



Postharvest Handling Update Cool Season Vegetables

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UCCE Vegetable Pest Management and Postharvest Issues
Santa Maria, June 9, 2010

Produce Facts

- Harvest indices
- Quality indices
- Temperature and RH
- Freezing point/damage
- Respiration rates
- Ethylene production
- Effects of ethylene
- Effects of modified atmospheres
- Physiological disorders
- Postharvest diseases
- Mechanical injury
- PHOTOS

140
Fruits
Vegetables
Flowers



ABOUT US
Find Experts
RECOMMENDATIONS:
Produce Facts in: ■
English ■ Español ■
Français ■ العربية ■
Home Storage ■
Summary Table ■
Modified Atmospheres ■
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March - April 2010
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[Stone Fruits](#)

Publications

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We proudly present our 2010
"Fruit Ripening & Ethylene
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pages of new photos and
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Now Open for Enrollment!

- May 5-7 [Fresh Produce Marketing Strategies Short Course](#) held at the San Francisco Grand Hyatt. [Enroll OnLine](#).
- June 14-25 [Postharvest Technology Short Course](#) on the UC Davis campus. [Enroll OnLine](#).
- June 28, 29 [Walnut Dehydrator Workshops](#) (Chico, and Modesto). [Enroll Online](#).

Link to February's Fruit Ripening & Ethylene Management [Workshop Handouts](#).

Opening in Spring 2010:

- September 14-16 [Annual Fresh-cut Workshop](#).
[and more....](#)

Link to the interactive
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developed by Paul Singh, Ph.D.

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index.html updated March 27, 2010

Causes of Quality & Postharvest Losses

Leafy Vegetables



Lettuces

Spinach

Cabbage

Chard

Broccoli

Celery

Herbs

Endives

Asparagus

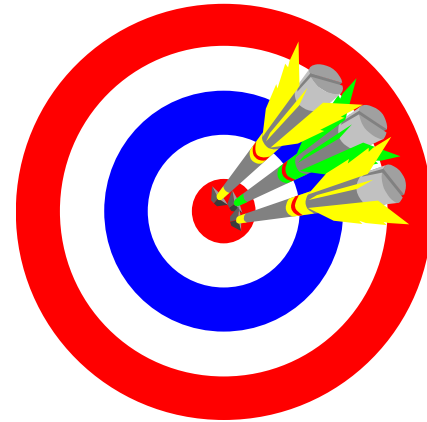
Green Onions

- ◆ Water loss
- ◆ Mechanical damage
- ◆ Loss of chlorophyll and other nutrients
- ◆ Respiration rates
- ◆ Microbial growth
- ◆ Sensitivity to ethylene



Fresh Produce Deterioration

- **Metabolic changes:**
 - respiration, ethylene,
 - texture, aroma, etc.
- **Growth and development**
- **Transpiration**
- **Mechanical injury**
- **Physiological disorders**
- **Decay; microbial growth**



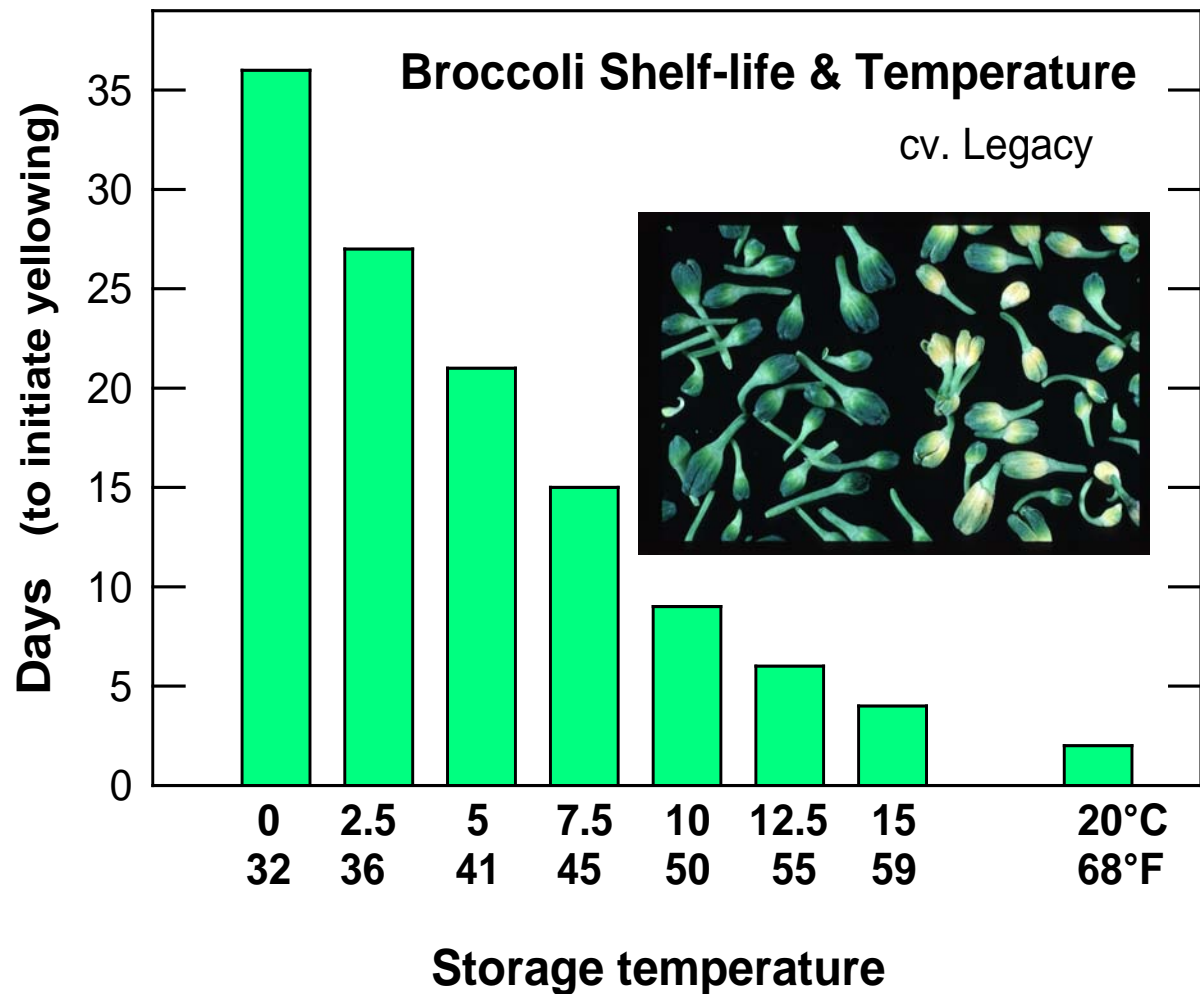
**Temperature
Affects All
Causes of
Deterioration**

