharvest Quality

Minimize delay from harvest to cooling
Use appropriate packaging to reduce water loss
Use low temperatures throughout distribution

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Water Loss and Postharvest Quality

- How does water loss occur?
- What are critical levels of water loss?
- Where does water loss occur in handling?
- How to control water loss?

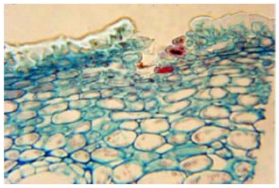
Postharvest Water Relations
Water loss
Water gain

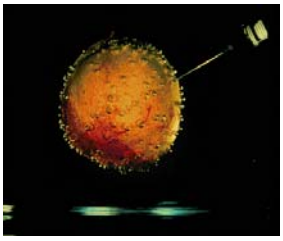
Fresh Produce and Water Loss

- Fresh produce contains 65% (garlic) to 95% (lettuce) water; water content for most products is 85-90%
- Harvested products begin to lose moisture immediately upon cutting from the plant
- Water loss = transpiration
- Water loss = weight loss (except if dry matter loss in storage)
- Water loss is water vapor movement from product to the environment
- Water loss is affected mainly by packaging, temperature, relative humidity and airflow

Water loss

- Through stem end
- Through epidermis and stomates
- Through peel and lenticels
- Through damaged areas





J.L.J. Bezuidenhout. 2005. Lenticels different plant species, Thesis. Univ. Pretoria., SA. Light microscopy mango lenticels

Water loss is Cumulative

Impacts on Quality

Loss of Salable Weight

Loss of Fresh Appearance

- Gloss
- Shrivel
- Pitting, sunken areas

Loss of Texture, Turgidity

Changes in Product Physiology

Critical levels for many products

<3% no visual effect, texture

3-5% visual quality affected

>5% shrivel, lose salability

Weight loss
1 = 2%
2 = 4-5%
3 = 7-8%
4 = 10-12%
5 = 15-17%

These berries were kept cold and lost less than 1% weight and look fresh

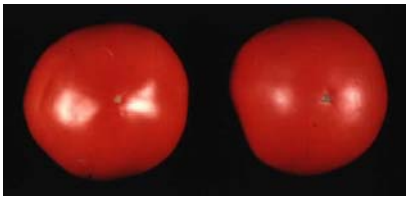
These berries were held at ambient temperature and lost more than 10% weight and look old and tired

Romaine Lettuce is marketable until 5% weight loss

0.4% 5.2% 10.3% 13.9%

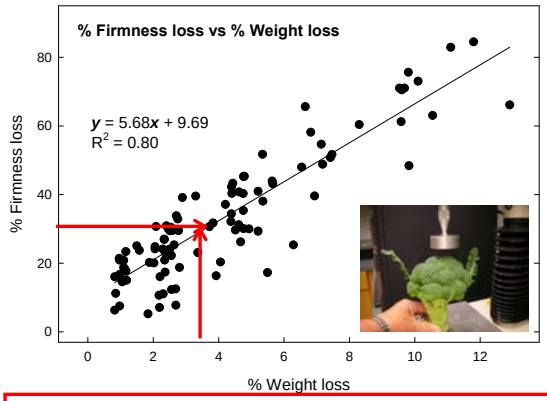
Ripened at 15C

- Higher gloss
- Less weight loss
- Firmer



Tomatoes Ripened at 20C

Texture and Water loss



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- Minimize delay from harvest to cooling
- Use plastic liners with holes to reduce water loss
- Keep it cold
- About 3-4% weight loss = soft head

Water Loss and Fruit Physiology

Water Loss and Fruit Ripening

Water loss during initial phase of ripening affects rates of ripening
Water loss is a stress and caused increased synthesis of ethylene
Therefore minimize water loss during initial 72 hours after harvest

Stage when induce water loss	Total % Water loss	Days to ripen
Pre-climacteric	5.6	14.1
Climacteric	5.3	15.7
Post-climacteric	5.2	17.0

Early season fruit; Induced water loss conditions: 20C with 20%RH
Control, 20C 95%RH lost only 1.3% weight and required 16.4 days to ripen
Decay was less on fruit from treatments with water loss than on control fruit

