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$_2$ yields CO$_2$ + H$_2$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
Potato

Curing

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

Dziekanowski Farm, Hadley MA
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 promotes 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)

Windrow in the field

- Avoid bruising
- Butternut: Remove stem
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

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

Abobora

*Cucurbita maxima X Cucurbita moschata*

http://www.worldcrops.org/crops/Abobora-japonesa.cfm
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.

Harvest timing
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
<table>
<thead>
<tr>
<th>Freeze Tolerance - Fall &amp; Storage Vegetables</th>
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<tbody>
<tr>
<td><strong>Most susceptible</strong></td>
</tr>
<tr>
<td><em>injured by one light freeze</em></td>
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<tr>
<td>potato, sweet potato</td>
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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

3rd harvest 11/30
= 125 days after seeding

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Days to Maturity</th>
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<tbody>
<tr>
<td>Berlanda</td>
<td>85</td>
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<tr>
<td>Carson</td>
<td>90</td>
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<tr>
<td>Bolero</td>
<td>75</td>
</tr>
<tr>
<td>Deep Purple</td>
<td>80</td>
</tr>
<tr>
<td>Florida</td>
<td>95</td>
</tr>
<tr>
<td>Brest</td>
<td>90</td>
</tr>
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</table>
Carrot

Storage

• Store at 32-34°F and 98-100% RH.

• Ventilated or perforated packaging -- needs O₂

• 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 ethelyne
  – Bitter & off taste develops at 0.2 microliters/L ethelyne
  – 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. Alexender, 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 CO₂ and low O₂
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)

Postharvest & Storage session
Wednesday morning

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