Postharvest Handling Update

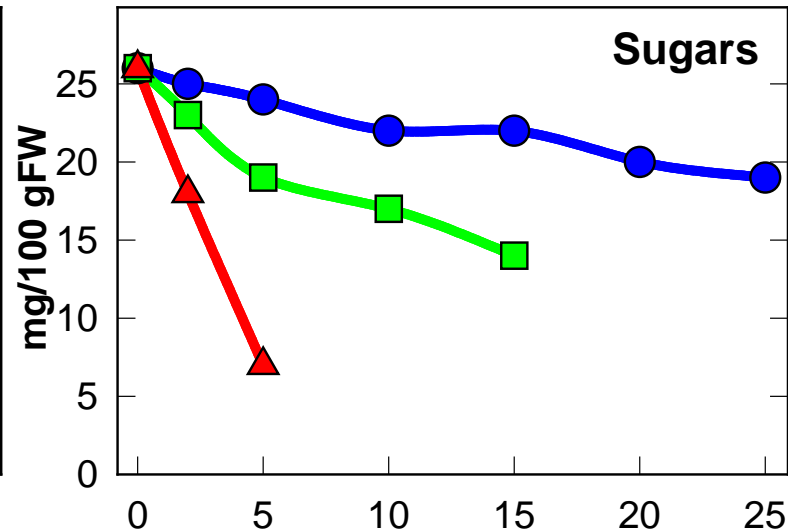
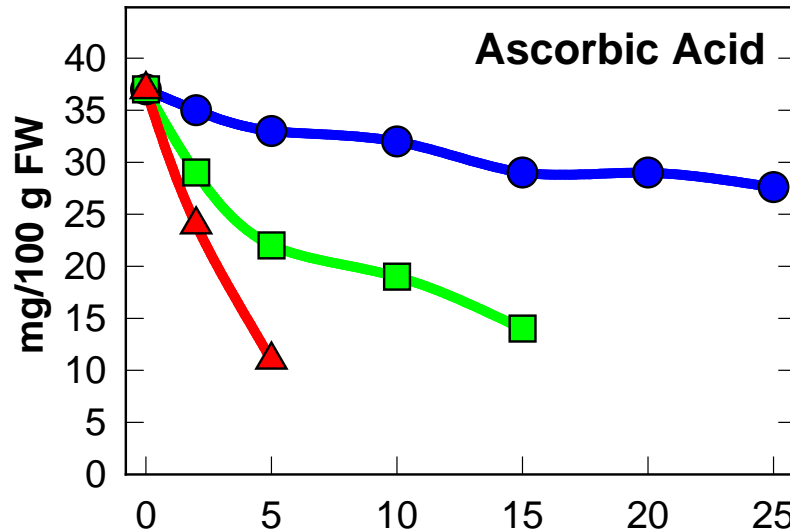
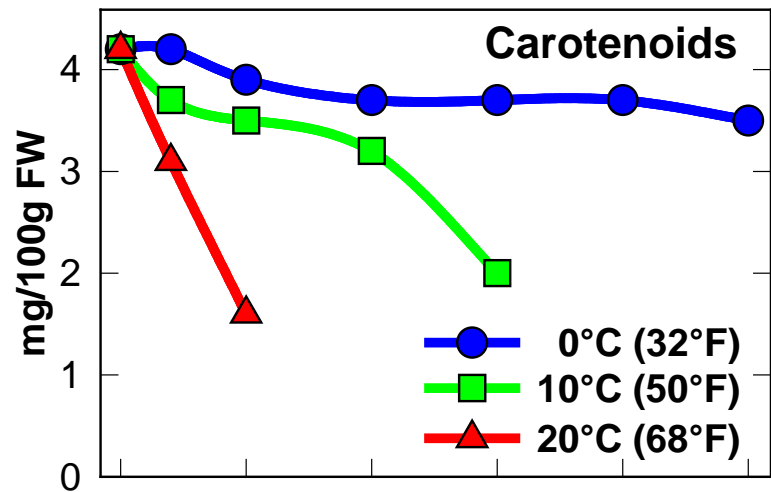
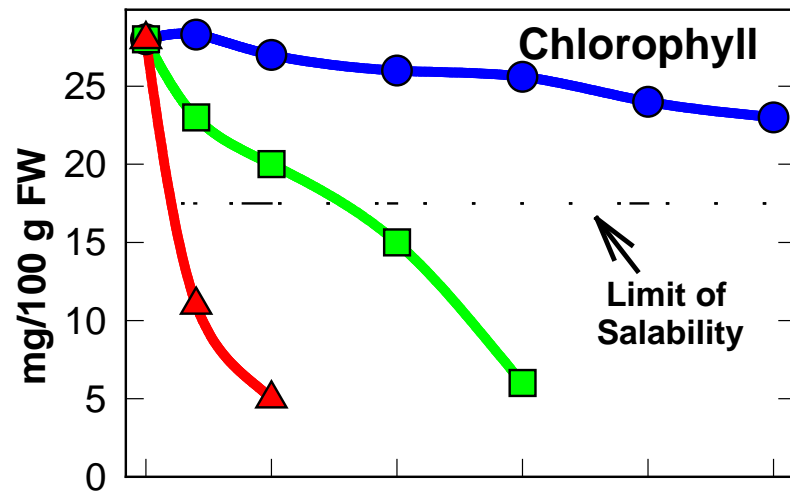
Cool Season Vegetables

- Broccoli
 - Iced to iceless product; firmness and water loss
- Specialty Brassicas
 - Compare postharvest performance to broccoli
- Fresh-cut and modified atmospheres
 - Response of broccoli and sugar snap peas
- Cauliflower --needs postharvest work
- Cabbage Quality and Temperature
- Lettuce Varieties
 - Fresh-cut performance

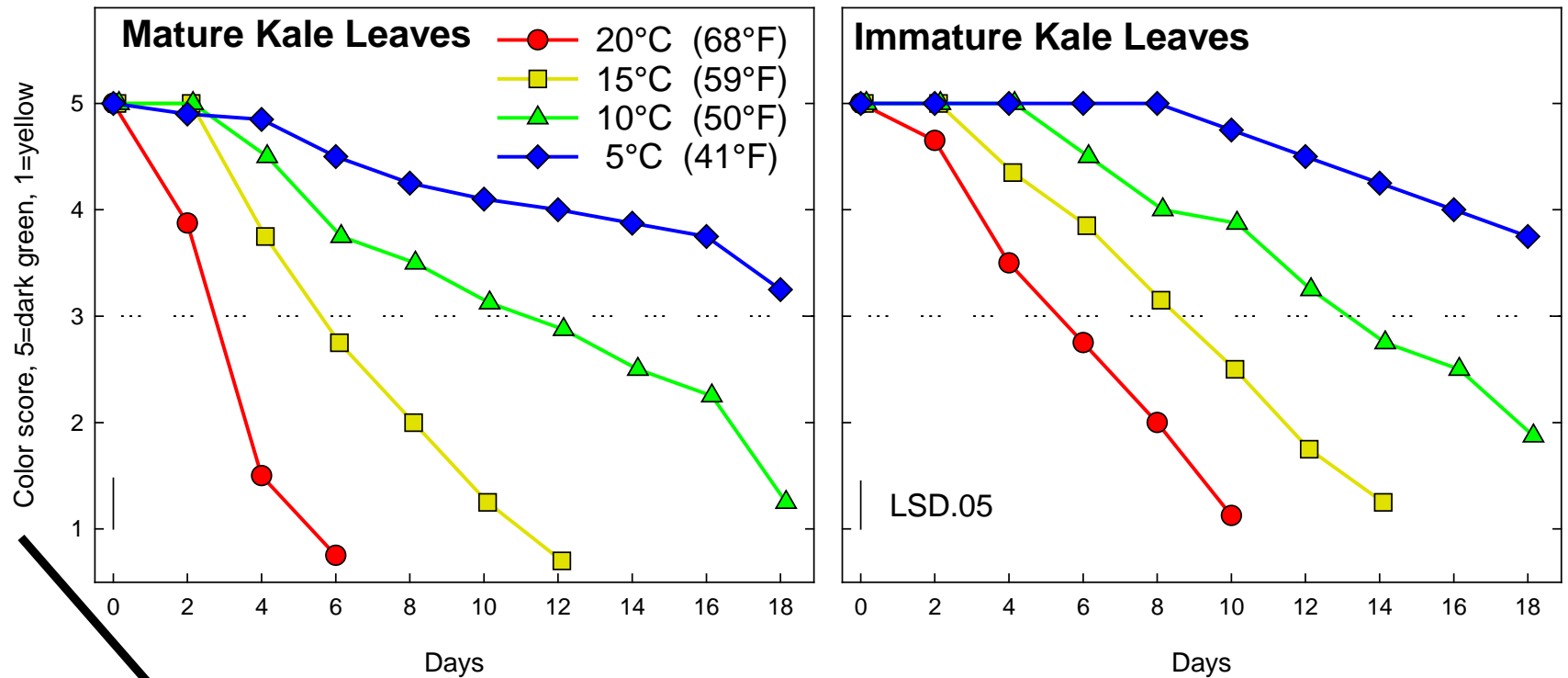
Fresh appearance
Green florets
Tender stem
No discoloration
No breakage
No decay
No off-odors