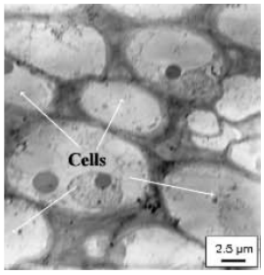
Burdon, J. et al. 2005. Mode of action of water loss on fruit quality of 'Hass' avocadoes. NZ and Australia Grower's Conf., 2005

Skin/epidermis

Fruit

100% RH in air spaces

Assume 25C 100% RH



Environment

Temperature
Relative Humidity—less than 100%
Air velocity

Assume 25C with 40%RH

Water loss and temperature

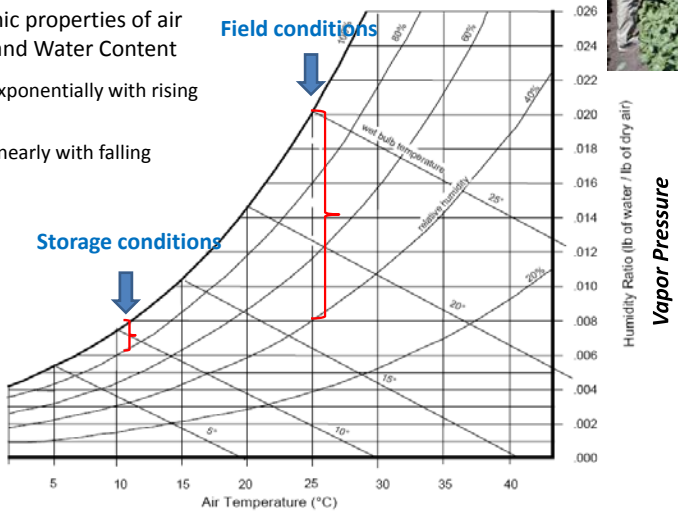
Wt loss (%/day) = product K x VPD

Psychrometric Chart

Thermodynamic properties of air
Temperature and Water Content

VPD increases exponentially with rising temperature

VPD increases linearly with falling humidity



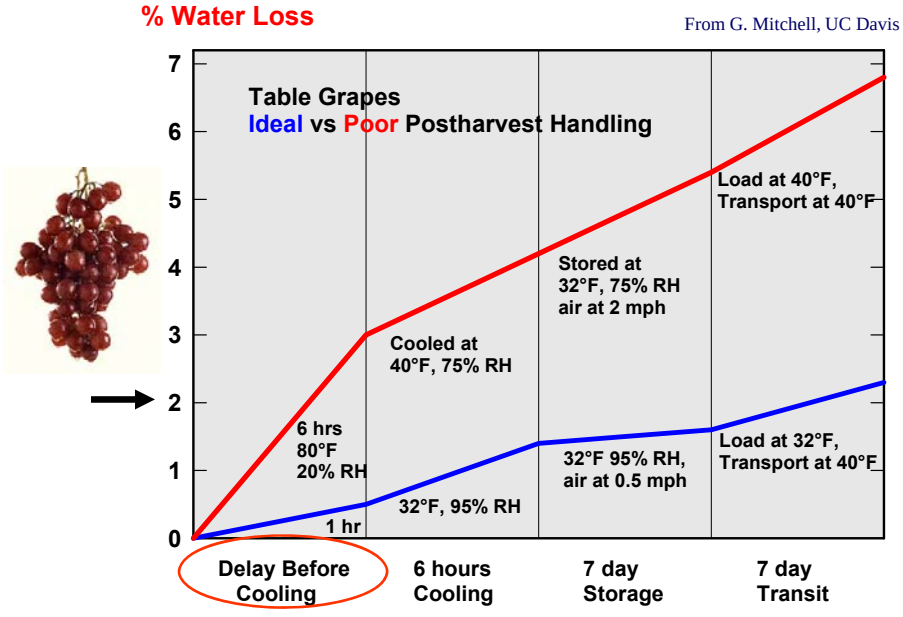
Handling at harvest is critical for water loss management

Basil

Highly susceptible to water loss
Very chilling sensitive

Situation:
Excellent quality crop
Harvesting late in day
High temperatures, ~30° C
Low RH, ~50%;
Little protection from ambient
Long delays to packinghouse

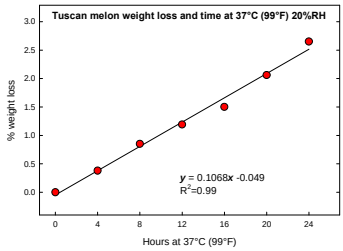
What can be done to improve this handling???



