

Postharvest Handling of Vegetables - Some Basics

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Beyond Market...

- Post Harvest Handling effects how produce looks and tastes at the market, in customers refrigerators and on their plates at home.
- Customers assess quality at each of those points.

Not the reaction we want...



3 rules for handling produce

- Keep it cool
- Keep it wet
- Handle with care

Post Harvest Biology

- Vegetables are living tissues. They continue to live, or metabolize, after harvest.
- Vegetables may have a delicate balance of flavors, colors, nutritional components, etc. A slight change can make a difference
- Vegetables are 90-95% water
- Ultimately all vegetables become unusable or unmarketable

Respiration

Sugar
Starches + O₂ → CO₂ + H₂O
Nutritional components
Other 'goodies'

Heat and
Energy

All living tissues are respiring - oxidizing various components to provide energy to keep living

Respiration losses

- Storage/taste carbohydrates (sugars, starches, fats, oils)
- Pigment, proteins, vitamins
- Secondary metabolites (off flavors)
- Loss of weight (carbon)

What does that mean?

The greater the respiration after harvest, the more vegetables start to:

- Look worse
- Smell and taste worse
- Weigh less

'Not all vegetables are created equal'

Respiration rate varies among different vegetables depending on the type of plant tissue involved.



- High- Developing shoots and leaves
- Moderate- Ripened or ripening fruits
- Low- Underground storage organs

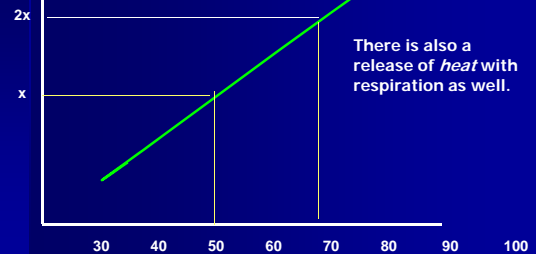
How to slow respiration...

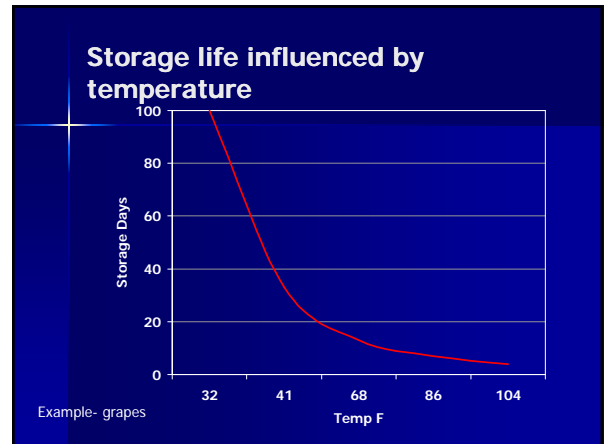
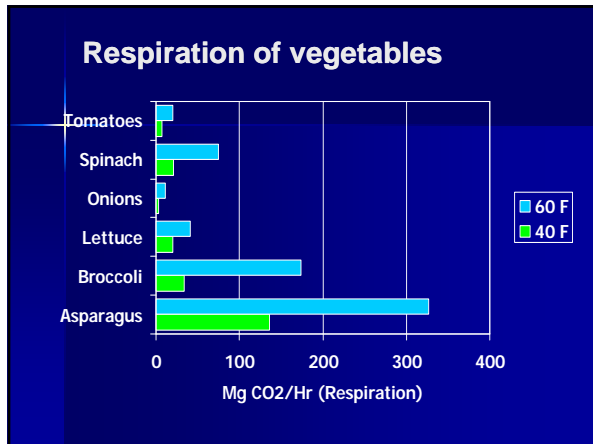
KEEP IT COLD



Respiration increases with increasing temperatures

There is generally a 2-4 fold rate of increase in respiration for every 18 F increase in temperature.





