Identifying and minimizing internal and external apple disorders

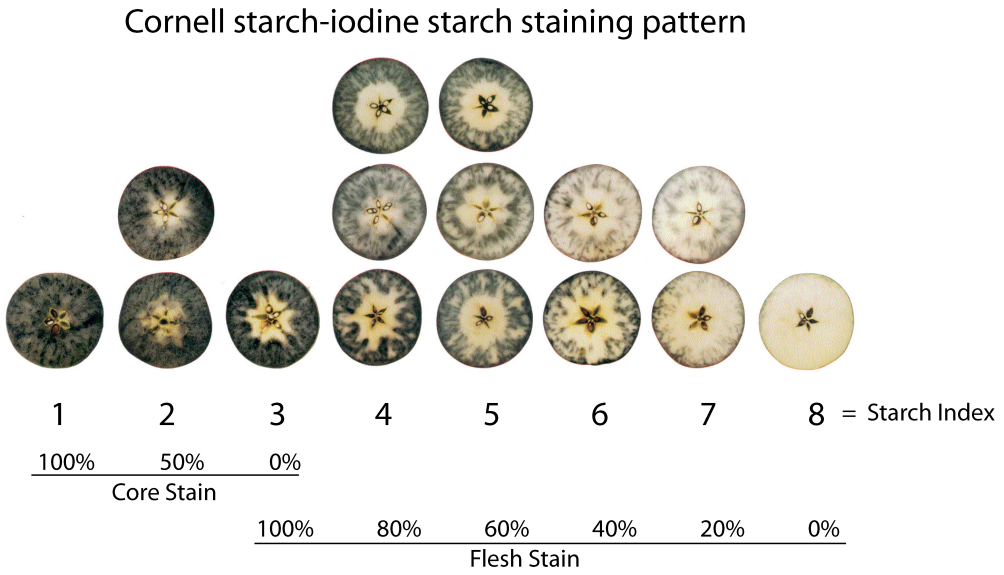
R.M. Beaudry, MSU

Fruit are stored, but are not storage organs

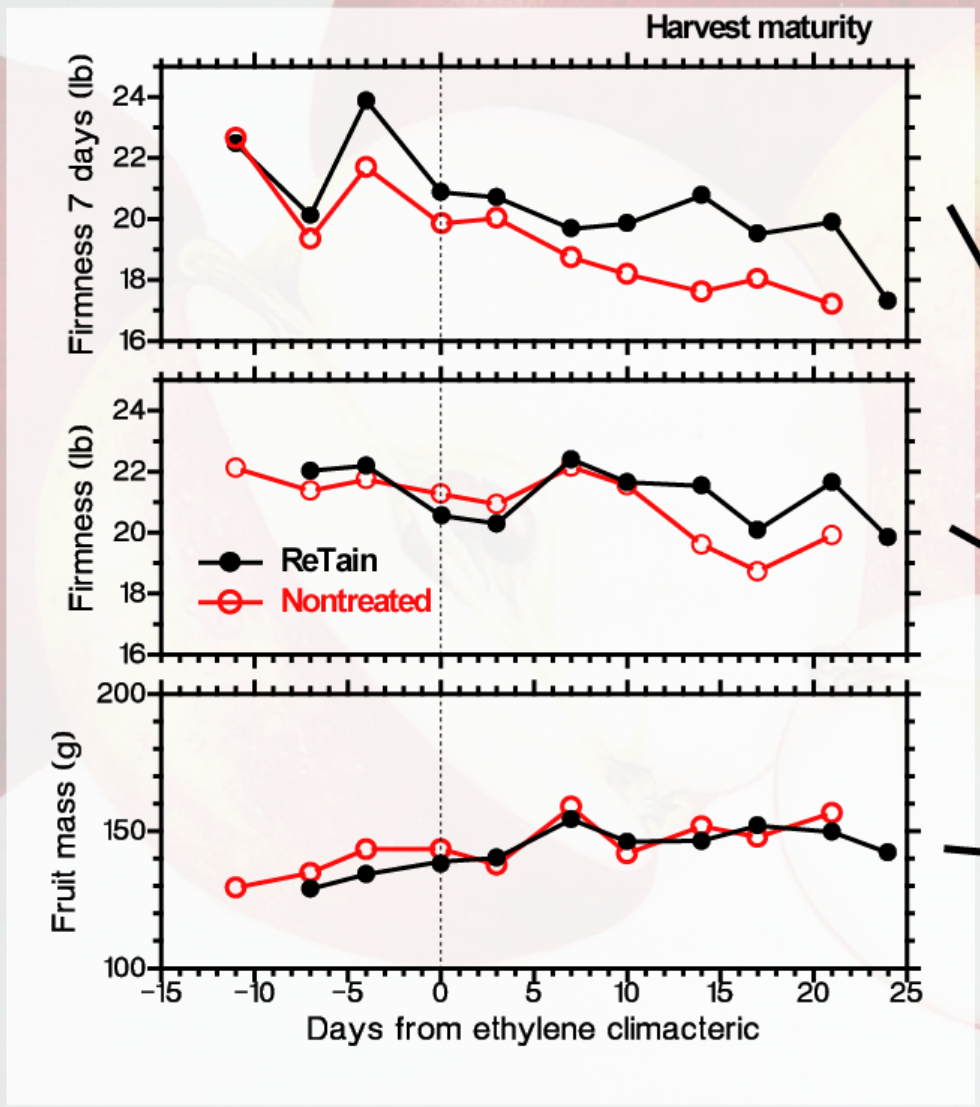
- Biologically, fruit are ‘designed’ to be consumed, not stored.
- Storage environments are stressful
- Apples are variable
- Marketing is unpredictable
- Humans are fallible