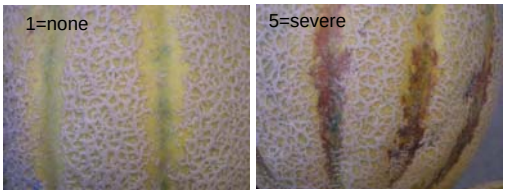
Water loss is Cumulative

Weight loss of Tuscan melons held for different periods at 37°C (99°F) before cooling, storage and shelf-life.

Cooling delay	% weight loss before cool	% weight loss storage 10D 5°C	% weight loss shelf-life 4D 20°C	Total Weight loss %	Suture browning score
0 h delay control	0.00	2.14	0.97	3.08	1.2
4 h delay	0.38	1.95	0.96	3.25	1.3
8 h delay	0.85	1.85	0.78	3.45	1.3
12 h delay	1.19	1.62	0.79	3.56	1.4
16 h delay	1.50	1.32	0.85	3.63	2.8
20 h delay	2.06	1.47	0.68	4.15	4.0
24 h delay	2.80	1.41	0.71	4.85	4.2
LSD.05	0.21	0.42	ns	0.60	0.8



Suture browning Tuscan melons



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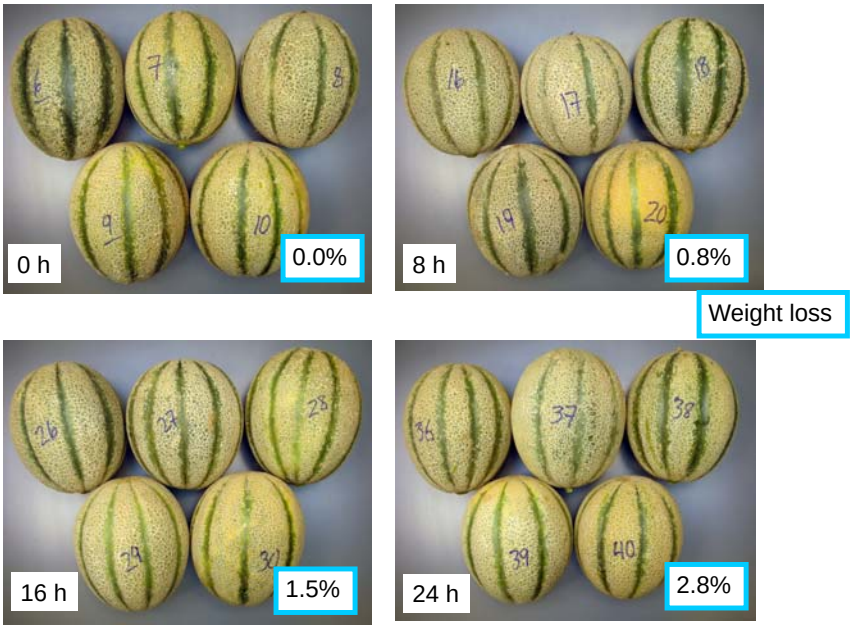
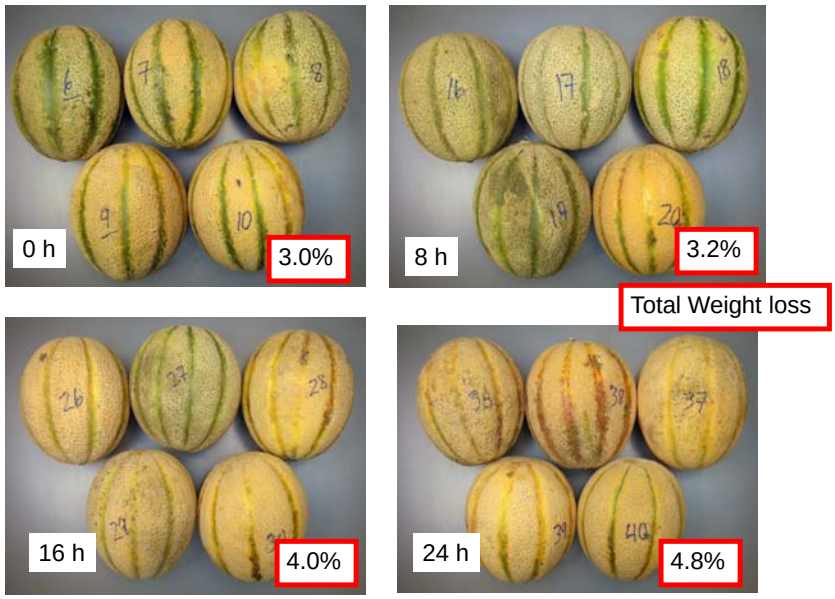
Delays to cool of Tuscan Melons; fruit held at 37°C (99°F)



