

USE OF SMARTFRESH ON DIFFERENT VARIETIES

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SmartFresh™ Quality System

2010 APPLE USE RECOMMENDATIONS



Guidelines updated on an annual basis

- Highlight factors to maximize effectiveness of SmartFresh and minimize risk
- Based on industry knowledge and that gained from researchers

Our research is driven by mutual goals – to identify keys to maintaining while understanding the underlying processes:

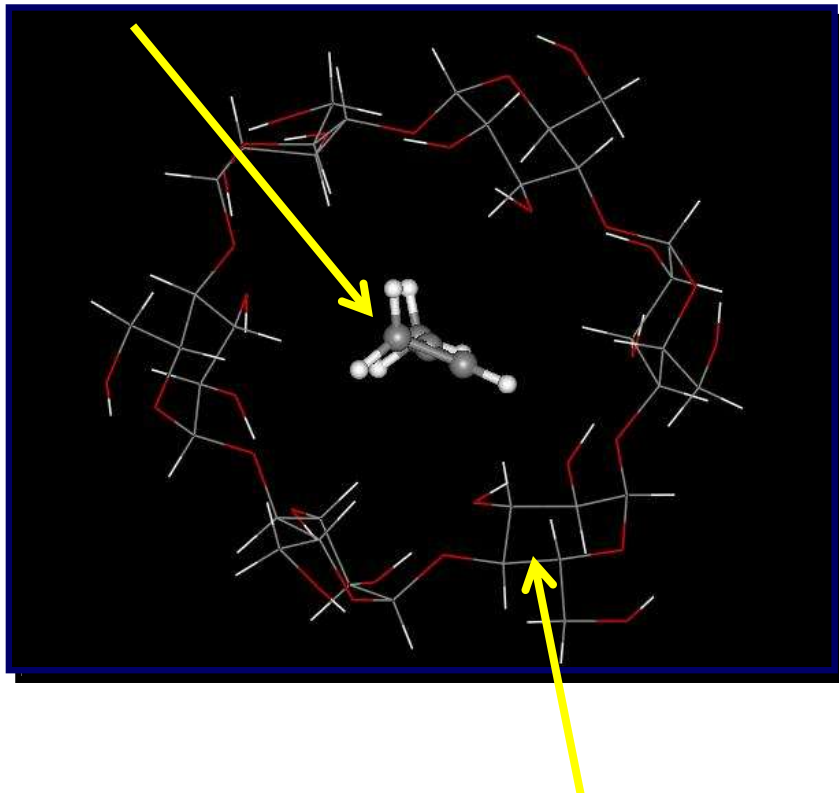
1. Firmness and quality attributes
2. Controlling and avoiding storage disorders



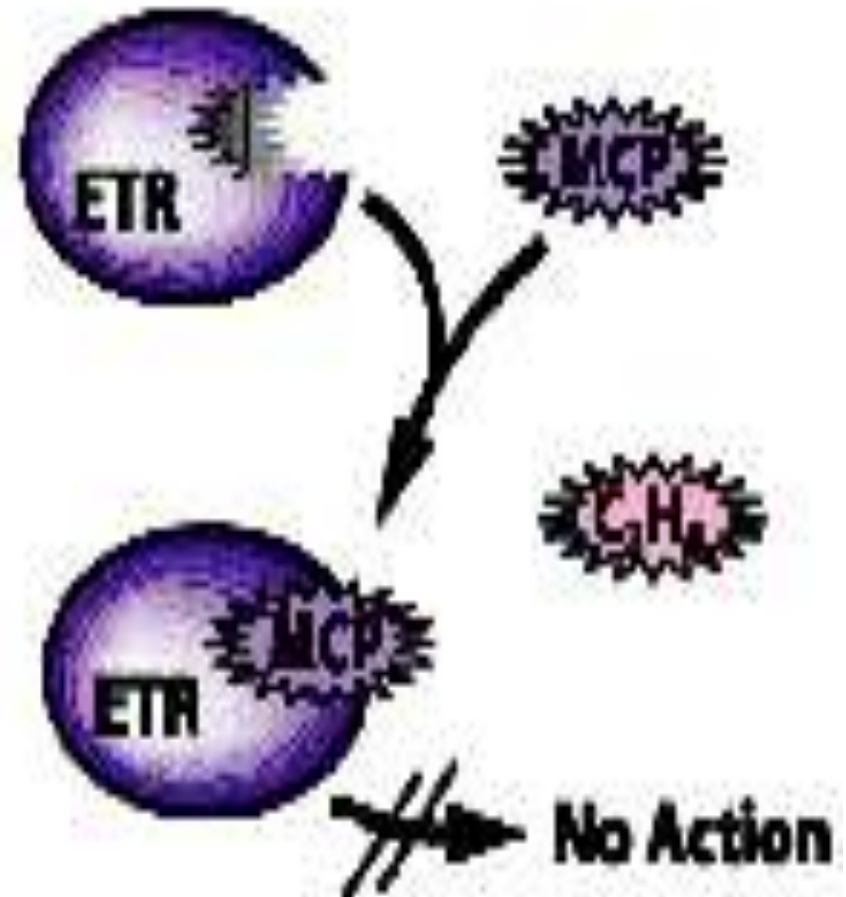
What is SmartFresh?

1-Methylcyclopropene (1-MCP)

1-MCP



Sugar powder



PA apple varieties

- Braeburn
- Cameo
- Cortland
- Empire
- Fuji
- Gala
- Gingergold
- Golden Delicious
- Granny Smith
- Honeycrisp
- Jonathan
- McIntosh
- Mutsu
- Nittany
- Pink Lady
- Red Delicious
- Rome
- Stayman
- York