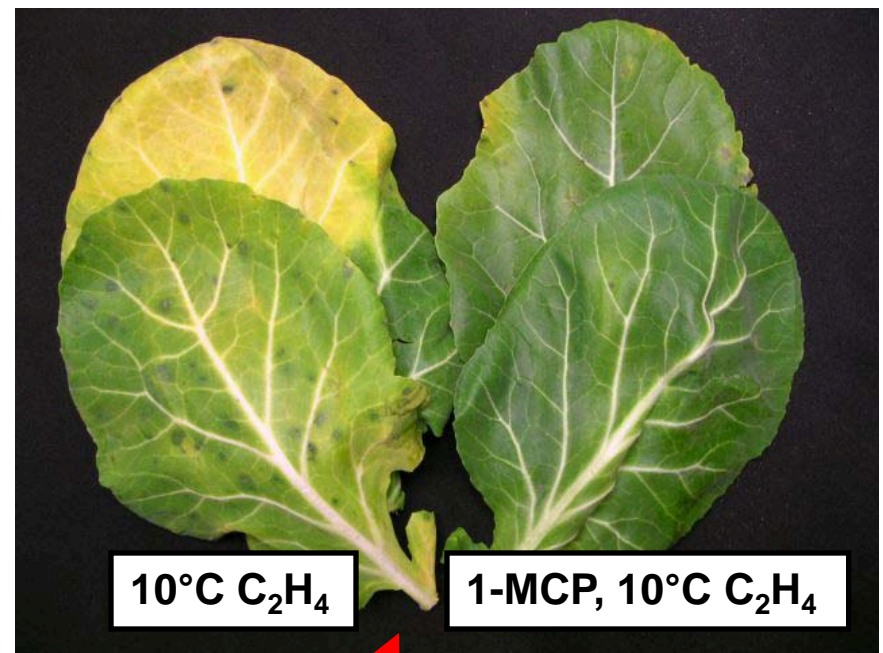
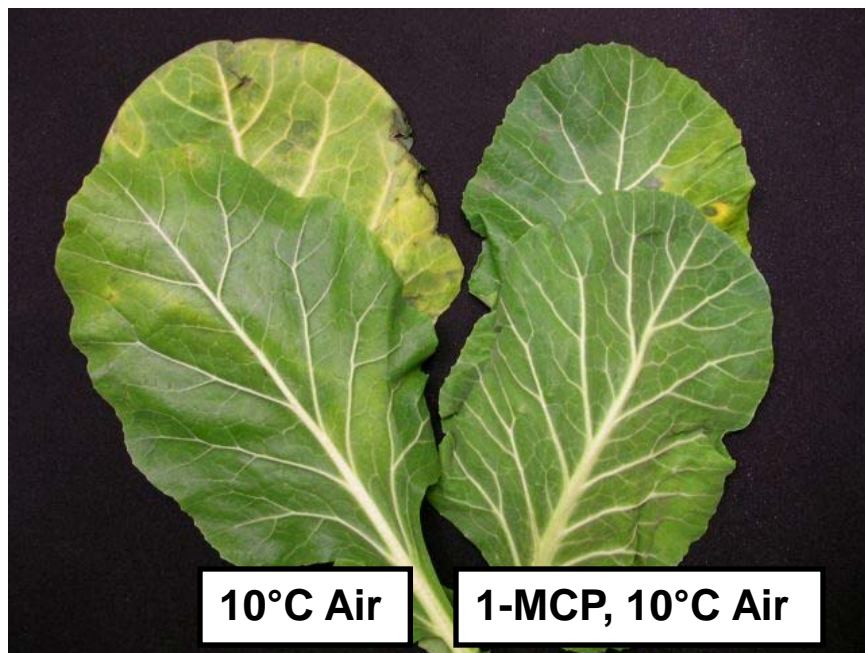


Broccoli Compositional Quality and Storage Temperature

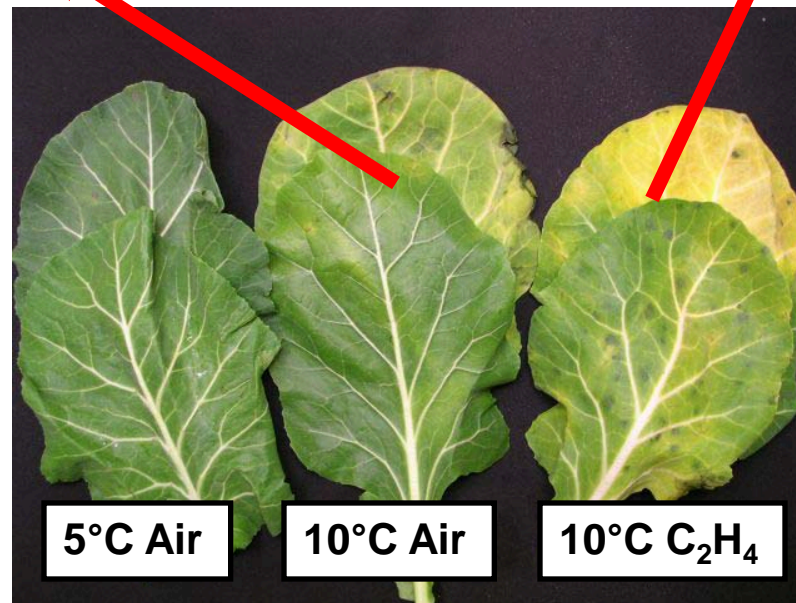


Loss of green color by **mature** and **immature** Kale leaves stored at 4 temperatures for up to 18 days.





