

# Maintaining Quality of Winter Vegetables in Storage

Ruth Hazzard UMass Extension  
Vegetable Program

‘Expanding Winter Harvest and Sales of New  
England Vegetable Crops’  
*funded NE SARE*

Ruth Hazzard & Amanda Brown  
UMass Extension Vegetable Program  
Becky Sideman, UNH  
Claire Morenon, CISA and Kate Donald,  
SEL

Advisors: 8 farmers; Susan Han,  
postharvest physiologist

# Vegetables after harvest are alive

## Type of organ

- Leave blades, stalks, core
- Fruit

## Fleshy storage organs:

- Tuber
- Bulb
- Root/enlarged stem

## crops

- Cabbage, Brussels Sprouts
- Squash
- Potato, sweet potato
- Onion, garlic
- Carrot, beet, turnip, rutabega

## Mission: make SEEDS

- Regrow, flower, seed
- Ripen and decay to release seeds

# Our mission: maintain flavor, texture, appearance

## **TOOLS**

- Quality in the field
- Harvest timing
- Harvest methods
- Curing
- Storage conditions

## **Key Factors**

- Temperature
- Humidity
- Airflow

# Respiration

- Carbohydrate + O<sub>2</sub> yields CO<sub>2</sub> + H<sub>2</sub>O + heat
  - ‘vital heat’
  - Ventilation
- Respiration rates rise with temperature

# Potato

## Harvest for storage – at maturity

- After vines die (on their own or with help)
- When skins are 'set'
- Ideal tuber temperature 55-60 °F
- Avoid harvesting tubers when <45 °F – bruising
- If > 62, use active cooling



Photo by Richard E. Tucker

tuckertaters.com



ces.ncsu.edu



Dziekanowski Farm,  
Hadley MA



# Potato



## Curing

- Cure at 55-65 °F, 95% RH for 2-3 weeks
- Tuber temperature
- Ventilate the pile
- Suberization & wound healing
- Reduces respiration rate

# Potato

## Storage

- Grade out disease
- Reduce temperature slowly
- Seed potato: 38- 40°F
- Tablestock: 45-50 °F (cooler)
- Chip: > 50 °F
- RH 95%
- 5-8 months

## Notes

Darkness prevents greening

Low RH: shrinkage, pressure  
bruising

Low T: starch converts to sugar  
Bring T up slowly.



# “warm, dry” group

## Sweet potato and winter squash

- Subject to chilling injury
  - Reduces disease resistance
  - Pitting
  - Internal tissue browning
- Curing recommended
  - heal wounds
  - Convert starch to sugar
- Store at 55-60 F, 50-70% RH



# Sweet Potato

## Harvest when....

- soil temperatures fall consistently below 65°F,
- before first frost,
- or when tubers are adequately sized.
- Minimize wounding and bruising during harvest.

## Horticultural notes

- Beauregard, Covington
- With or without plastic
- Adequate moisture





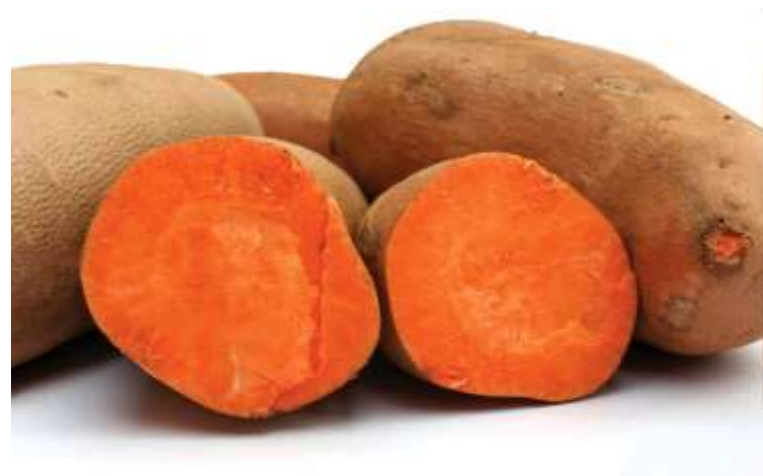
# Sweet Potato

## Curing

- Cure at 80-86°F and 85-95% RH for 4 to 7 days.
- Ventilation (respiration)
- Wound healing, suberization
- Empty greenhouse, warm barn

## Waiting for flavor.....

- Starches convert to sugars for the first 30 days
- Wait at least 3 weeks postharvest for best flavor.