Outline of today's presentation

Part 1: Factors that affect
Quality

Part 2: Storage disorders

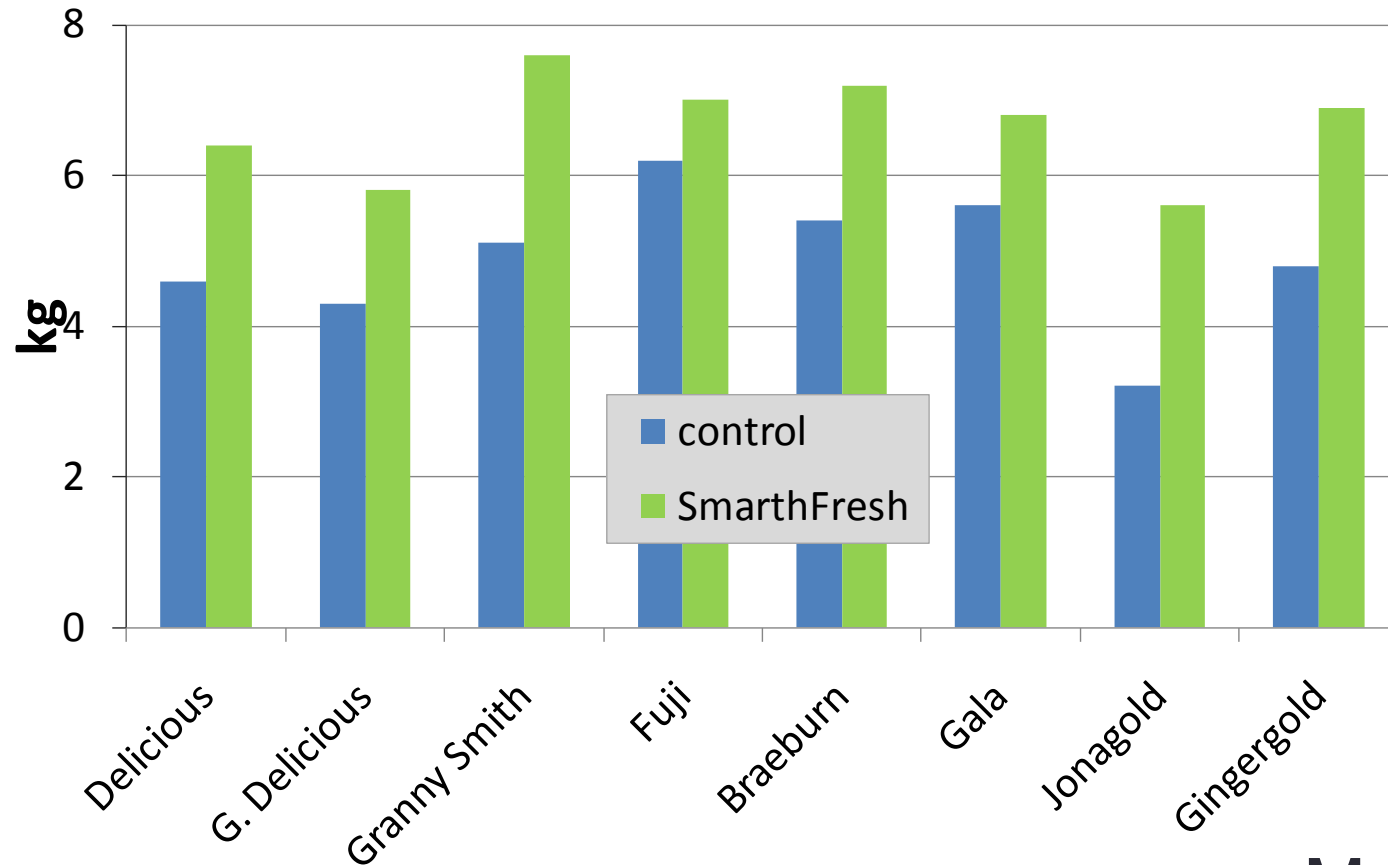
Part 1: Factors that affect Quality

Understanding of ethylene production both pre- and post-harvest

- Variety
- Maturity
- Plant growth regulators
-
- Postharvest handling

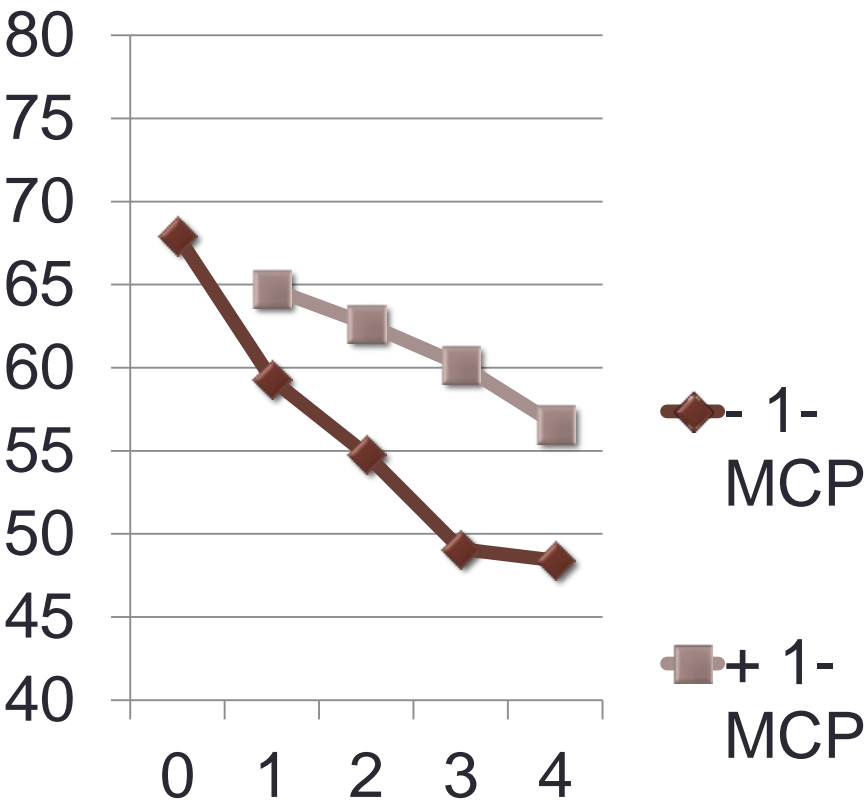
Apple firmness

6 months air @ 0.5°C + 7 days @ 20°C



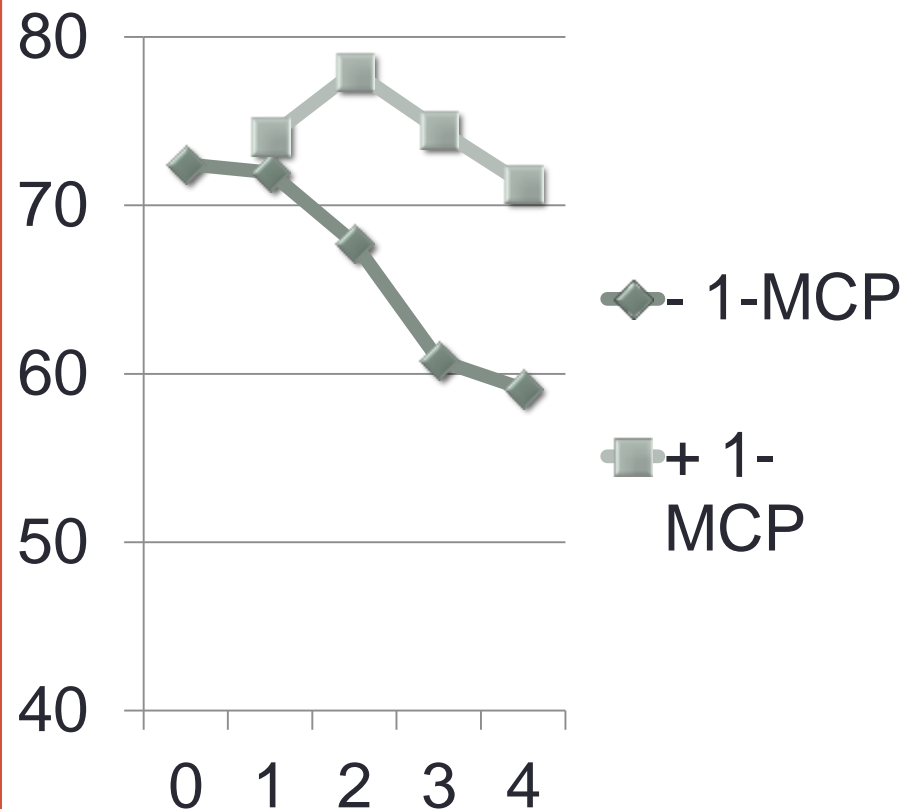
Comparison of two cultivars: Firmness (N) in air storage

McIntosh

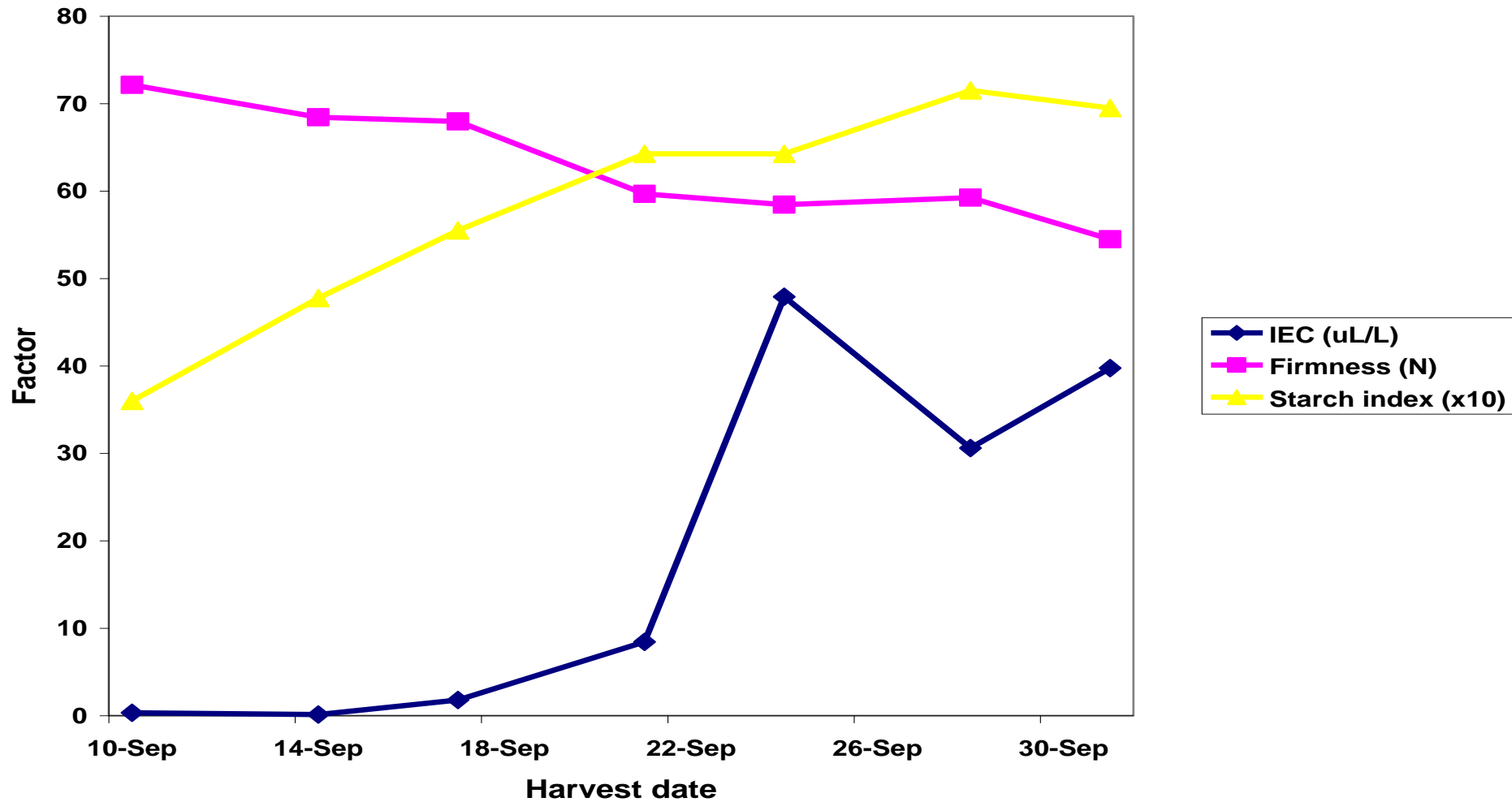


STORAGE TIME (Months)

Empire

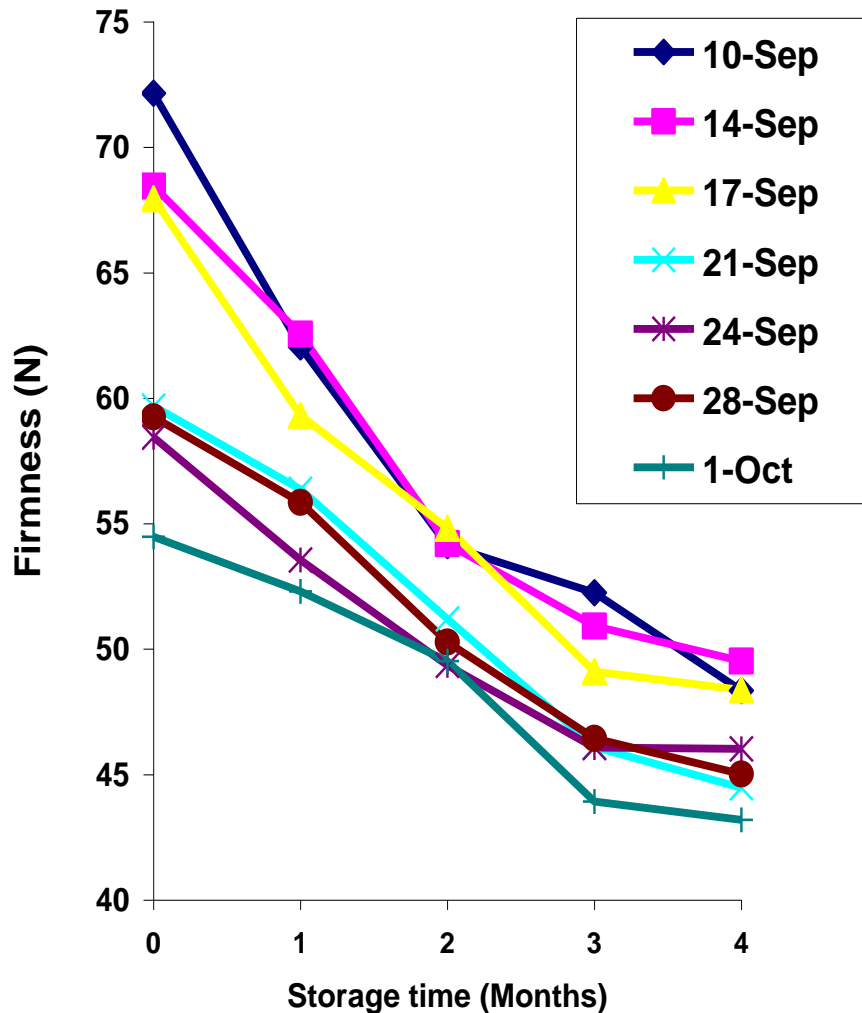


Fruit maturity

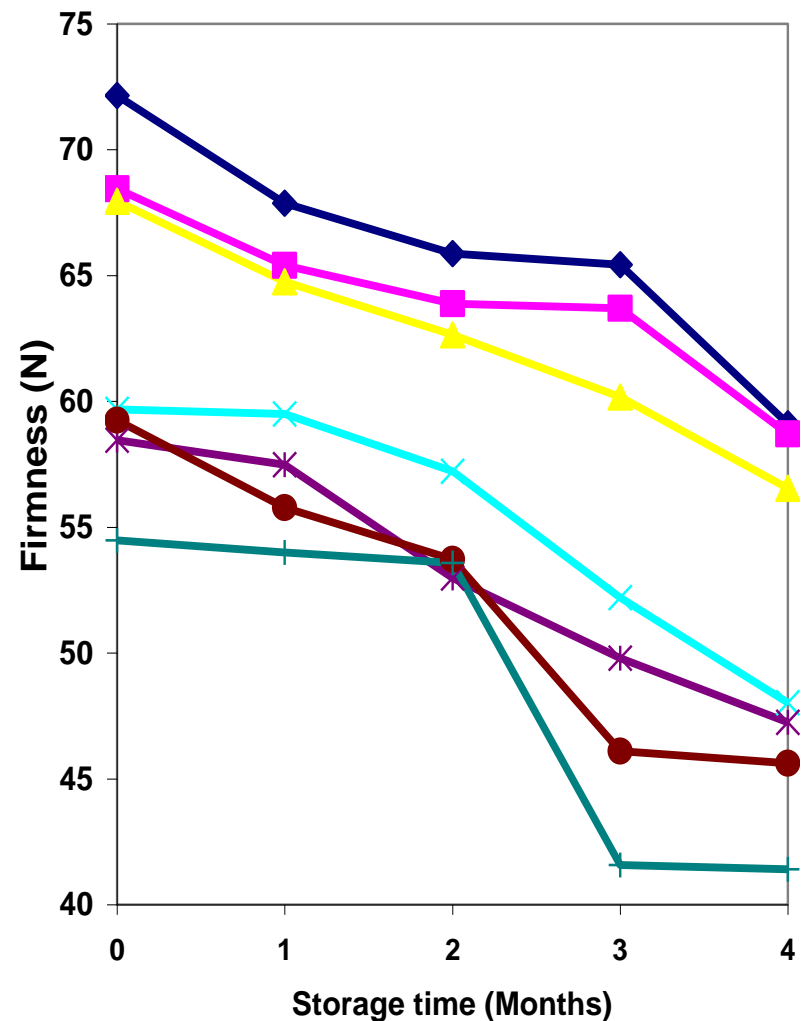


Firmness (N) during storage

No 1-MCP



1-MCP





Naphthaline acetic acid (NAA)