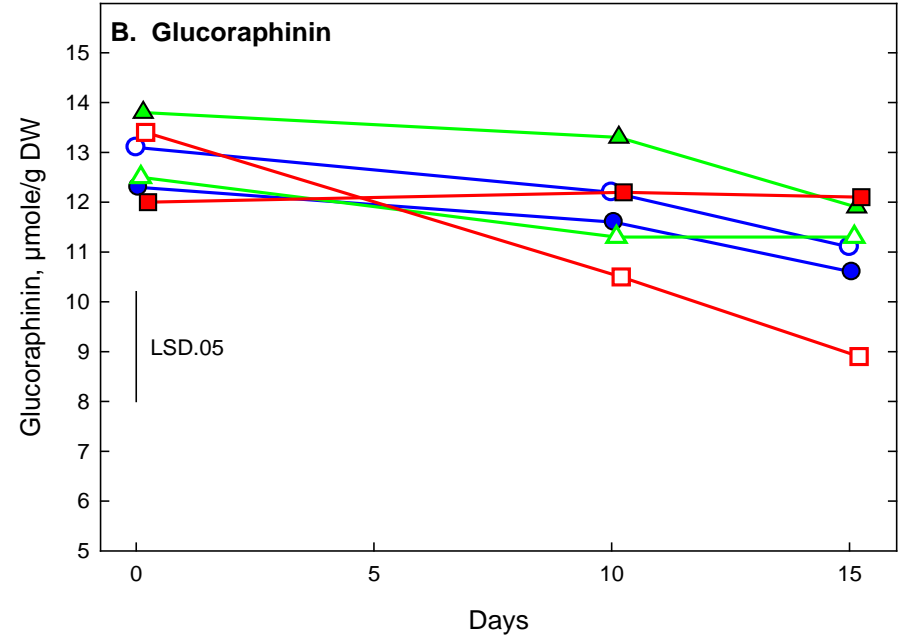
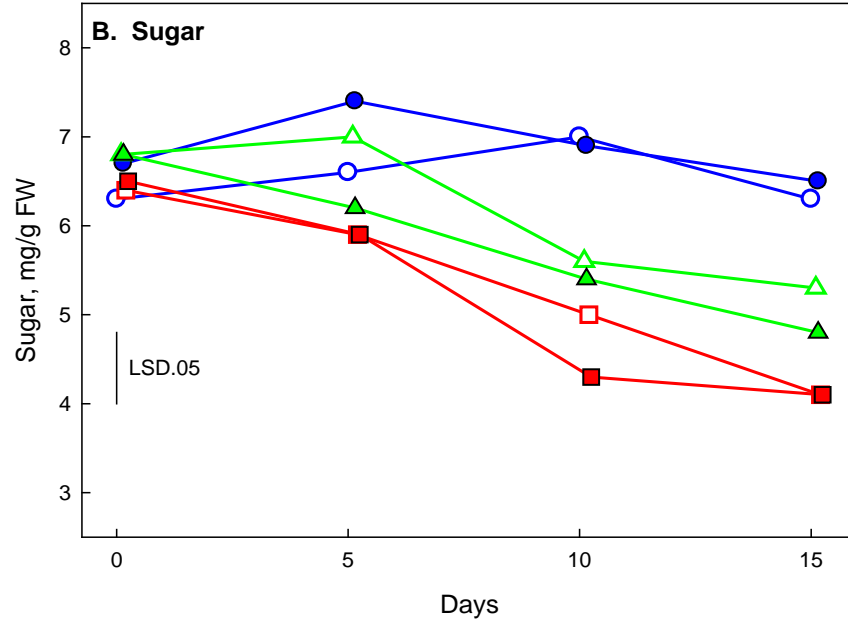
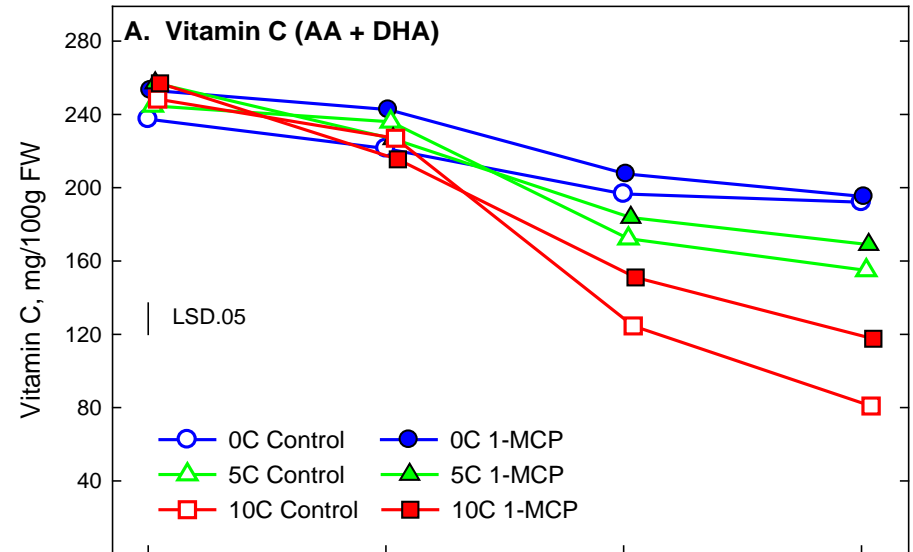
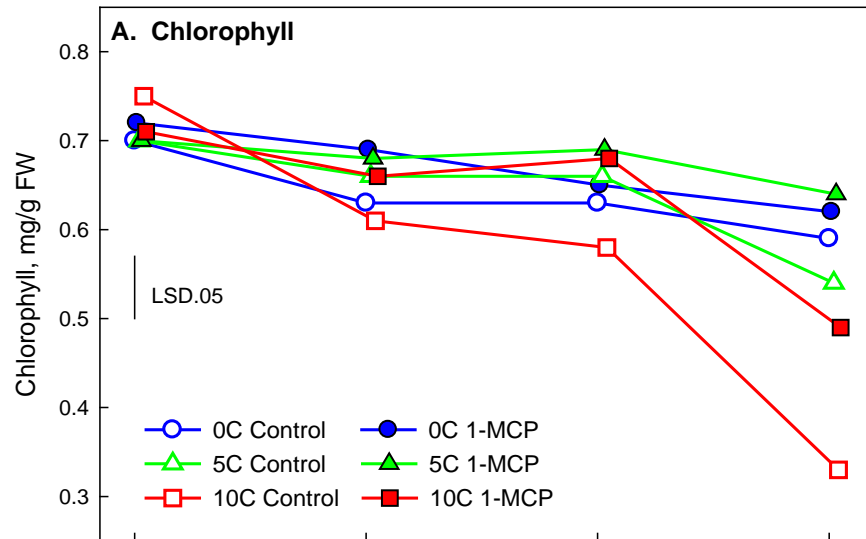
Collards



12 days; 8 ppm C₂H₄;
500 ppb 1-MCP

1-MCP=1-methyl-cyclopropene, SmartFresh™, AgroFresh

Broccoli and Temperature and 1-MCP (no ethylene exposure)



Glucoraphin produces Sulforaphane – potent Phase 2 Enzyme Inducer, inhibit cancer



Specialty Brassicas Comparative Study

Gai-lan

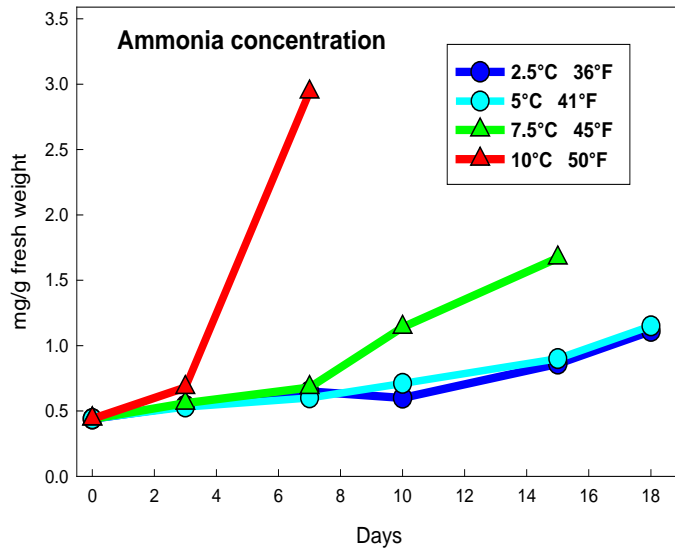
Choi-sum

Broccoli raab, rapini

Broccolini

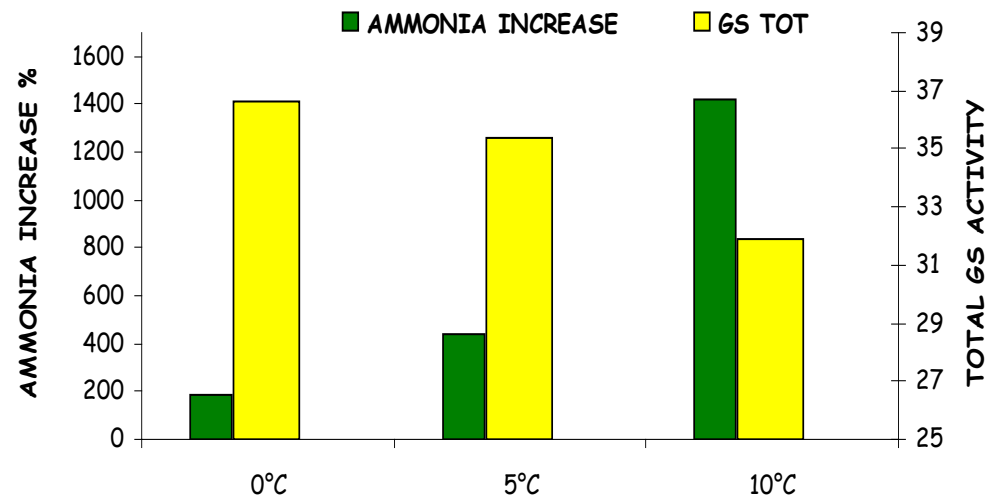
Marketable quality
 Compositional quality
 Response to Temperature
 Response to atmospheres

| Broccoli raab | Florets | | | Stem Tissue | | |
|---|---------|-----------|-----------|-------------|----------|-----------|
| Component | Initial | 5C, 8d | 10C 8d | Initial | 5C 8d | 10C 8d |
| Total sugars, mg/gFW | 5.2 | 4.5 | 3.7 | 17.4 | 14.4 | 12.0 |
| Ammonia, μ mole/100gFW | 1.1 | 1.4 | 2.3 | 0.5 | 1.0 | 1.1 |
| Antioxidant activity mg Trolox/100g FW | 117 | 100 | 92 | 47 | 43 | 32 |
| Vitamin C, mg/100g FW | 235 | 176 | 112 | 87 | 86 | 88 |