- ### Simplest and cheapest way to start with a "cool" product...
- Pick it when the temperature is coolest (right after dawn)
 - Most days have a 20-25 F day/night temperature variation
 - You can cut respiration easily by 1/2 to 1/3 by this simple practice
 - Keep out of direct sun



Simplest and cheapest way to cool down product:

WATER

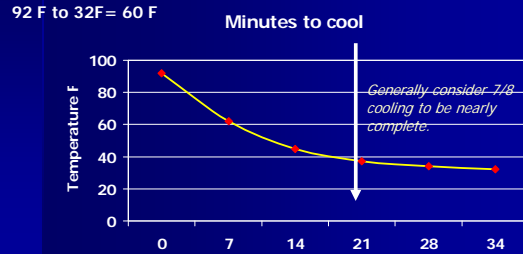
Estimated time for lowering temperature (product temperature 92 F with refrigerator/water at 32F)

92 F to 62 F
Cauliflower- single head, trimmed in a carton

- Refrigerator (no forced air) 5.5 Hours
- Forced air 1.4 Hours
- Hydro-cooled 7.2 min

General cooling process- "Half Cooling Time"

Getting to a final cooling temperature takes a long time- (take most of the heat out quickly and let the final few degrees be done in the refrigerator)



Hydro cooling

Produce (boxed or loose) exposed to chilled water



Conveyor



Batch



Flume (no boxes)

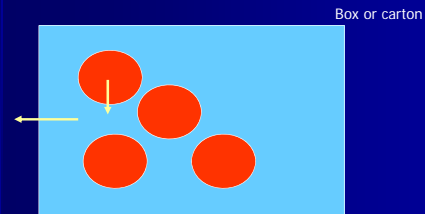
Keeping it cool in storage

- Stand alone refrigerators
- Commercial walk-in coolers
- "Cool-bot" and other modified air conditioners with homemade boxes.
- Shade
- Air conditioned space

Getting product cool varies among vegetables.

Heat out of product

Heat out of container

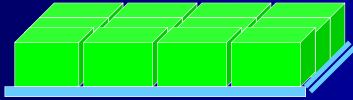


Watch for 'stacking patterns' that may limit the ability of air flow to remove heat from the products.

Vent holes in boxes

Slightly looser stacking

'Pull' cool air through the product



Remember, respiration is also generating heat

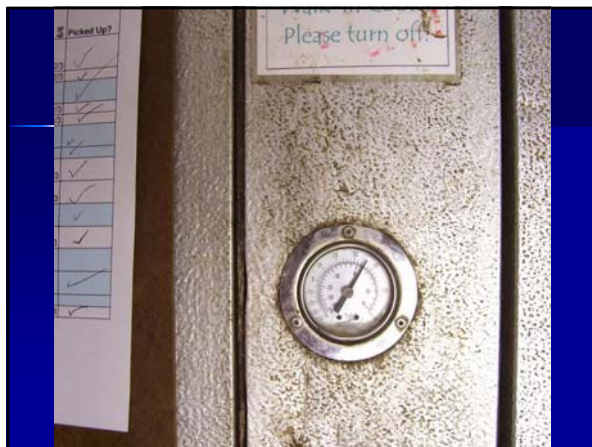
At 60° F BTU/'pickup load' of produce/day

- Asparagus 75,000
- Cabbage 8,000
- Leaf lettuce 15,000
- Potato 1,200
- Tomato 5,000

It would take about 5,000 BTU's per hour from a typical window air conditioner to maintain temperature

Monitoring product cooling

- Inexpensive metal probe thermometers available at most discount and auto supply stores (used to check air conditioning temperatures)



Ideal storage conditions vary among vegetables

- Different storage temperatures and humidity levels
- As a rule, 40 F to 32 F temps
- Knott's Handbook for Vegetable Growers
- Temps low enough to slow/stop respiration, high enough to prevent cold damage.

Partial cooling may be worse than no cooling at all

- Getting product wet may also encourage growth of diseases and rots that may not ordinarily be present



Chilling injury

- Some vegetables cannot be stored at temperatures approaching 32F
 - Sweetpotatoes, tomatoes
 - Peppers, eggplant, melons and cucumbers

Degree of injury depends on the crop, the time of exposure, and the temperature....

Chilling injury..