Disorder control begins at harvest

- Softening
- Watercore
- Superficial scald
- Soft scald
- Soggy breakdown
- Senescent browning



Softening



Gala

Averaged over 3 years (one location) from '96 - '98

After seven days at room temperature, treated fruit tended to be firmer.

At all but the latest harvests, treated and nontreated fruit had similar firmness

ReTain had no effect on fruit size

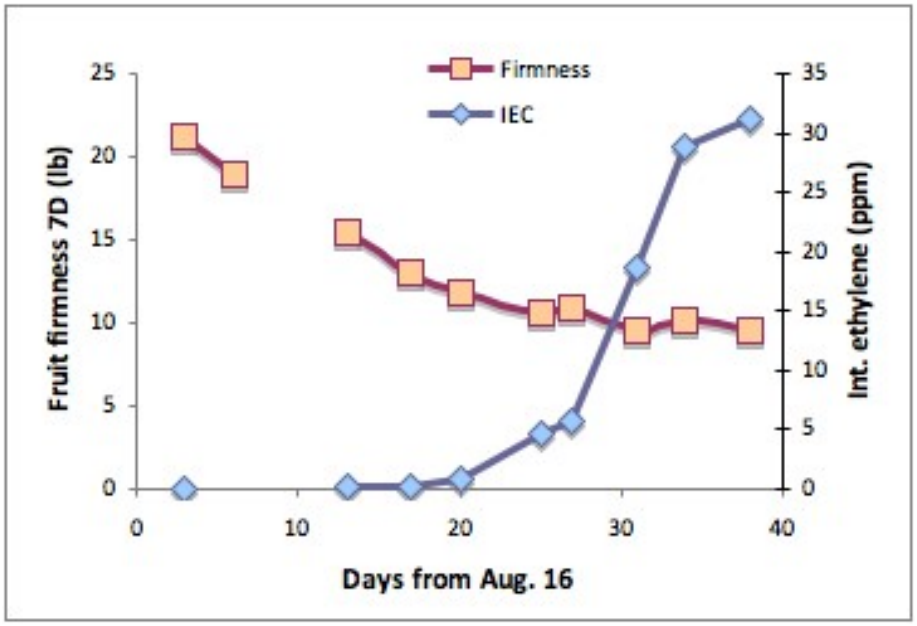
"Quality Of 'Gala' Apples As Influenced By Harvest Maturity, Storage Atmosphere And Concomitant Storage With 'Bartlett' Pears"

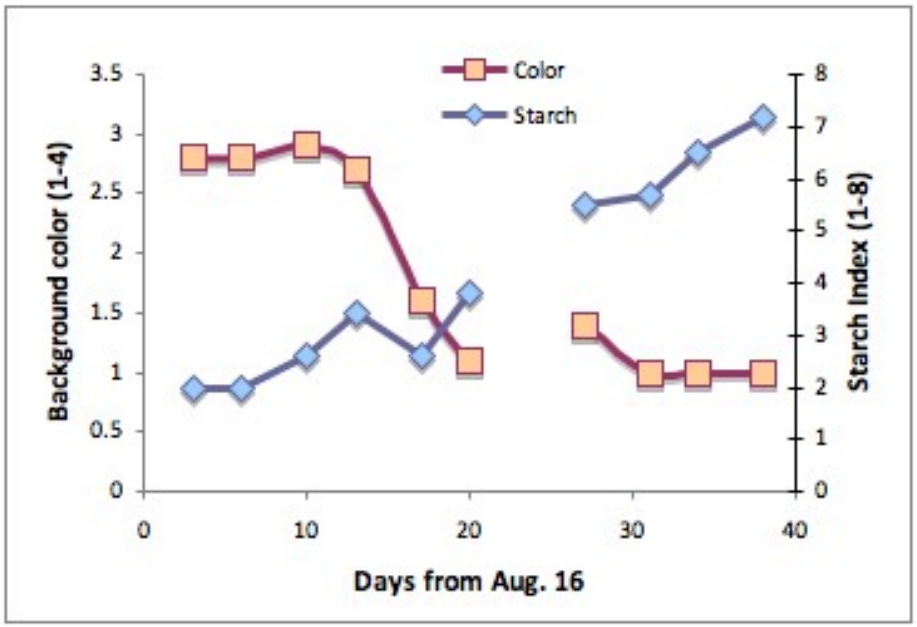
-Drake and Eisel (1996)