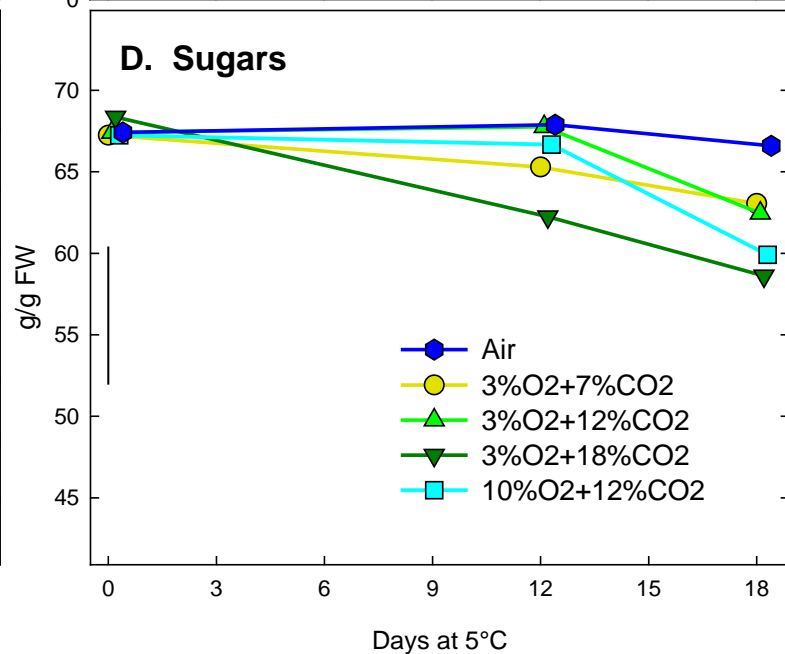
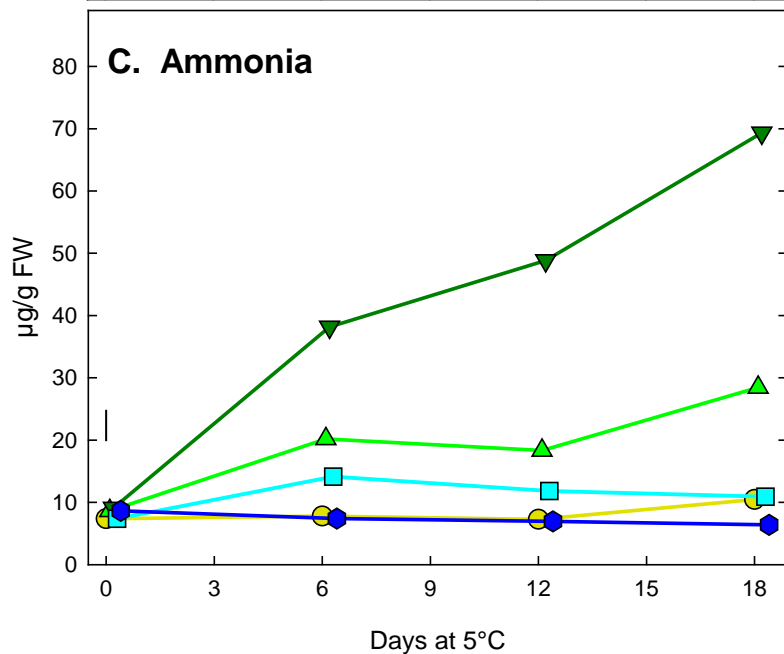
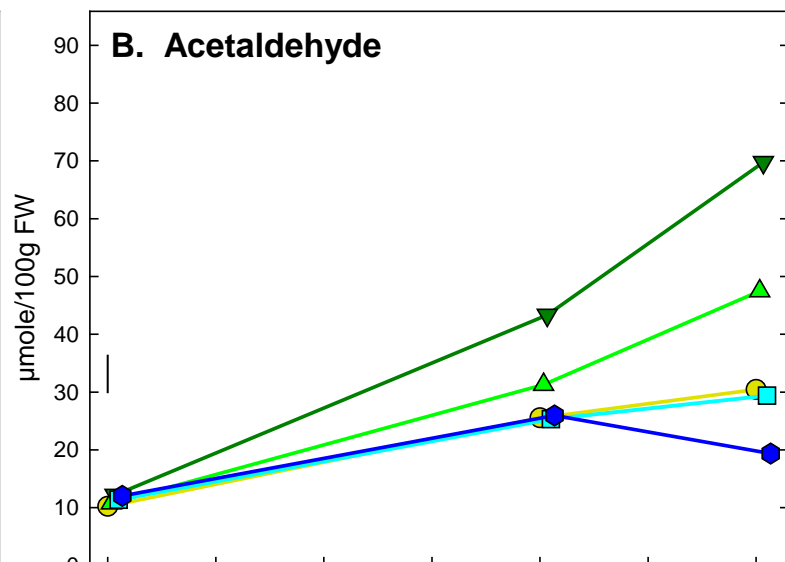
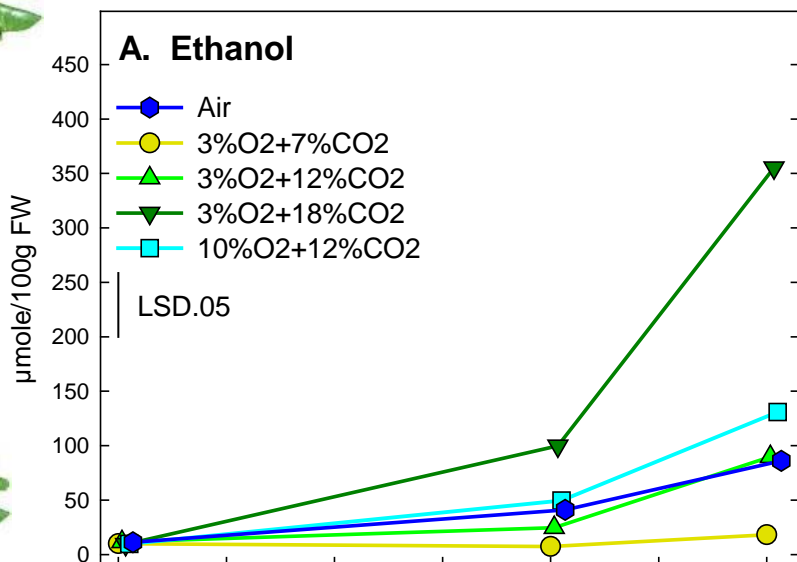
Changes in ammonia in spinach at 4 temperatures over 18 days