# Sweet Potato

## Storage

- Store at 55-60°F at 60-75% RH.
- Well-cured roots can store for up to a year in optimal conditions.
- Avoid Temp <50°F, chilling injury occurs
- Chilling injury pro decay, decreases

## Grain sacks, totes, bins





# Winter Squash

## Harvest

- All fruit for storage should be mature
- 45-50 days after pollination
- Prompt harvest – reduce risk of sunscald, fruit rots, insect & animal damage, hurricanes!
- Chilling injury accumulates at Temp < 50 °F (55 °F)
- Avoid bruising
- Butternut: Remove stem

## Windrow in the field



# Winter Squash



## Curing

- 80-85 °F, 10-20 days to heal wounds
- Starches in squash convert to sugars after harvest; curing at 70-80 °F for a week accelerate this process.
- Curing may not benefit mature, undamaged fruit
- The flavor of some squashes (butternut, kabocha types) benefits from storage for 30-60 days after harvest

# Winter Squash

## Abobora

*Cucurbita maxima* X  
*Cucurbita moschata*

### Storage

- Store at 55-60°F and 50-70% RH.
- Good air circulation
- Storage potential varies with variety, from 2-6 months.
  - Butternut, Hubbard, Abobora 6 mo
  - Buttercup
  - Acorn, Delicata 5 weeks





## **Black rot – keep it dormant!**



## **What to avoid**

- Avoid chilling injury, which accumulates when temperatures are below 50°F (some say 55°F).
  - Chilling wipes out disease resistance to fruit rots
- Watch for cold spots in storages – circulate heat & air
- High RH promotes disease
- High Temp reduces flesh quality



# “Cold, dry” Onion and Garlic

- Cure to dry neck, scales
- Topping needed
- Store 32°F and 65-70% RH.



# Garlic



## Harvest

- Timing: leaves turning yellow, but 60% are still green.
- Cloves should fill the wrappers.
- Avoid bruising

## Curing

- Cure for 10-14 days in a warm, dry, well ventilated area
- Cured: outer skins are dry and crispy, neck is constricted and the center of the cut stem is hard.

# Garlic

## **storage**

- Short term (<1mo) room temperature
- Long term (6-7 months) 32°F and 65-70% RH.
- Good airflow prevents condensation on bulbs
- Seed garlic should be stored at 50F.

## **What to avoid**

- High Temp (>65F) causes dehydration
- Intermediate Temp (40-65F) promote sprouting
- High RH promotes root growth and mold.
- Fluctuations in temp. cause condensation

# Onion

## Harvest - timing

- Harvest when 50-80% of tops have fallen, bulbs mature
- Harvest when the weather is dry to reduce post-harvest disease.



## Curing

- Cure in warm (68-86°F) and dry (70% RH) conditions with good air flow
- Field curing (2 weeks)
- Final curing: Barn/GH/storage
- Complete when neck is completely dry and tight.
- Top bulbs, 2-3 inches of stem.