Apple fruit are responsive to CA storage – even when subsequently stored in air

TABLE 5.
FIRMNESS, ACID, AND COLOR CONTENT OF GALA APPLES AND BARTLETT PEARS AFTER 45 DAYS OF CA PLUS 30 DAYS OF RA STORAGE

Gala Atmosphere	Firmness (N)	Titrat. Acidity (% Malic)	Color External Hue	Color Internal Hue
Gala				
RA	12 lb b[z/]	0.34	40.5 a	92.0 b
CA/RA[y/]	14 lb a	0.36	39.8 b	94.5 a

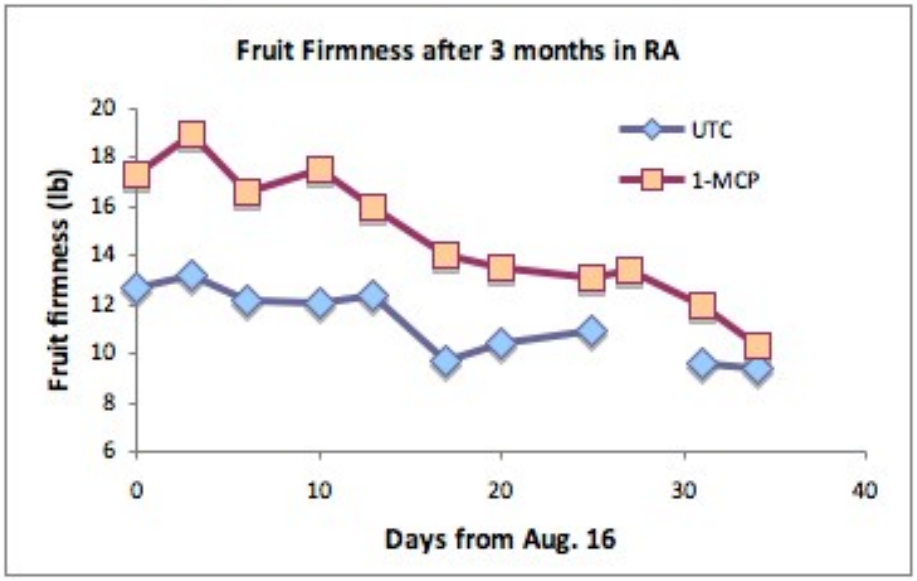