Changes in ammonia and GS activity in Spinach



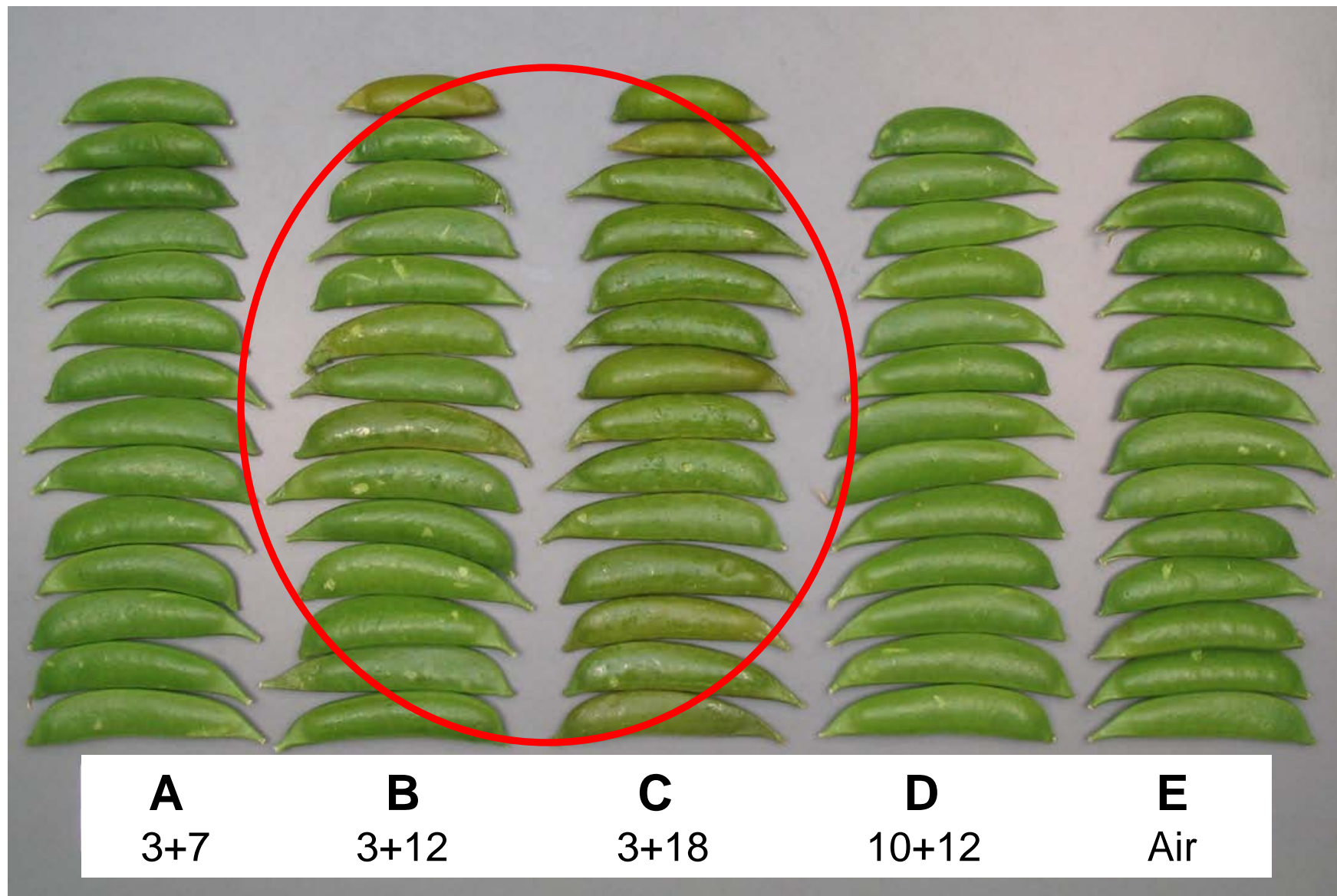
6 days, data of Eghle Catalano, 2007

Test #2



18 days at 5°C (41°F)

Air=Best quality



DAMAGING



Broccoli Storage Conditions

- 0°C with very high humidity
- MA: 5-8% O₂ + 7-10% CO₂

Iceless Broccoli
Temperature-yellowing
Moisture loss-softening



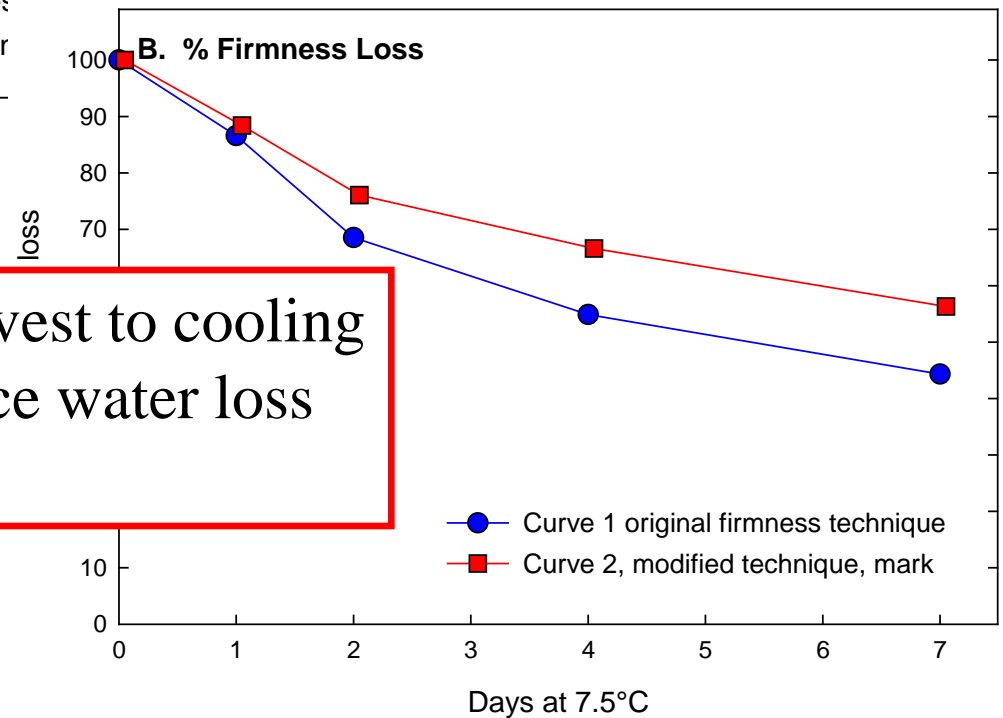
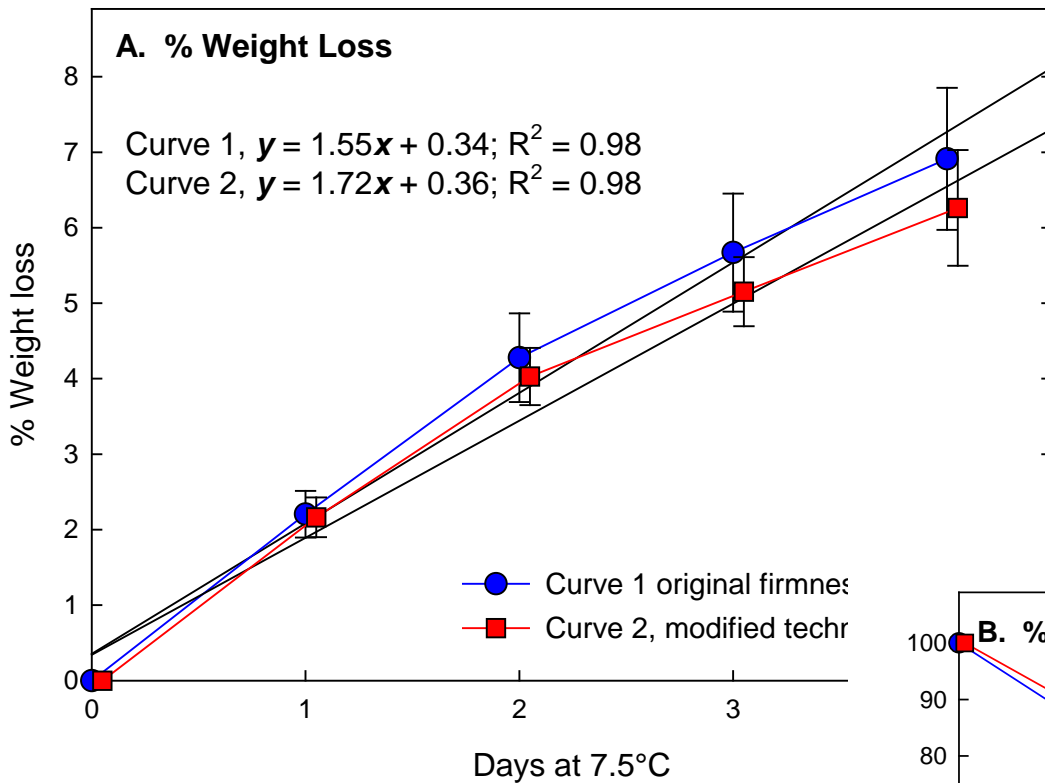
Table 1. Broccoli head firmness and compactness scoring and the relationship to firmness measurements on texture analyzer. This table based on preliminary 2009 data.