Aminoethoxyvinylglycine (AVG)

Prevent fruit drop
Harvest and labor management

Responses of fruit to SmartFresh

Plant Growth Regulator

Retain[®]

Soluble Powder

FOR USE ON APPLE, PEACH, AND STONE FRUIT (EXCEPT CHERRY)

ACTIVE INGREDIENT:
 (S)-2-Amino-3-(2-dimethylaminoethyl)-3-butenoic acid hydrochloride 10%
OTHER INGREDIENTS 90%
TOTAL 100%

EPA Reg. No. 73049-05
 EPA Est. No. 33762-5A-001 (Lot No. Suffix "04")
 33887-AD-1 (U.S. No. Suffix "00") List No. 12017

INDEX:
 1.0 First Aid
 2.0 Precautionary Statements
 2.1 Hazards to Humans and Domestic Animals
 2.2 Personal Protective Equipment (PPE)
 2.3 User Safety Recommendations
 2.4 Environmental Hazards
 3.0 Directions for Use
 4.0 Agricultural Use Requirements
 5.0 General Information For Use
 6.0 General Application Instructions
 7.0 Compatibility With Other Agricultural Products
 8.0 Apple and Pear
 9.0 Stone Fruit (except Cherry)
 10.0 Storage and Disposal
 11.0 Notice to User

**KEEP OUT OF REACH OF CHILDREN
CAUTION**

1.0 FIRST AID

| | |
|--------------------------------|---|
| If inhaled: | <ul style="list-style-type: none"> Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice. |
| If on skin or clothing: | <ul style="list-style-type: none"> Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice. |

NET LBS. NUMBER 4

Have the product container or label with you when calling a poison control center or doctor, or going to hospital. You may also contact 1-800-852-0898 (24 hours) for emergency medical treatment and/or transport/emergency information. For all other information, call 1-800-9-VALENT (932-5363).

2.0 PRECAUTIONARY STATEMENTS

2.1 HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CAUTION
 Harmful if inhaled or absorbed through skin. Avoid breathing spray mist. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

2.2 Personal Protective Equipment (PPE)
 Applicators and other handlers must wear:

- Long sleeved shirt and long pants.
- Shoes plus socks.
- Waterproof gloves.

Hard-wear applicators must wear chest/neck filtering respirator (MSHA/NIOSH approved hazard prefix TC-21CL or a NIOSH approved respirator with N, R, P, or HC filter when applying this product).

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

2.3 User Safety Recommendations
 Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then, wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

2.4 Environmental Hazards
 Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater and rinsate.

3.0 DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the State/Tribe agency responsible for pesticide regulation.

4.0 AGRICULTURAL USE REQUIREMENTS
 Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170.

FRUITONE[®]

N

FOR TRAINING USE CONTROL OF PEST HONEYDEW OF CITRUS AND PEACH. FOR PROTECTING THE FRUIT OF APPLE AFTER THE FOLLOWING HARVEST

ACTIVE INGREDIENT:
 Naphthalene-2-acetic acid, sodium salt 27%
INERT INGREDIENTS 73%
TOTAL 100%

Formulated by LFB or representative LFB

FOR THE FOLLOWING EMERGENCIES, PHONE 800-852-0898
 TRANSPORTER: CHEMTEC 1-800-424-9090
 OTHER: AMVAC 1-800-955-5123 1-822-324-8818

**KEEP OUT OF REACH OF CHILDREN
CAUTION**

STATEMENTS OF PRACTICAL TREATMENT

IF ON SKIN: Immediately wash skin with plenty of soap and water. Get medical attention if irritation persists.

IF SWALLOWED: Call a physician or Poison Control Center. Take 1 or 2 glasses of water and induce vomiting by forcing back of throat with finger or backhanded spoon. Taking more of water is not advised. Do not get anything to eat and do not induce vomiting.

IF INHALED: Flush eyes with plenty of water. Call a physician if irritation persists.

IF INHALED: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. Get medical attention.

NOTE: It is impractical to provide adequate information for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural products. It is the user's responsibility to follow, understand, and maintain safe practices. Take extra precautions. Take extra precautions and wear protective clothing to the extent that the label about Worker Protection Standard (WPS) and restricted entry periods. The requirements in this label only apply to use of this product that are covered by the Worker Protection Standard.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CAUTION: Harmful if inhaled through the skin or eyes. Irritation to contact. Avoid contact with skin, eyes, or clothing. Avoid breathing spray mist.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
 Applicators and other handlers must wear:

- Long-sleeved shirt and long pants.
- Shoes plus socks.
- Waterproof gloves.

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Wash and wash PPE separately from other laundry.

GENERAL INFORMATION

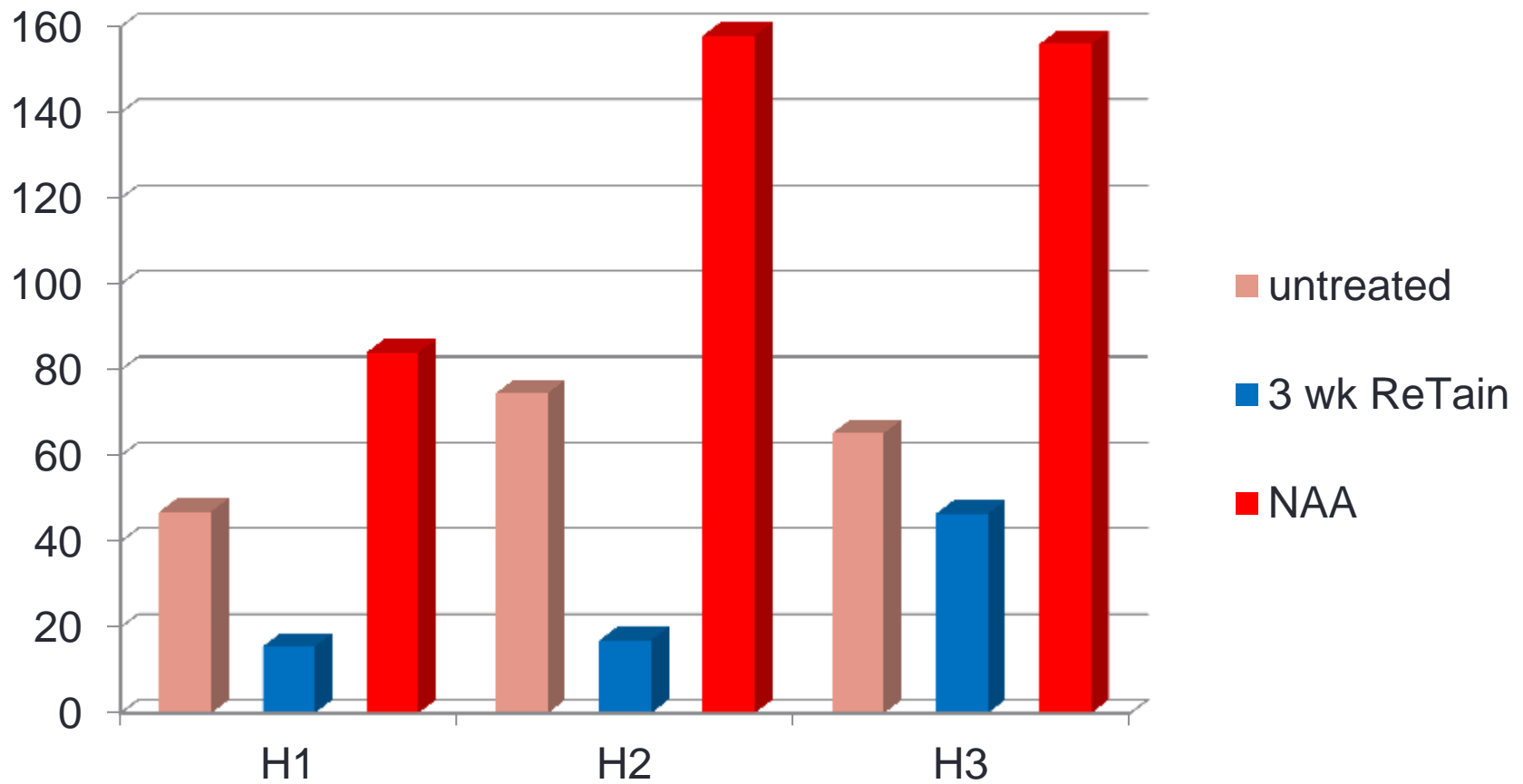
FRUITONE is an active plant hormone for use in food production. The response of fruit trees to an application may vary in different years. In carrying this out, the grower should consider the condition of weather, climate, soil, drainage, tree vigor and soil fertility choosing the correct use and timing for application. Application using well-aerated water to ensure available surface spray coverage with good spray equipment is important. Application can be made in the range of 10 to 400 gallons of water per acre. The response varies relative to the type of equipment used, tree size and density of foliage. Each grower should consider all variables in site and application timing for best usage and maximum benefit when responding to any program.