- High respiration
- Uneven ripening
- Off flavors
- Pitting
- Premature rotting
- Discolored or woody
- Fungal disease



Injury that is not reversible-product is permanently injured.

Chilling injury threshold temperatures *

- Beans, cucumbers, eggplant, okra, peppers, 45 F
- Melons 45-50 F
- Tomato (ripe) 50 F
- Pumpkin and winter squash 50 F
- Sweetpotato 55 F

Curing

- After harvest, a short warm dry (humid for sweetpotatoes) period to
 - Toughen skins
 - Dry out surface
 - Put product in a 'storage state'
 - Improve flavor and texture (sweetpotatoes and squash/pumpkins)
 - Heals over scratches and bruises



Curing for Irish potatoes, pumpkins, squash (except acorn squash), and onions

Warm (70-80F), dry conditions for 5-7 days after harvest

Curing for sweetpotatoes

Warm (80-85 F), humid conditions for 5-7 days after harvest

"Ripening Fruits"

- Develop an internal gas compound-*ethylene*- that 'drives' the ripening process
- Will cause premature senescence in other produce if mixed



Ethylene producing and ethylene sensitive vegetables

Produce Ethylene

- Muskmelon
- Honeydew
- Tomatoes
- (Many fruits)



Ethylene Sensitive

- Beans
- Broccoli
- Cabbage
- Cucumbers
- Lettuce
- Peas
- Peppers
- Squash
- Watermelon

When ethylene producing products are stored with ethylene-sensitive products

- Premature senescence (yellowing)
- Toughness in some products
- Bitterness in carrots
- 'Sleepiness' in flowers



Removing ethylene

- Sachet
- Wrap/blanket
- Filters/Filtration systems
- Separate storage/closed containers



Keep it wet

- Most vegetables are 92-95% water
- A 2-5% loss of water may make a product unmarketable
 - Wilting
 - Shriveling
 - Loss of 'shine'
 - Sponginess

Prone to water loss

- Leafy crops most subject to loss of water (surface to volume ratio)
- Other crops covered with a waxy skin or hard surface



Water loss depends on shape and configuration

Water to move through the product to the outside and how readily it can move through an outside 'skin' of heavy cells or wax

You can get a clue as to what produce should be kept wet by whether it is displayed in a store in 'misting' displays and kept cool or out in the middle in dry self-standing displays

% Water loss that results in unmarketable product

- Asparagus 8%
- Cabbage 7%
- Celery 5%
- Lettuce 3%
- Spinach 3%

Effects of water loss

| | |
|----|---|
| 5% | Increased cell enzyme activity |
| 1% | Increased respiration, ethylene production, yellowing |
| 2% | Susceptible to chilling injury |
| 3% | Increased physiological disorders |
| 4% | Faster loss of vitamins, loss of flavors |
| 5% | Loss of gloss, more chilling injury |
| 6% | Loss of textural quality, limpness |

Managing water loss

- Cooler at appropriate humidity
- Packaged/stored in mostly closed containers
- Protected from wind or drying air movement
- Misted or kept out of wind when displayed

No soggy produce

- Do not leave produce, including leafy green, sitting in water or heavily water logged. This can lead to disease, damage and waterlogged product.
- Totes or boxes should be drained after hydrocooling.

There are some exceptions to cool and wet

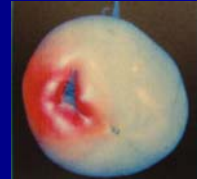
- Cool, dry storage
- Warm-sprouts
- Wet-roots and rots



Handle with care

- Injury leads to increases in respiration and may provide an entry point for disease organisms

Note the increase in ripening near the damaged spot on this tomato



Injury not only leads to increased respiration- but can be an entry point for disease organisms.



'Wound' Periderm (second skin)

- Regrow 'skin' cells
- Some chemicals form in area
- Respiration rises with cellular activity



After Harvest

- Keep it cool
- Keep it wet
- Handle with care

At market

- Keep product and bins out of direct sun
- Have mister or spray bottle for greens
- Herbs/greens bunches can be set in clean, cool, potable water to prevent wilting.
- Clear plastic bags/clamshells can act as mini-greenhouses.
- Share proper storage info with customers