| Subjective score | Description | Objective firmness N compression force* |
|------------------|---|---|
| 5 | Heads hard, very tight and firm | 65-100N |
| 4 | Heads firm, a few outer florets may be loosened | 50-80 |
| 3 | Heads moderately firm, with some florets loosened** | 40-60 |
| 2 | Heads moderately soft, with most florets loosened | 25-40 |
| 1 | Heads soft, with extensive loosening of florets | 10-25 |

*Heads compressed with a flat disc to a depth of 7.5 mm

**A score of 3 is likely the limit of marketability at retail.





- ❖ Minimize delay from harvest to cooling
- ❖ Use plastic liners to reduce water loss
- ❖ Keep it cold

14 days air



2.5°C (36°F)



5°C (41°F)



7.5°C (45°F)

14 days 5°C (41°F)



5% O₂



5% O₂ + 7.5% CO₂



5% O₂ + 15% CO₂



14d 5°C

Air

1%O₂ +15% CO₂



Quality Problems
Graying
Loss of fluid
Off-odor

Cauliflower Quality

color is cream white

freedom from mechanical injury

freedom from decay

overall attractive appearance

no discoloration on cut edges

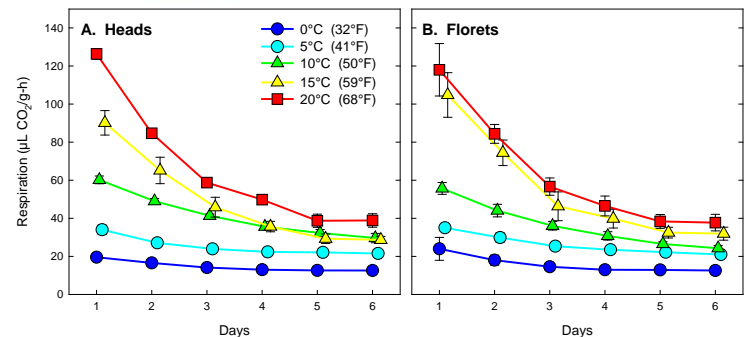
minimal number of small pieces; good integrity of cut florets

good aroma and odor as fresh or microwaved food

retain high content of sugars and Vitamin C

RESEARCH TO DO

- Evaluate the performance of cultivars for quality of fresh market and fresh-cut product
- Evaluate the impact of initial postharvest handling on the shelf-life and quality of fresh-cut cauliflower florets.
- Evaluate the impact of production conditions (seasonability, fertilization, irrigation) on the quality and shelf-life of cauliflower florets

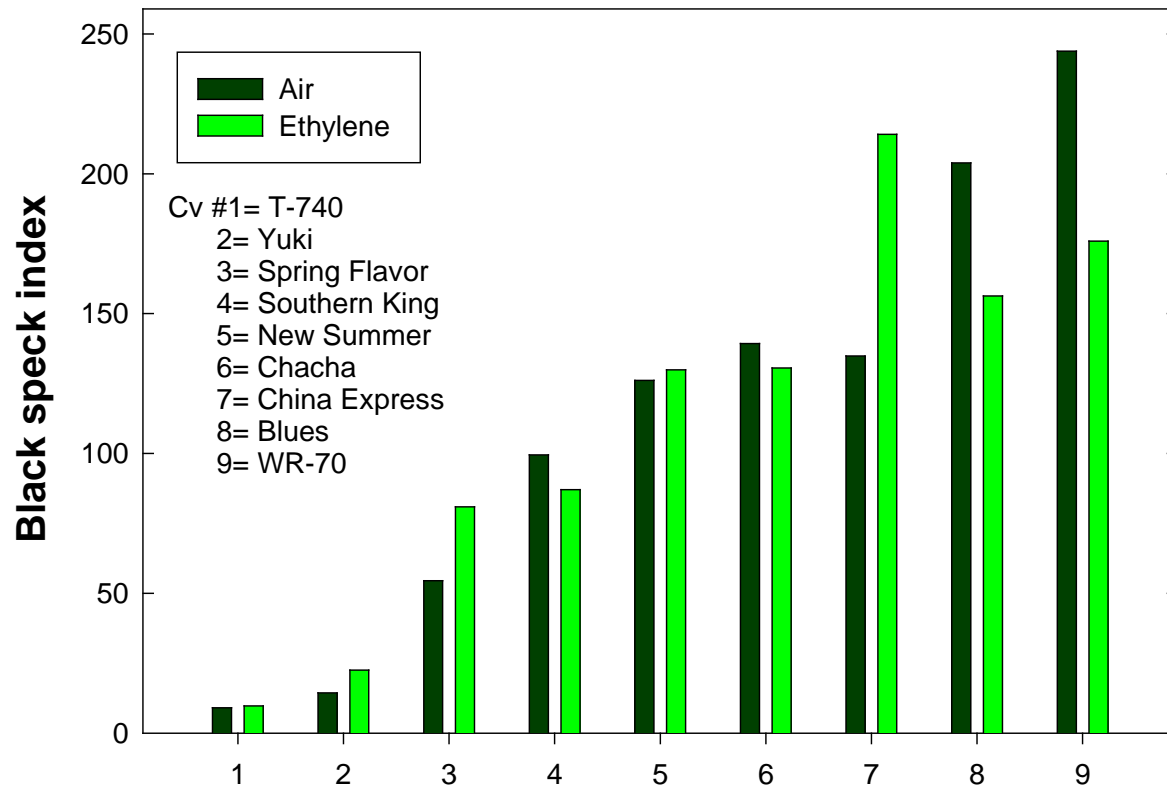




Napa or Chinese cabbage Black Speck Disorder



Black Speck Disorder on Chinese Cabbage



Black speck index = black speck score multiplied by % extension.

- ❖ **Black speck development on Napa cabbage stored in air or in ethylene is the same.**
- ❖ **PAL enzyme levels similar; 1-MCP does not reduce black speck.**
- ❖ **Cultivars vary greatly in their susceptibility to black speck.**

Cabbage Quality and Temperature

CDFA WIC Stores Small Farm Program Project

Shermain Hardesty, Lucia Kaiser, and Advisors

- Retail handling—good to poor conditions
- Impact on marketability and nutritional value—conditions to retain 80% original nutrition
- Vitamin C, Antioxidant Activity, Carotenoids
- Wide range of temperatures (0-29°C; 32-84°F)
- Cabbage performs well over temp range—should be available in all WIC stores