EPA Reg. No. 5481-407 EPA Est. No. 5481-04-4

AMVAC
 4100 E. Washington Boulevard
 Los Angeles, CA 90023, USA
 1-323-284-3670 • www.amvac-chemical.com

McIntosh ReTain/NAA trial

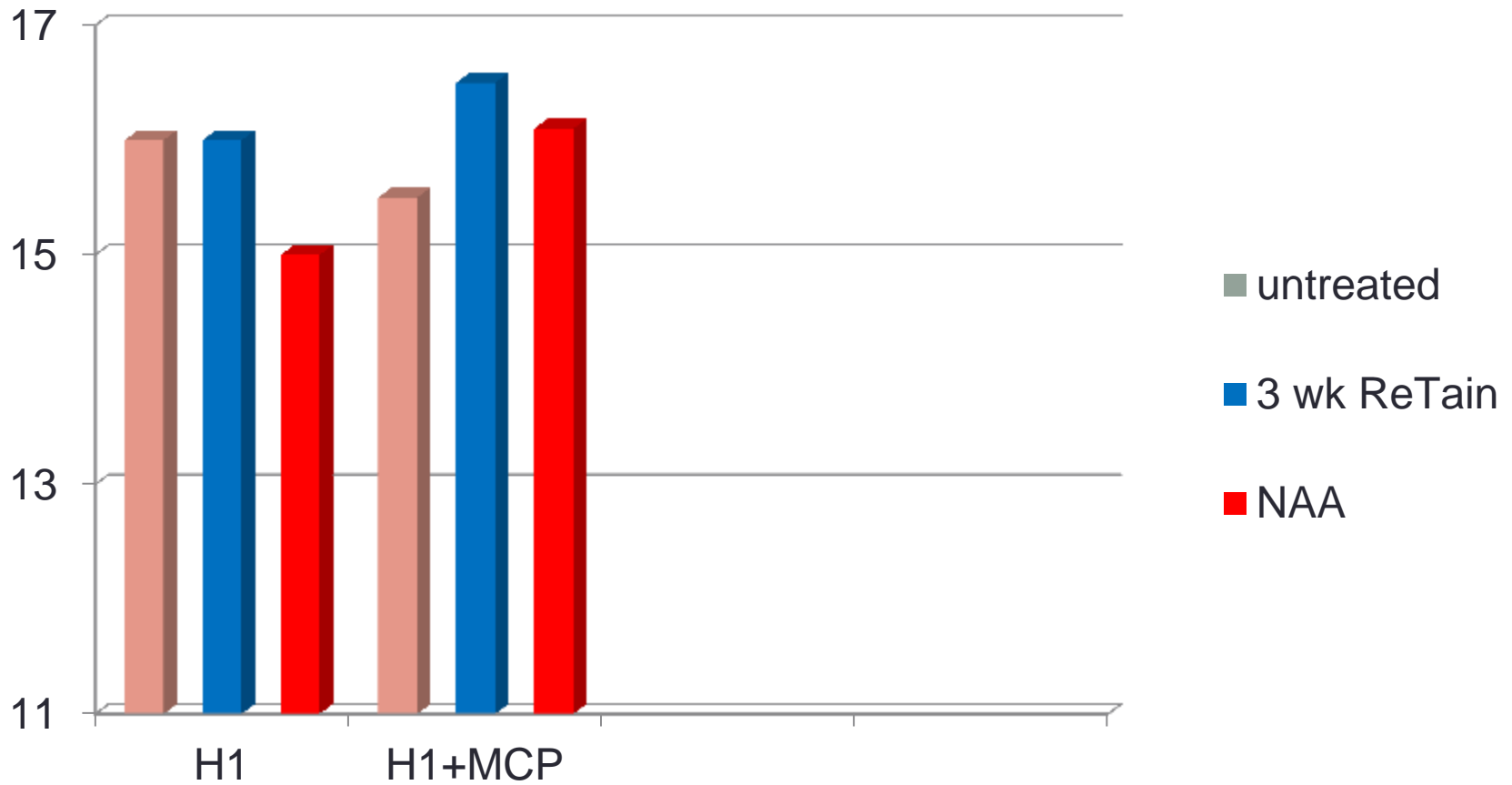
IEC (ppm) at harvest



Robinson, Hoying, Nock, Watkins unpublished

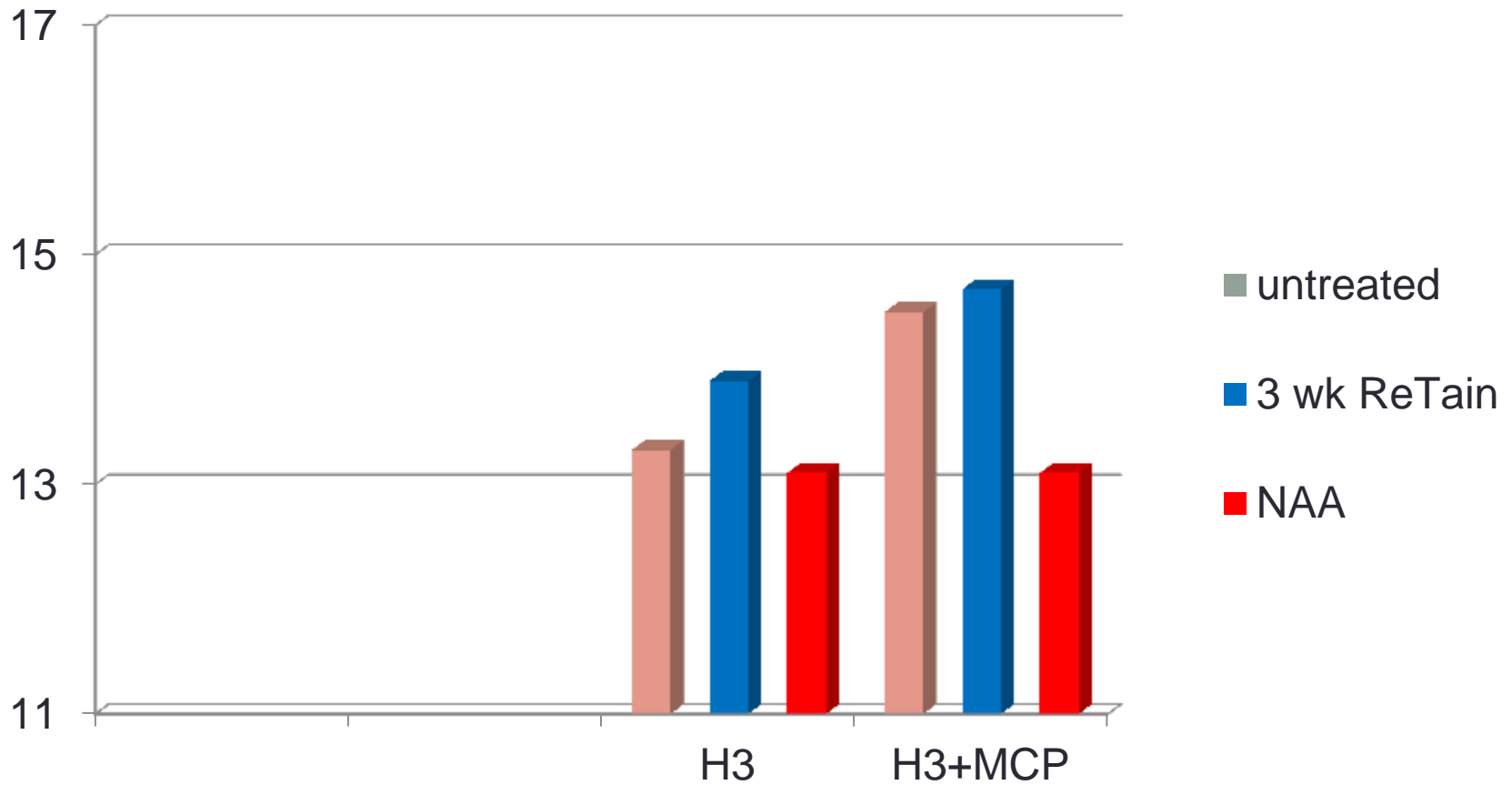
McIntosh ReTain/NAA trial

Firmness (lb) after 3 months air storage + 1d



McIntosh ReTain/NAA trial

Firmness (lb) after 3 months air storage + 1d



Take home message for preharvest factors

- Variety differences related to metabolic rates, especially rates of ripening and associated ethylene production. [Can be affected by growing region.]
- Responses of fruit at harvest are greatly affected by maturity at harvest
- Maturity, and thus response to SF, can be affected greatly by plant growth regulators

Postharvest handling

- High volume crop that is typically accumulated for several days before application of CA storage
- Ripening processes are ongoing



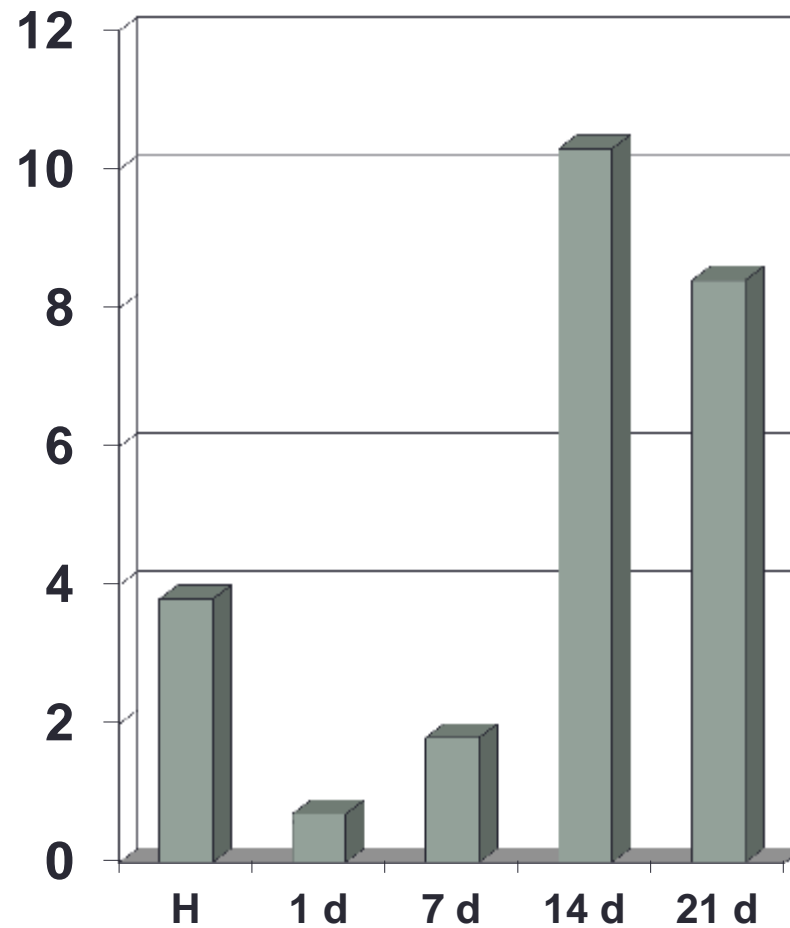
Two examples

- Delays between harvest and SmartFresh treatment
- Treatment of fruit with SmartFresh quickly after harvest and delay before CA storage