Melon visual quality after delays to cool, storage at 10d 5°C + 4d 20°C



Litchi Browning:
Water loss is a major contributor: **8% water loss for peel browning**. Mechanical damage, senescence, improper storage temperature, and postharvest pathogens also contribute.

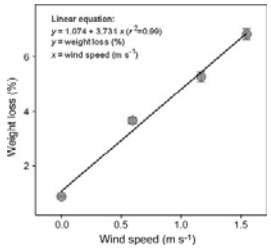
Predicted postharvest moisture loss from litchi with idealized handling.

Stage	Temp. (°C)	RH (%)	Wind speed (m s^{-1})	Duration (h)	Predicted moisture loss (%)	Cumulative moisture loss (%)
Harvest	30	65	1.5	3	1.87	1.87
Pre-cooling	5	75	1	5	0.38	2.25
Storage	5	75	0	5	0.06	2.31
Transport	7	66	0	12	0.23	2.54
Wholesale	5	75	0	3	0.04	2.58
Wholesale display	25	22	0	2	0.27	2.85
Transport	7	66	0	2	0.04	2.89
Retail	20	50	0.5	6	0.90	3.79

38h

Bryant, P.H. 2012. A model of postharvest moisture loss under air currents to reduce pericarp browning of litchi. Postharvest Biol. Tech. 73: 8-13.

Wind speed and weight loss



Litchi
~8% weight loss = desiccation browning

Harvest Conditions	Temp. (°C)	RH (%)	Wind speed (m s^{-1})	Duration (h)	Predicted moisture loss (%)
Standard	30	65	1.5	3	1.9
No wind	30	65	0	3	0.3
Delay	30	65	1.5	6	3.6
Extreme	35	50	1.5	6	6.3

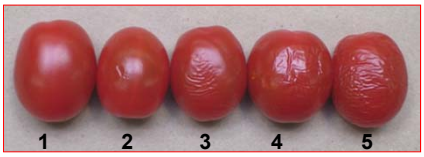
Bryant, P.H. 2012. A model of postharvest moisture loss under air currents to reduce pericarp browning of litchi. Postharvest Biol. Tech. 73: 8-13.

Role of cultivar in postharvest quality loss
Example: Grape tomatoes and weight loss

12days 20C 50%RH

Cultivar	Shrivel *	% weight loss
Ahern 299	3.5	13.2
Amsterdam	3.2	15.2
Harris LI-34	4.6	15.6
Hazera 1319	4.3	18.0
Rotterdam	2.4	11.8
TC 1260	3.6	14.9
LSD.05	0.6	1.5

*Shrivel score -1-5 scale, 1=none, 2=slight, 3=moderate, 4=moderately severe, 5=severe



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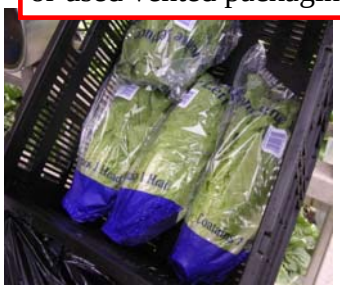
Simple packaging to reduce water loss.
Need to cool product before packaging (room or hydrocool)
or used vented packaging and vacuum cool (romaine lettuces)