# Can good curing & storage stop these diseases?



Thrips injury  
Botrytis leaf blight  
Botrytis neck rot  
Purple blotch  
(*Alternaria porri*)



# Onion

## Storage

- Store at 32°F and 65-70% RH.
- Avoid condensation by cooling slowly, constant temp, ventilation



## Notes

- Onions produced from seeds store longer than those from sets.
- Storage potential greatest with late, hard, pungent types



“cold, moist”

Carrot, beet, turnip, parsnip, rutabega  
cabbage, Brussels sprout

**Common traits:**

- Harvest cold or pre-cool before storage
- Dessicate rapidly, need RH >95% (98-100%)
- Store as close to freezing as possible
- Long storage life at proper conditions



## Freeze Tolerance - Fall & Storage Vegetables

<b>Most susceptible</b>	<b>Moderately Susceptible</b>	<b>Least Susceptible</b>
<i>injured by one light freeze</i>	<i>recover from 1-2 light freezings</i>	<i>lightly frozen several times w/o injury</i>
potato,	onion	beets
sweet potato	winter squash	Brussels Sprouts
	carrot	cabbage
		kale
		kohlrabi
		parsnip
		rutabega
		turnip

Note: freezing temperature is generally below 32F (varies with crop)



# Carrot

## Harvest

- Maturity measures: size, days to harvest, looks and taste!
- Moderate freeze tolerance (Freezes at 29.8°F (-1.2°C))
- Harvest before heavy freeze.
- Dig when roots are cool/cold, keep cold
- 'Later harvest may improve storability'
- Trim tops to 1/2 inch.



## Storage Carrot Variety Trial

UMass 2011  
-- Amanda Brown

Seed date 7/26

3<sup>rd</sup> harvest 11/30  
= 125 days after  
seeding



Cultivar	Days to Maturity
Berlanda	85
Carson	90
Bolero	75
Deep Purple	80
Florida	95
Brest	90

# Carrot



## Storage

- Store at 32-34°F and 98-100% RH.
- Ventilated or perforated packaging --needs O<sub>2</sub>
- Totes (covered), ventilated bags, grain bags, bulkbag-lined bins...
- Can be stored 7-9 months.

## What to avoid

- Low RH -- shriveling and rubberiness.
- **\*\*** HIGH sensitivity to ethylene
  - Bitter & off taste develops at 0.2 microliters/L ethylene
  - Avoid storing with apples
- Avoid totally sealed containers/bags

# Carrots: when to wash?

- Handbook 66: “wash immediately”
- Infrastructure may dictate wash at harvest or just before sales
- Carrots washed late in storage period had fewer undesirable tastes (Seljasen et al 2004)
- Carrots stored unwashed have more staining, surface pathogens (Klaiber 2004; c. Alexander, Jerricho Settler’s Farm 2010)



# Carrot flavors



## “Carrot flavors”

- “Off” flavors: terpene, green, earthy , ethanol
- Tastes: sweet, acidic, bitter, sickeningly sweet, after-taste
- Texture: crispness, toughness
- Bruising & shock stimulate ethylene, other chemicals
- Off flavors with high CO<sub>2</sub> and low O<sub>2</sub>

# Other Roots: Beet, Turnip, Rutabega

**Same as carrots....**





# Cabbage

## Harvest

- Good head density stores better
- Mature but not overmature
- 3-6 wrapper leaves on head
- Harvest cool, or pre-cool

## storage

- 32°F , 98-100% RH
- Air circulation for uniform, constant T, RH, oxygen
- Light in storage reduces yellowing & weight loss

# Strategies to meet the needs

**Separate rooms; design each room to meet specific needs**



**Tangerini Farm  
twilight meeting,  
Millis MA, 2011**



**Automated mister  
for high RH**



# Use packaging to increase/modify RH



**Atlas Farm**

Produce on pallets, ready for Pioneer Cold (34°F , 50-70% RH)



**Riverland Farm**





# 'mix and match' Self-serve CSA Brookfield Farm



**Roots & potatoes together –  
insulated root cellar  
Cooled by outside air**



**Cabbage (wrapped) &  
onions together –  
insulated cold room**



- Squash must have heat



- Potatoes, roots must have insulation



# Resources on postharvest

**Winter Grower discussion group  
(sign up at  
[www.umasvegetable.org](http://www.umasvegetable.org))**

**Postharvest & Storage session  
Wednesday morning**

- USDA Handbook 66
- UC Davis postharvest website
  - General topics, crop by crop
  - <http://postharvest.ucdavis.edu/>