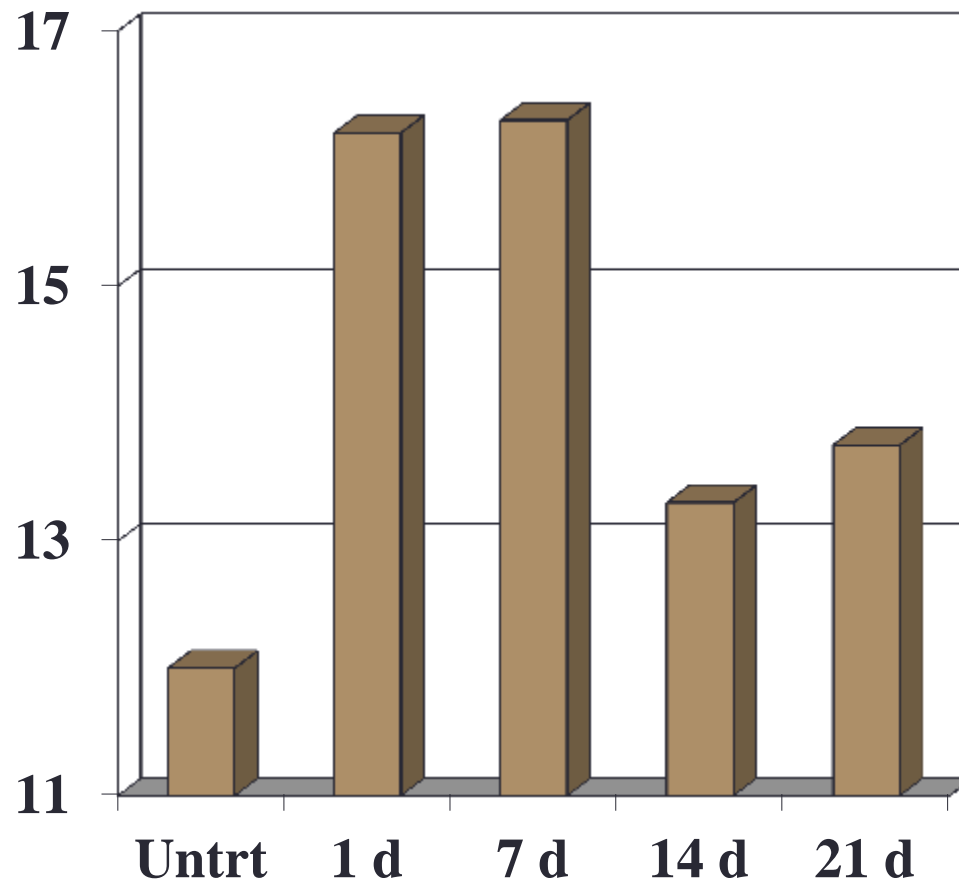
Example 1: Delays between harvest and 1-MCP treatment

- Jonagold fruit harvested, cooled overnight.
- 1-MCP applied after 2, 7, 14 and 21 days.
- IEC measured at time of treatment.
- Firmness measured after 5 months of storage in CA.

Jonagold, IEC (ppm) before 1-MCP and CA storage



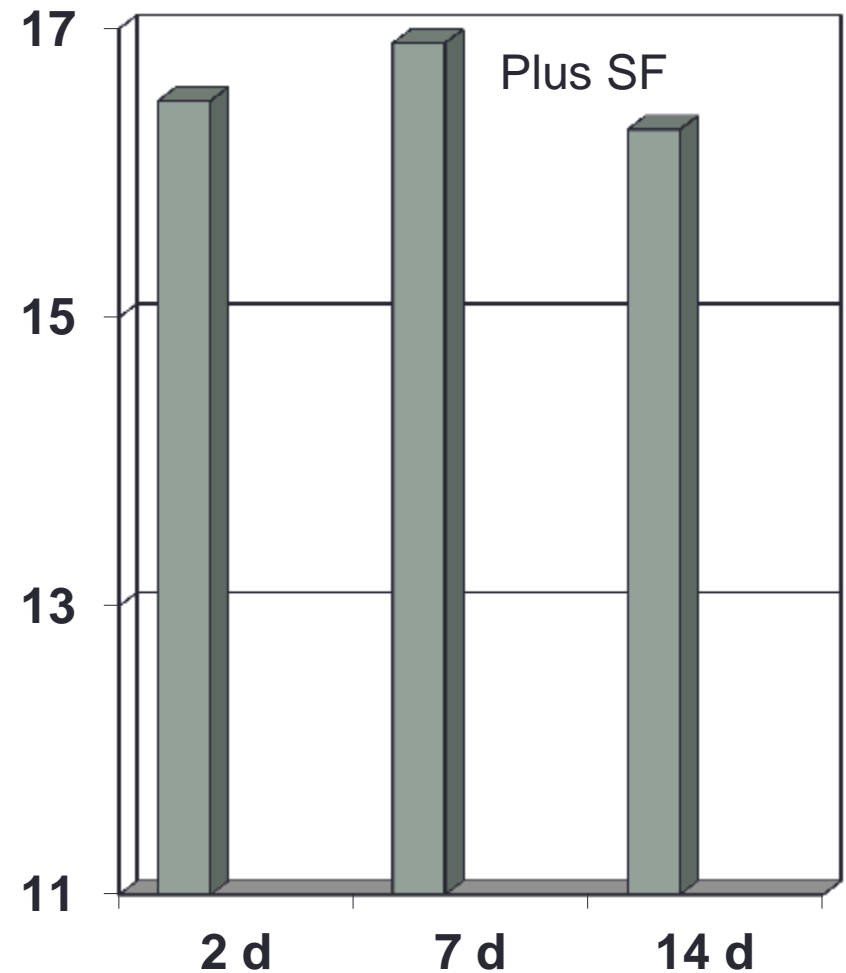
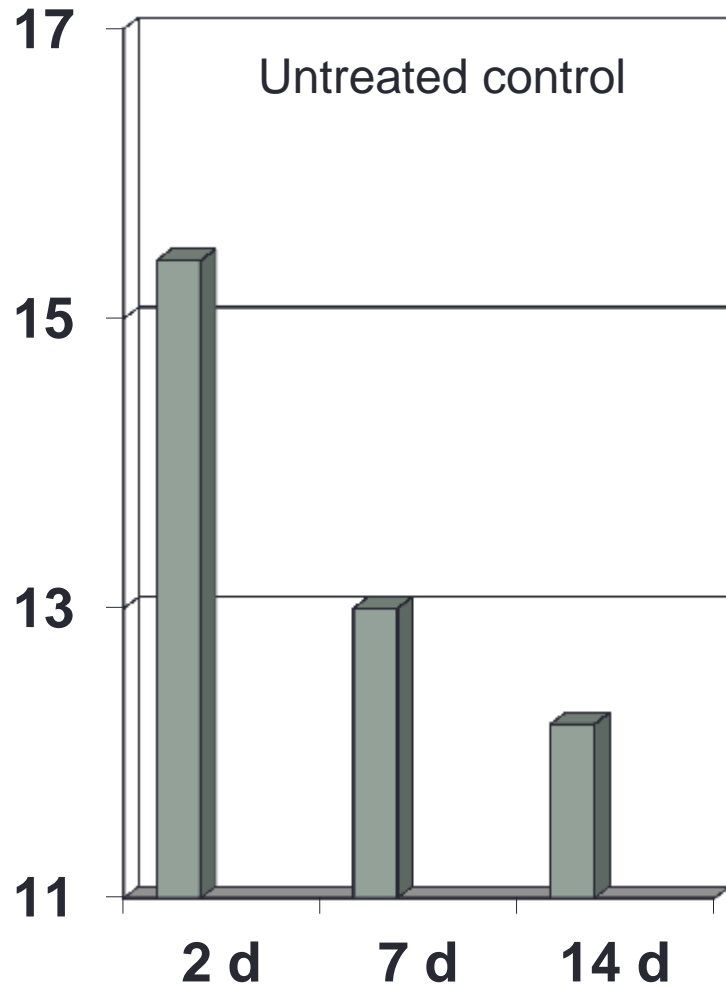
Firmness (lb) after 5 months CA



Example 2: Treatment of fruit with 1-MCP quickly after harvest and delay before CA storage

- Empire fruit harvested, cooled overnight.
- 1-MCP applied after 24 hours of cooling to 35°F.
- CA applied after 2, 7 and 14 days
- Firmness measured after 5 months of storage in CA plus 1 d at 68°C.

Firmness (lb) untreated or after SF trt one day after harvest - delayed CA (9 mo + 1 d)



Rapid 1-MCP treatment after harvest - ProPod™ Transition Rooms



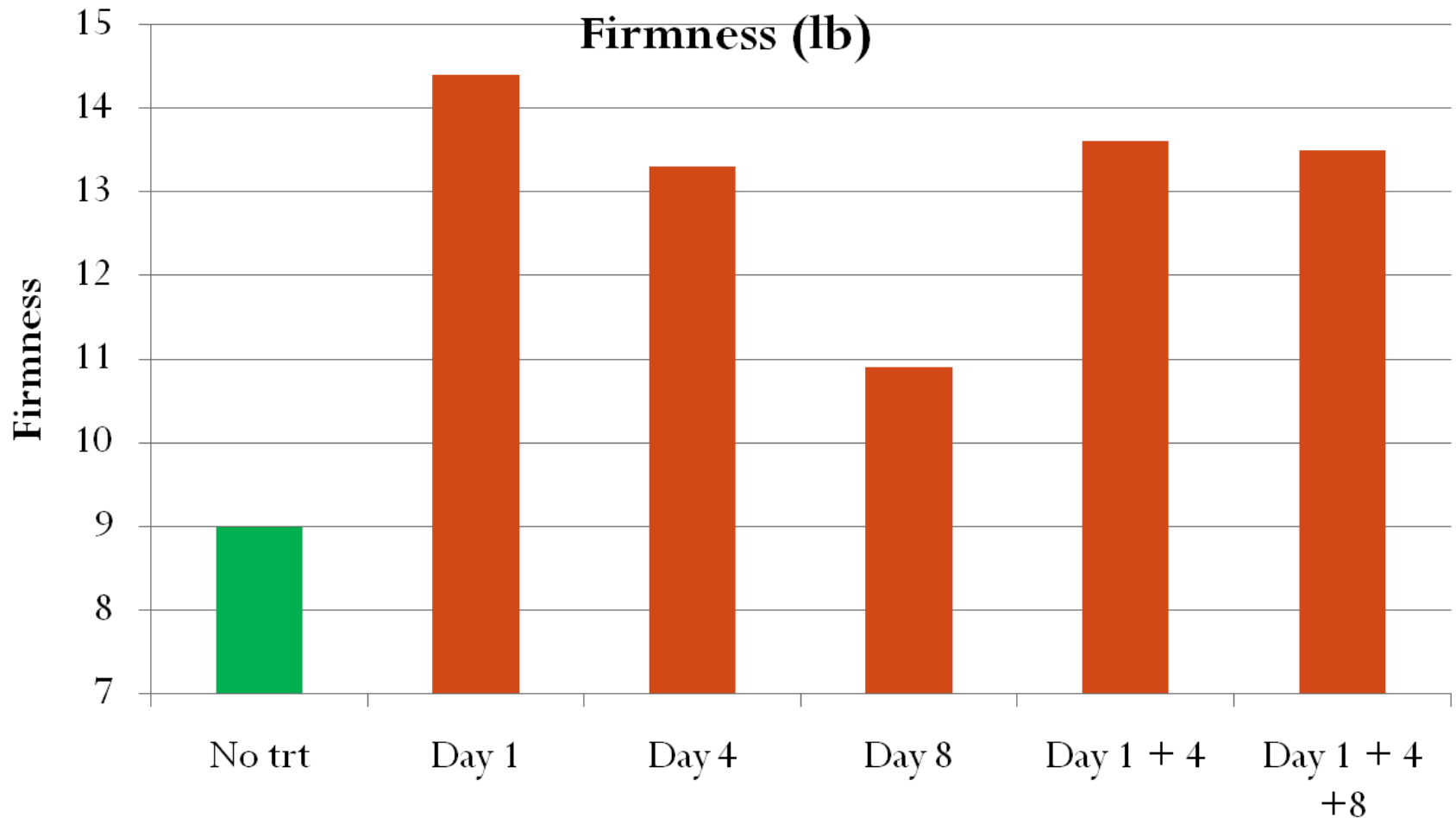
Multiple 1-MCP treatments

NYS SmartFresh label revision dated July 30, 2009

- Here and other countries where revision accepted that more than one 1-MCP application can now be made.
- Allows treatment of fruit while room is loaded, or during storage