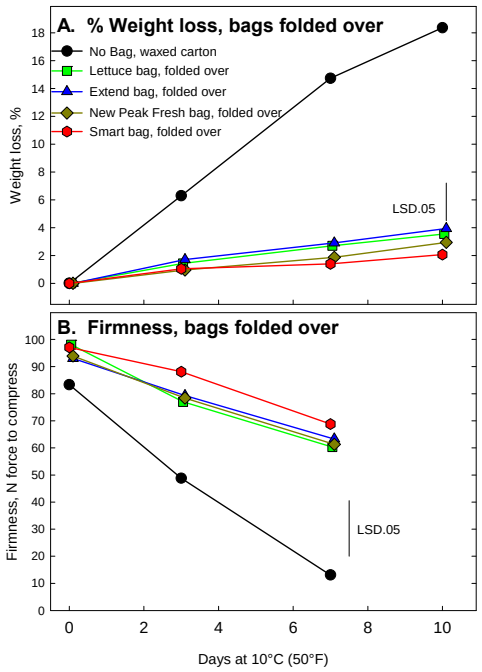


Peppers on a tray exposed to the environment for 1 day

7.5°C 67%RH	12.5°C 52%RH	20°C 37%RH	29°C 20% RH	37°C 17%RH

7.5°C 85%RH	12.5°C 87%RH	20°C 83%RH	29°C 85%RH	37°C 80%RH

Peppers on a tray covered with a plastic bag (not sealed)



Broccoli weight loss and firmness loss can be minimized with plastic liners.

Liners placed in field
And product vacuum cooled

Simple perforated PE lettuce or basil liners perform as well as more expensive plastic films.

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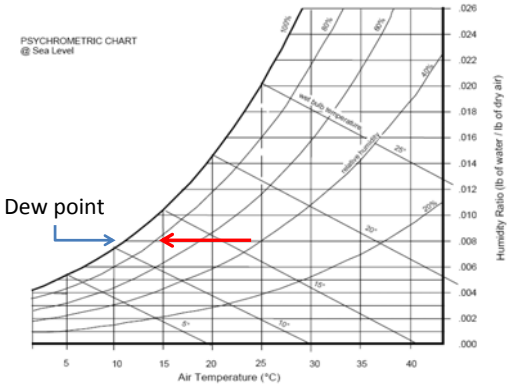
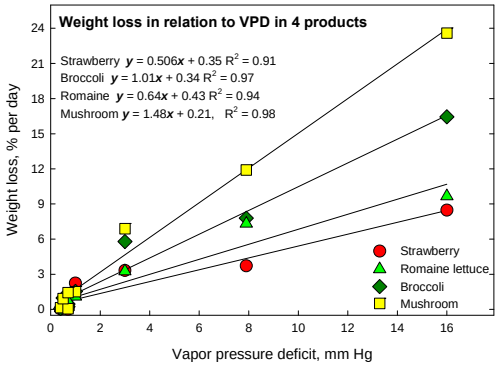
Condensation—worse than water loss for many products



A small amount of controlled water loss leads to longer postharvest life; Avoid free moisture



"Cold and Dry"

Bacterial growth: temperature and moisture

"Cold and Dry" Handling

Leafy green grower, Singapore. Product harvested in afternoon, cooled overnight in marine container, slightly dehydrated (5-8% weight loss) and then consumer packaged the following day.

Water loss control
Low temperature
Packaging appropriate
Minimize time

Water loss and Retail Handling—potentially very high rates of water loss

- Display ready reusable crates-what are advantages and disadvantages
- For product to tolerate such conditions at retail, must minimize water loss at earlier steps in handling chain
- Additional paper or plastic packaging can notably reduce water loss

Water Loss and Postharvest Quality

- Water loss occurs through natural pores and damaged areas
- Environmental conditions at harvest cause high water loss
- Harvest when cool
- Protect and shade in the field
- Reduce delays from harvest to start cooling
- Cool efficiently, then reduce air flow over product
- Temperature, RH, air flow during storage and transport
- Use protective packaging
- Protective treatments in some cases (waxes, coatings)
- Weight loss is cumulative, store only as long as necessary
- Problem conditions are at the beginning and end of the cold chain

REFERENCES

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