Fresh-cut Lettuces

Varieties of Iceberg, Romaine and Crosses

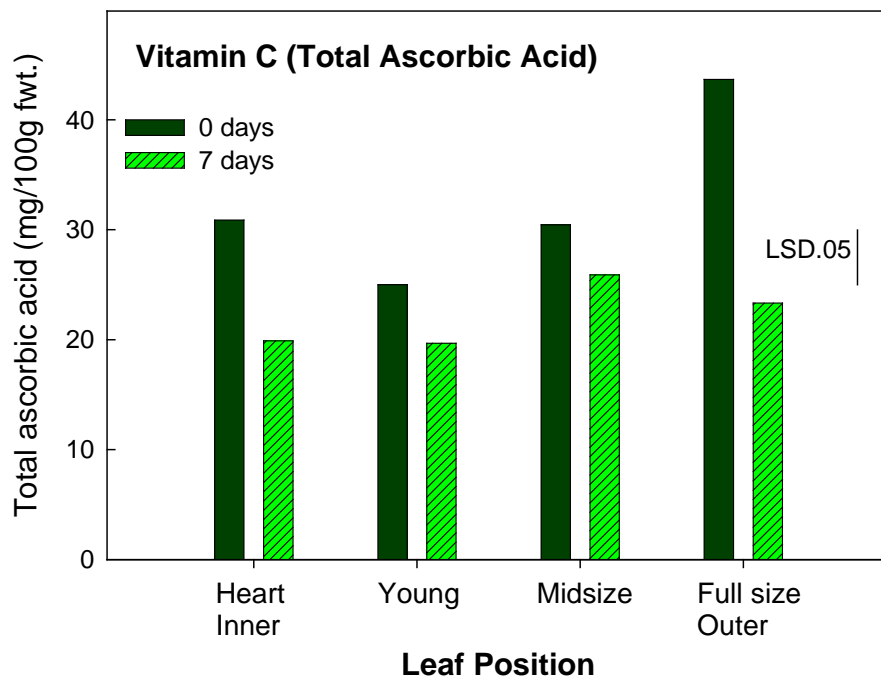
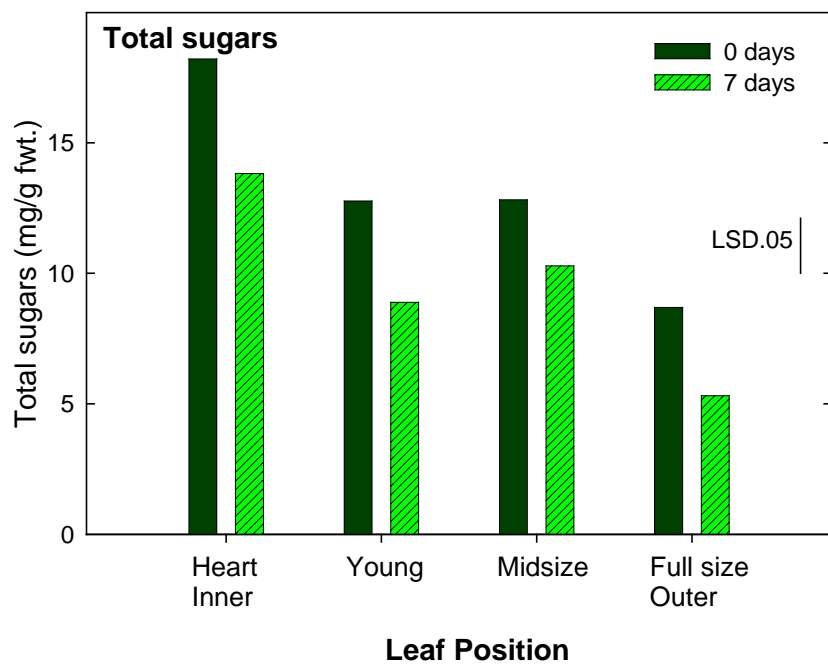
- **Performance as fresh-cut product**
 - Visual quality score
 - Discoloration
 - Decay
- **Respiration rates**
- **Phenolics and phenolic enzymes (PAL, PPO)**
- **Composition**
 - Number leaves per head
 - % dry weight
 - Sugars
 - Chlorophyll and carotenoids
 - Vitamin C
 - Ammonia

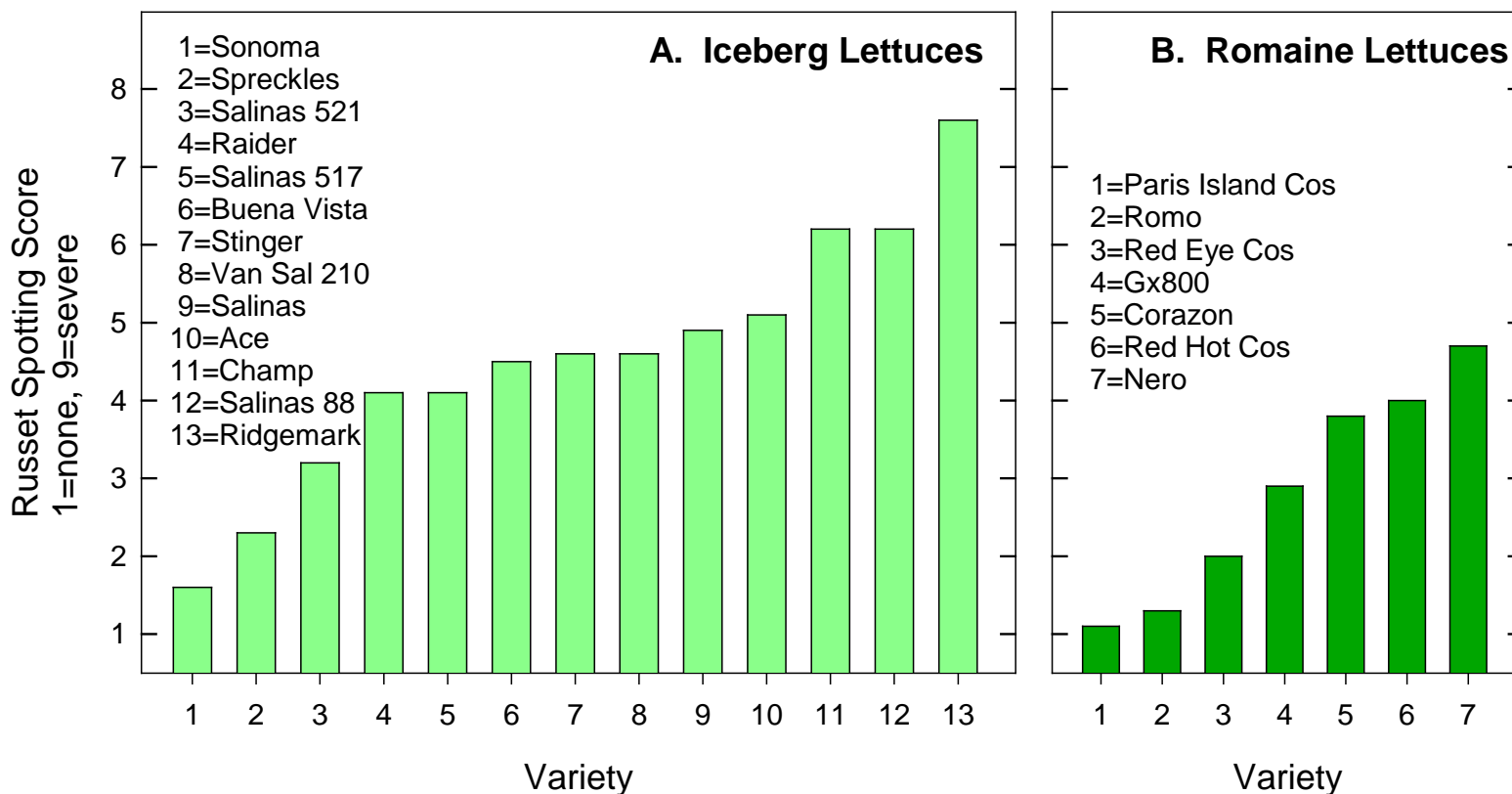
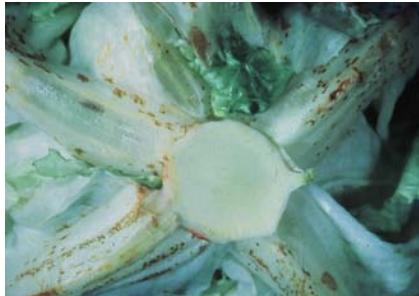


Discoloration Rating Scale for Romaine



Romaine lettuce





Development of Russet Spot Disorder on Iceberg and Romaine Lettuces. Intact heads were stored in 5ppm ethylene at 5°C (41°F) plus 1 week in air.

Is Temperature a Quality Issue or a Food Safety Issue?

- ✓ **Prevention of Contamination is most important**
- ✓ **Time and Temperature are Amplifiers of Risk**



10 Basic Postharvest Principles

- 1) Harvest at correct maturity
- 2) Reduce physical handling
- 3) Protect product from sun
- 4) Keep packingline simple and clean; ensure good worker hygiene
- 5) Select, classify, and pack carefully
- 6) Align cartons, strap pallet
- 7) Cool as soon as possible
- 8) Know market and product requirements
- 9) Coordinate efficient & rapid handling
- 10) Train and compensate workers adequately