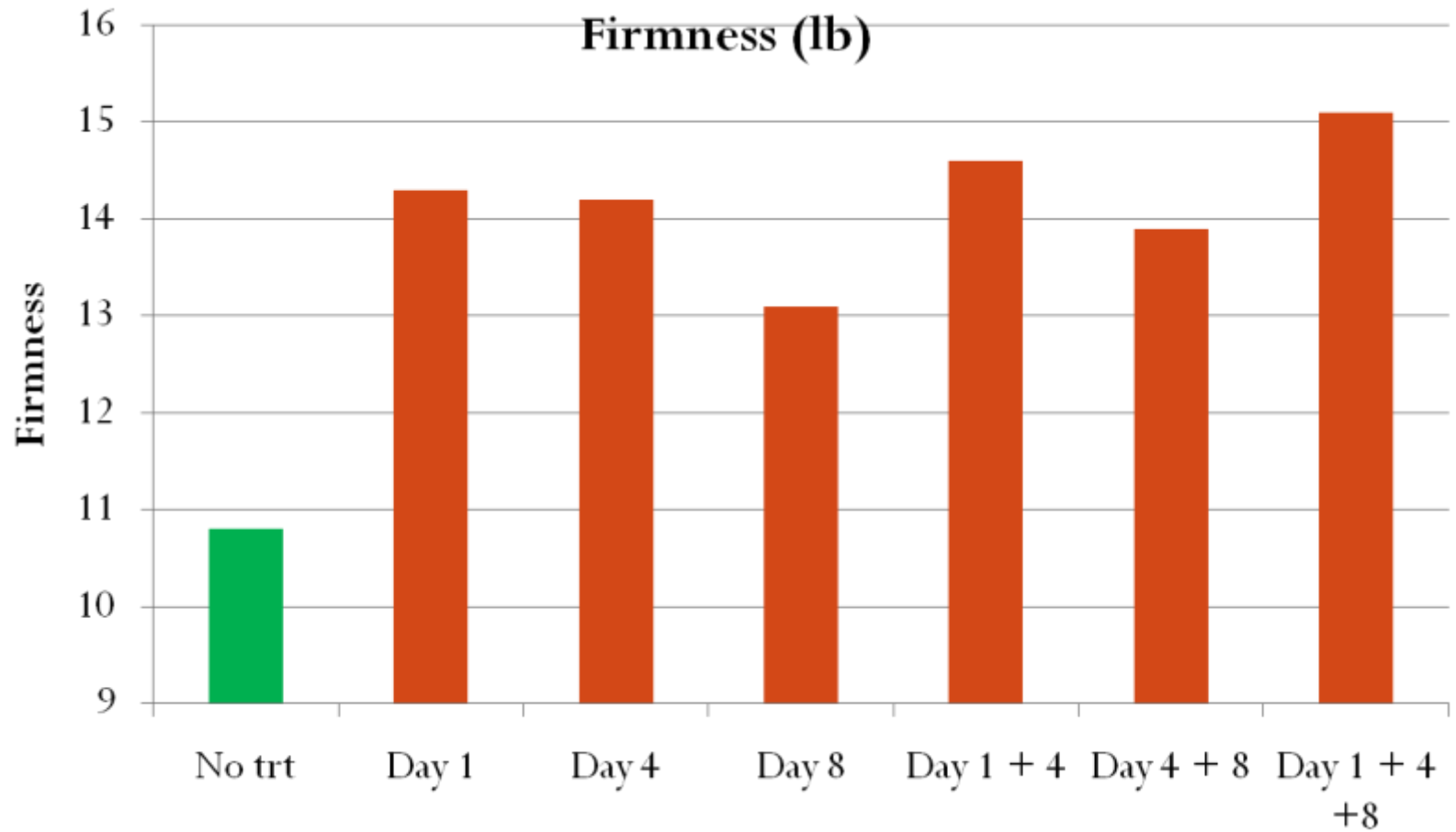
McIntosh – multi SmartFresh treatments

H1. 4 month removal + 7 days shelf life



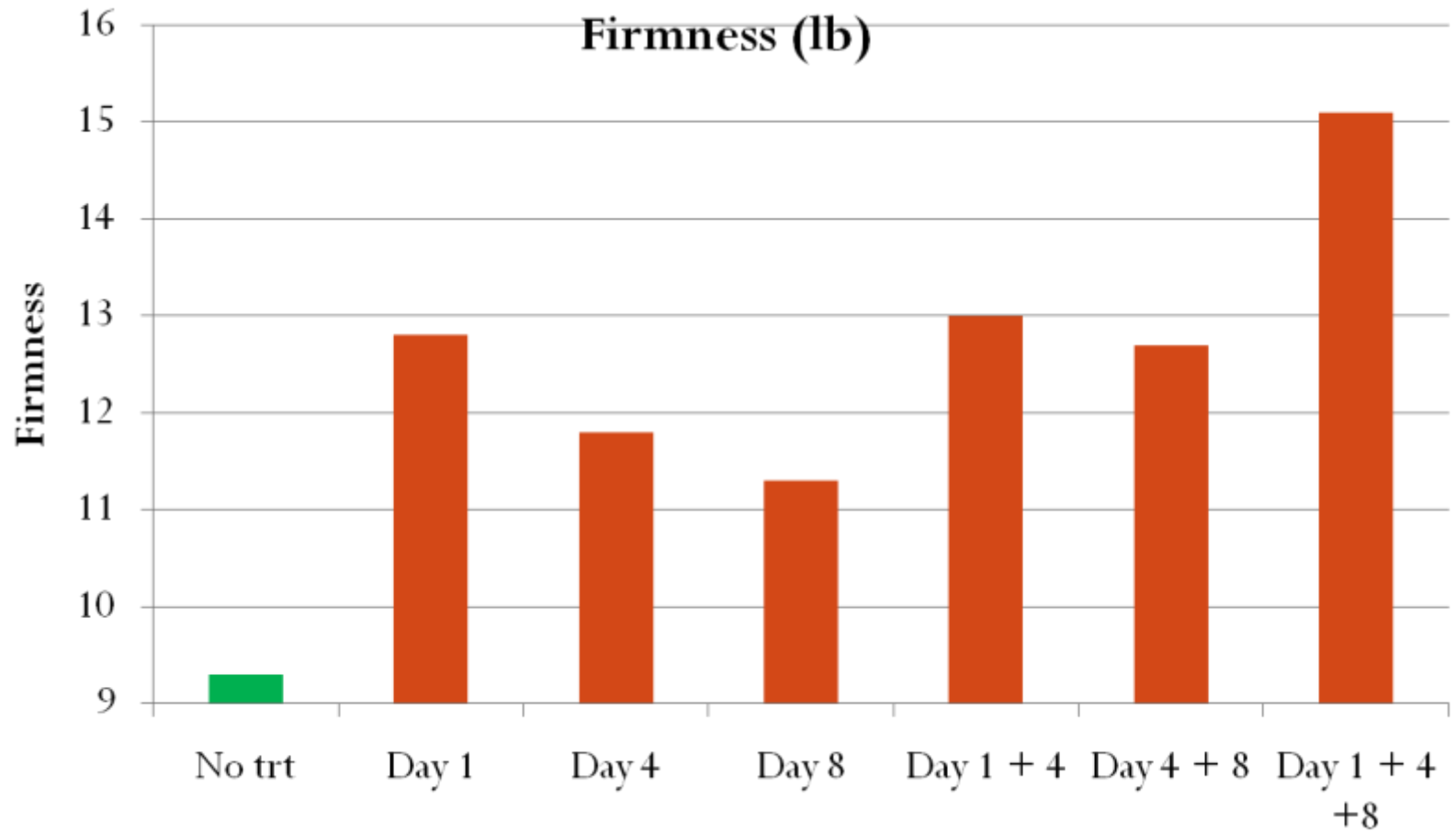
Empire – multi SmartFresh treatments

H1. 4 month removal + 7 days shelf life



Empire – multi SmartFresh treatments

H1.8 month removal + 7 days shelf life



Take home message

- Rapid 1-MCP treatment alone or multiple can maximize effectiveness of SF, but urgency is a function of variety and storage length

Part 2: Storage disorders

Inhibition

- Senescent breakdown
- Superficial scald

Enhancement

- Carbon dioxide injury (external and internal)
- Firm flesh browning
- Diffuse skin browning (G. Del.)

Superficial scald (storage scald)



- Can be controlled by SmartFresh
- SmartFresh inhibits production of the compound that causes scald development
- Effects usually maintained during storage, but some varieties 'escape', e.g. Cortland

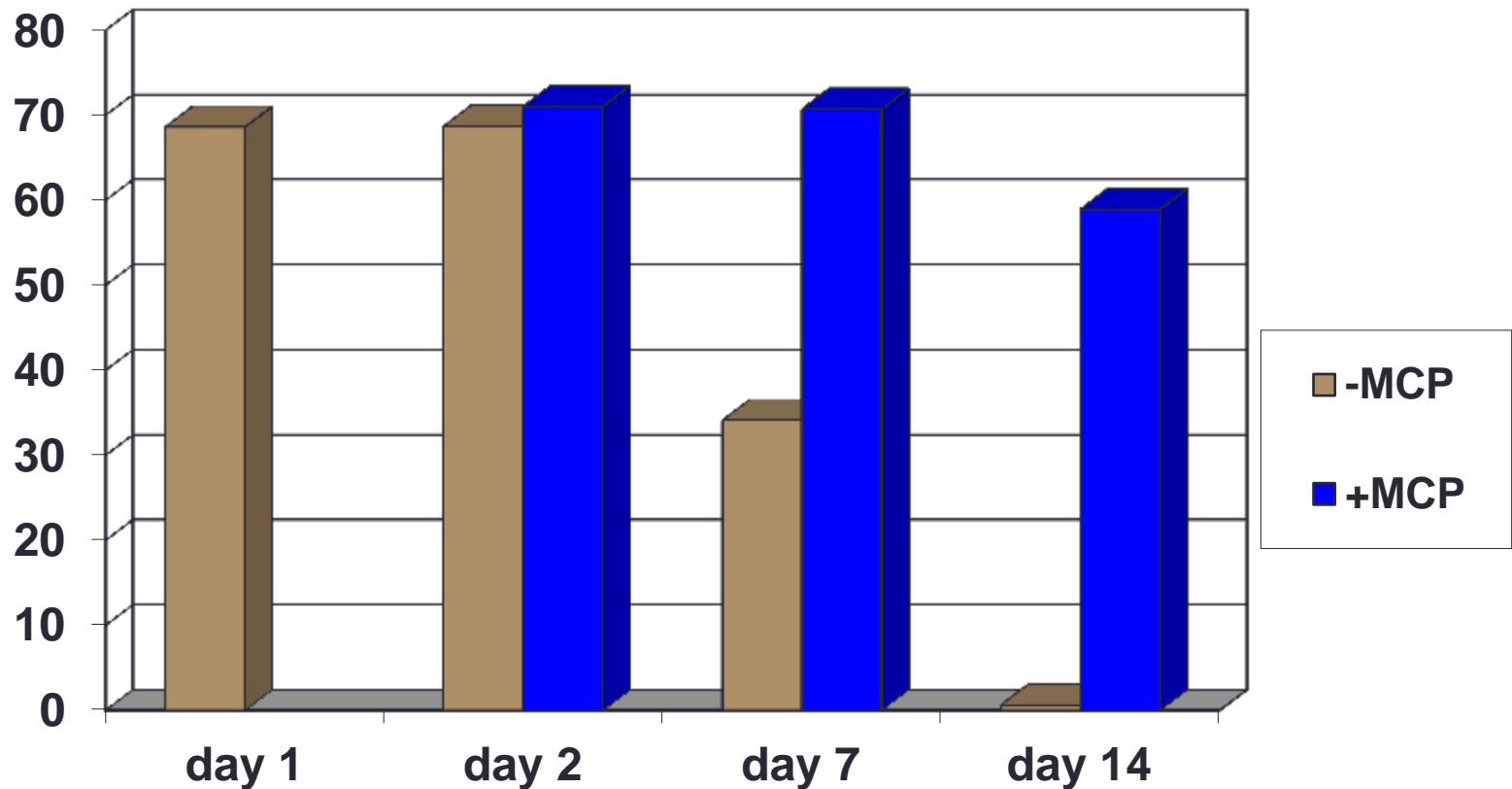
Carbon dioxide-related injury of apples

Higher incidence associated with

- Higher CO₂
- Early harvested fruit for external form
- Late harvested fruit for internal form
- Much greater risk with slower fruit cooling

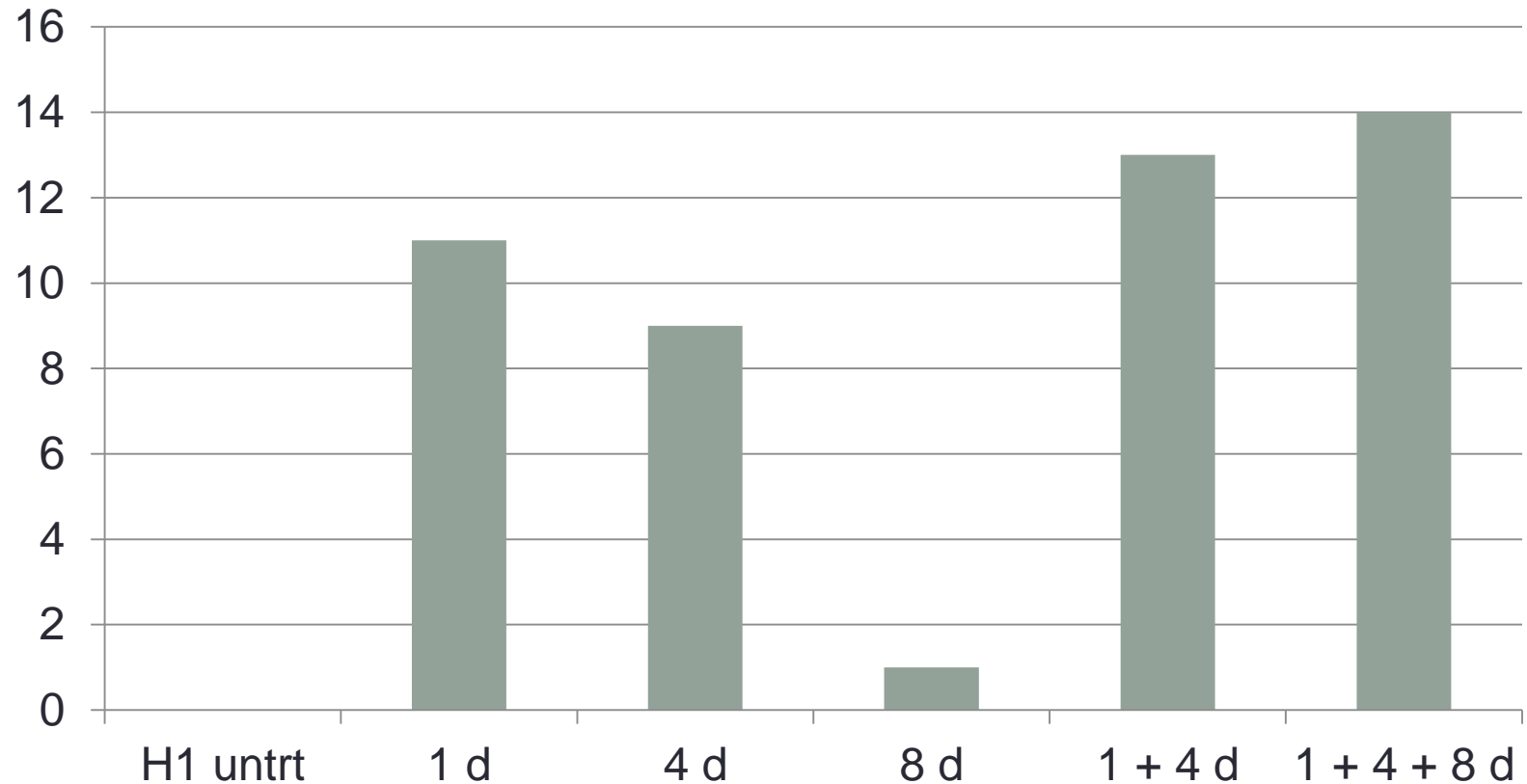


CO₂ injury (%) in apples exposed to high CO₂ one day after harvest, or untreated or treated with 1-MCP, and exposed to CO₂ 2, 7 and 14 days after harvest

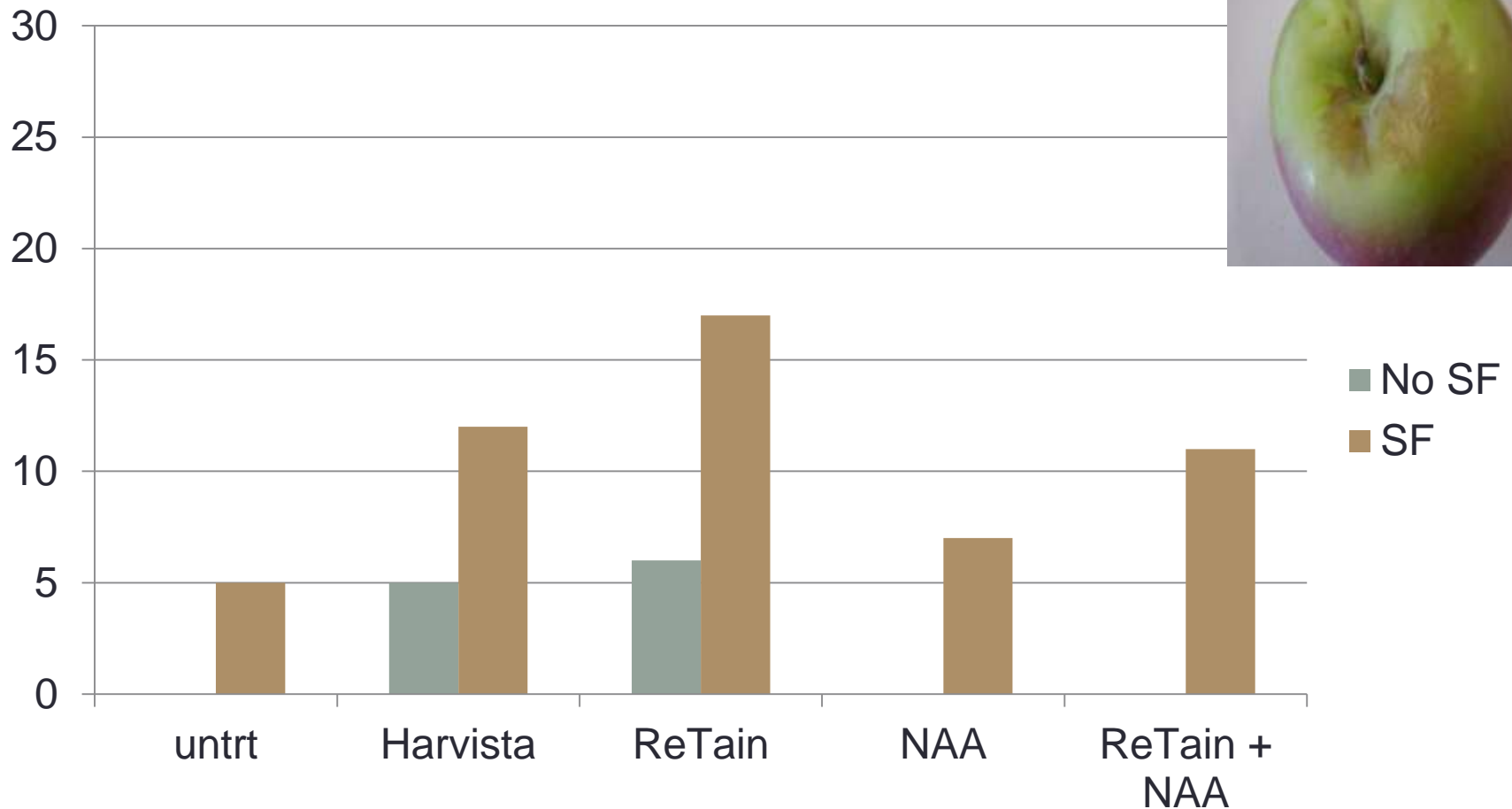


McIntosh – multi 1-MCP treatment 8 months CA

Carbon dioxide injury (%)



McIntosh: 8 months CA storage + 7 d – ext CO2 injury (%)



Strategies to avoid carbon dioxide injuries

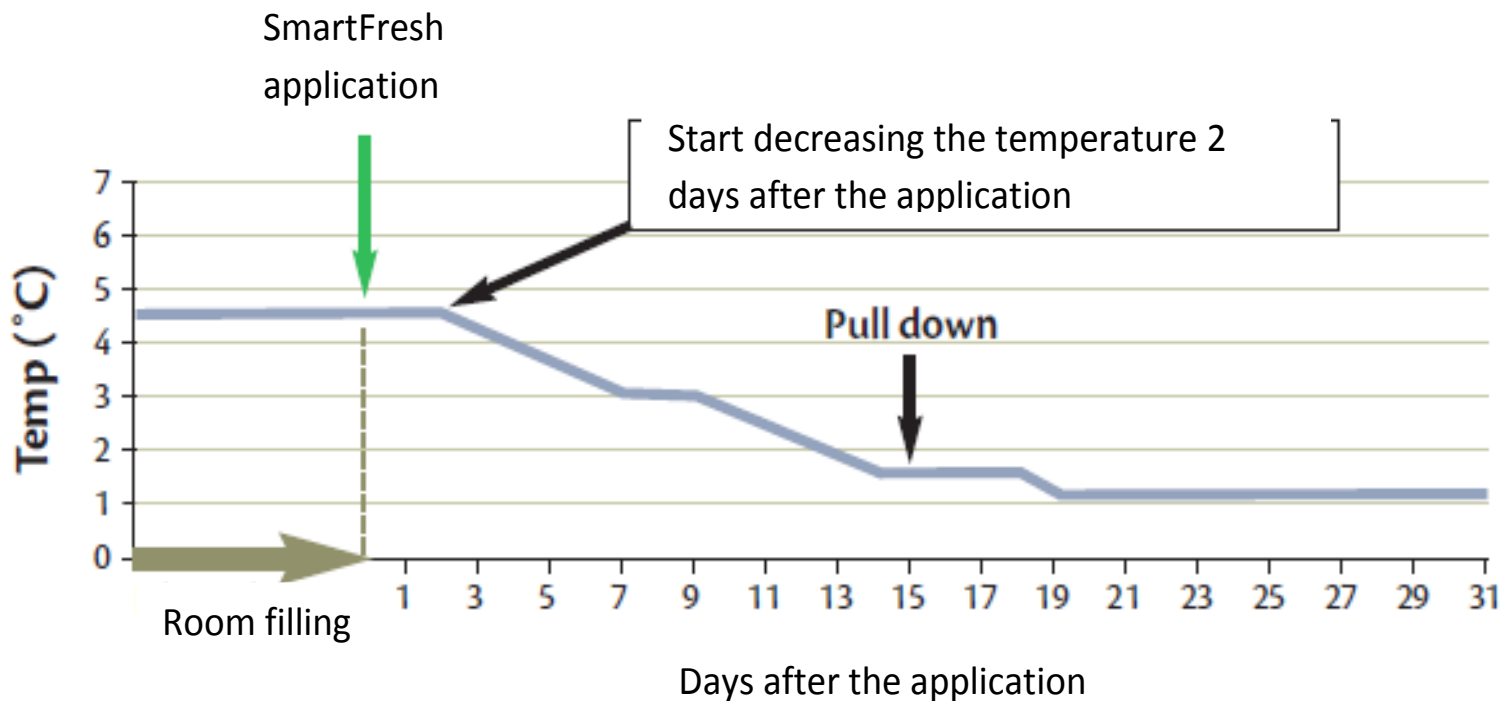
- Apply diphenylamine (DPA)
- Cool fruit properly, taking into account the cooling capacity of your refrigeration
- Delay SmartFresh treatment (some varieties)
- Maintain low CO₂ during loading of fruit by adding lime through the room
 - Turn on CA monitors while loading – health issue as well
- Maintain low CO₂ for the first 4-6 weeks

Diffuse skin browning



- Associated with rapid cooling of fruit
- Delayed cooling to low setpoint reduces risk

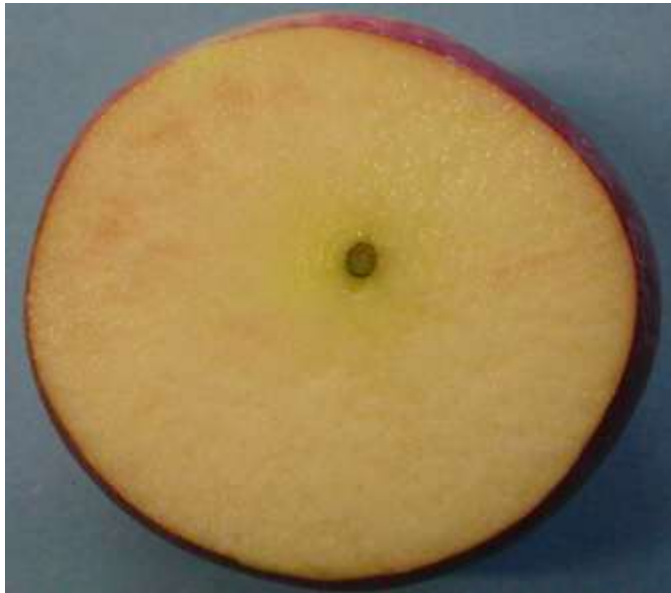
Golden Delicious



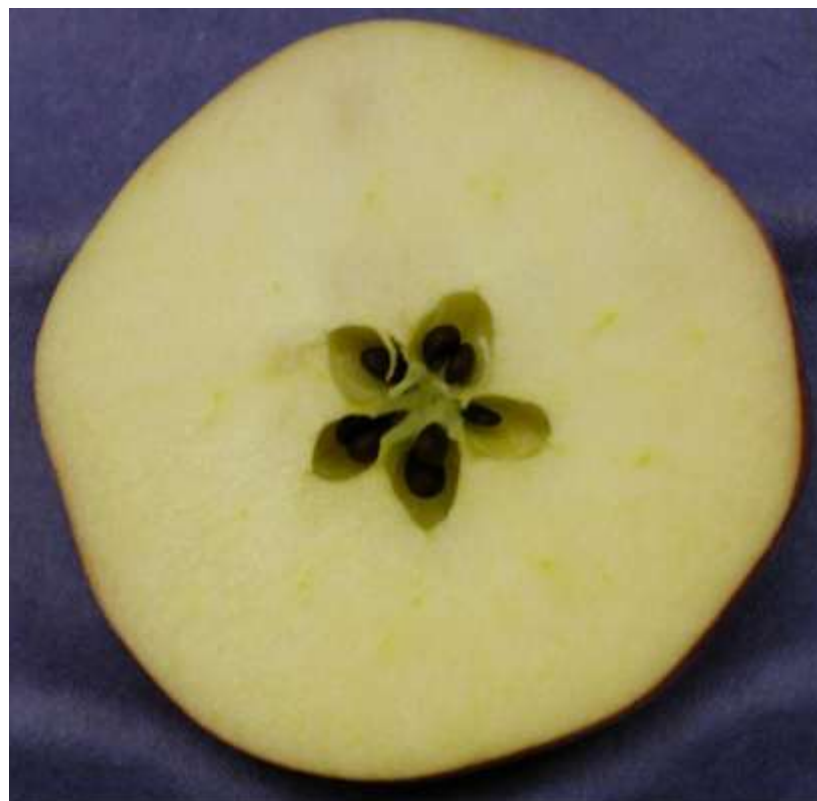
- Start oxygen pull down only when fruit temperature is below 2°C. Maintain CO₂ level below O₂ level, and anyway never above 2%

Flesh browning

Empire, but same as Gala
and other cultivars?



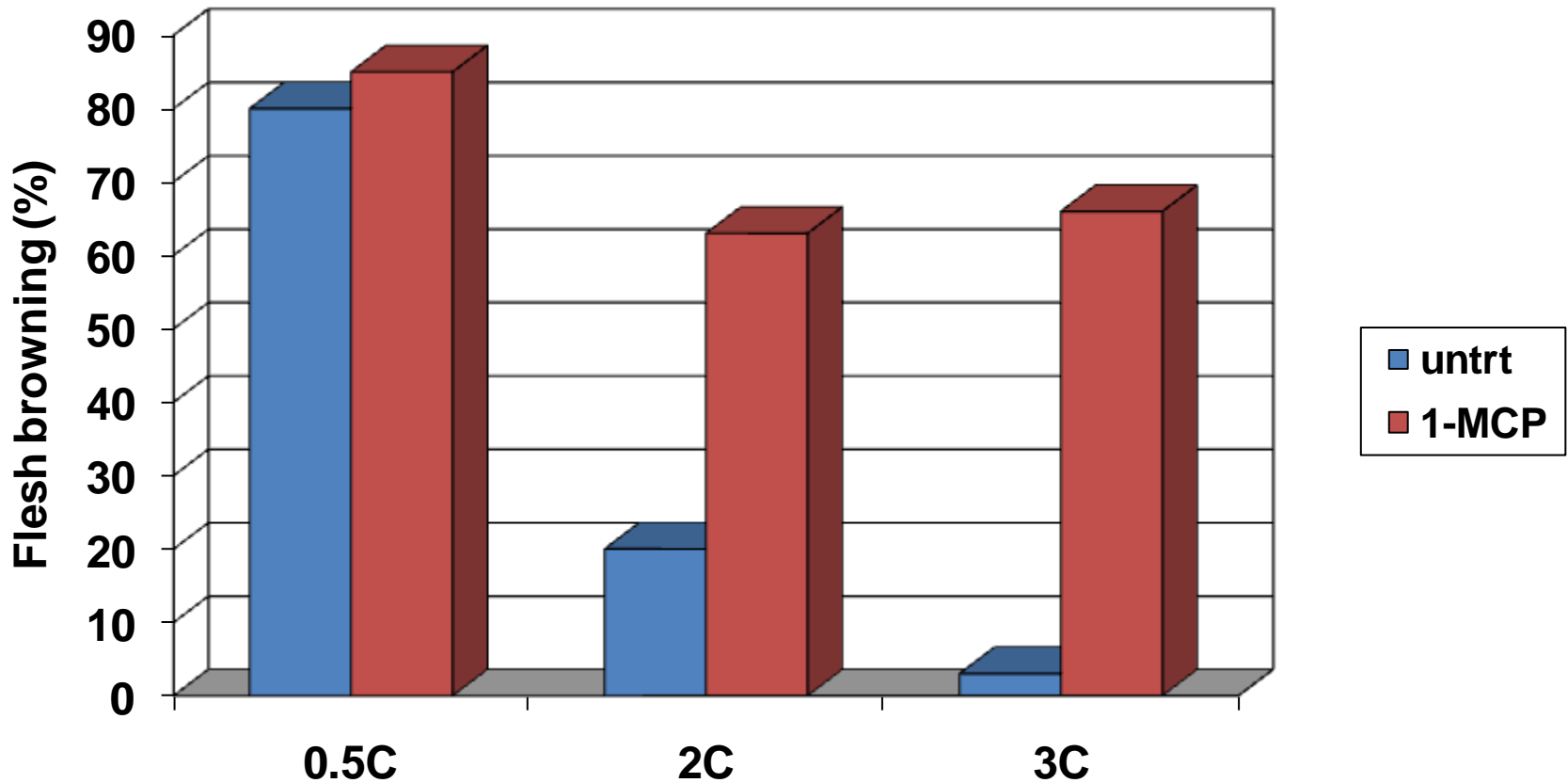
'Gala' stem-end browning



'Gala' internal browning



Flesh browning (%) at different temperatures during CA storage for 10 months



Flesh browning

- No solution yet for 'Empire' flesh browning
- 'Gala' promising effects of HC-like conditioning – SF treatment followed by conditioning period of 7 days at 50°F
- Ongoing work of urgency

In conclusion

- Ethylene is a key factor in SF success
 - Variety
 - Harvest maturity, also as affected by plant growth regulators
 - Postharvest handling
- Storage disorders must be considered – both positive and negative effects – in storage and marketing decisions