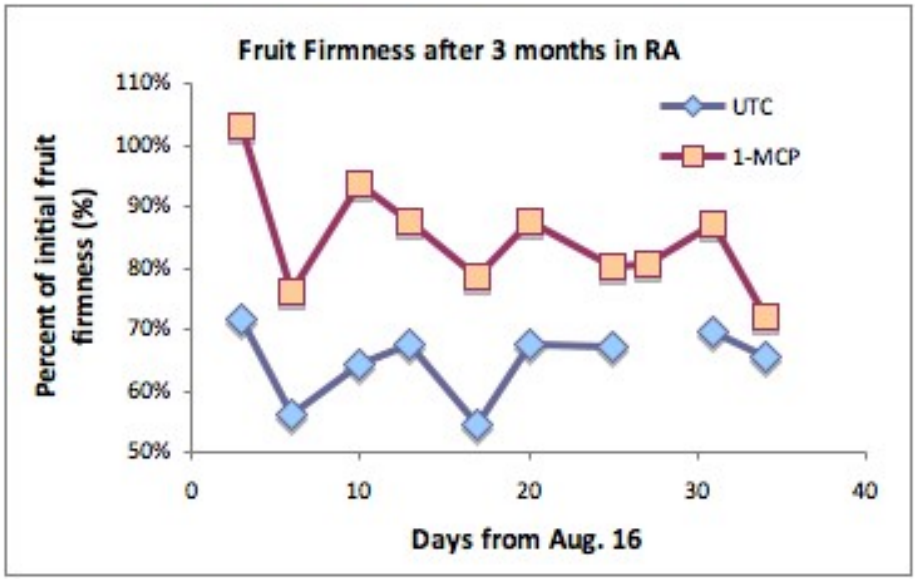


1-MCP application

Gingergold - Timing of application study

SmartFresh applied at 1 ppm across range of fruit maturities





Timing of application study

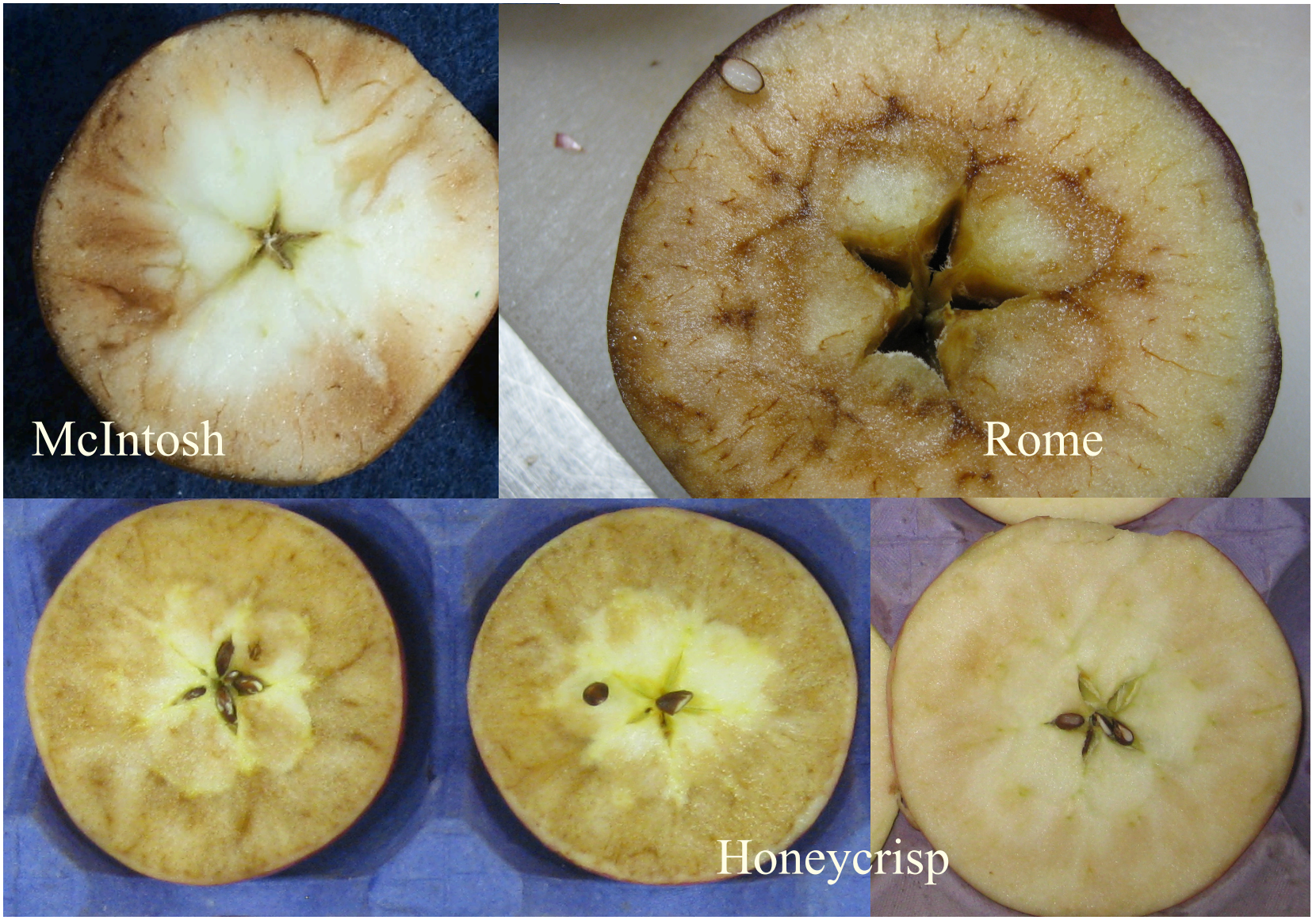
For some varieties, responsiveness to SmartFresh continues throughout maturation

Mealy breakdown

Mealy breakdown

- Somewhat variety-dependent
- Increases with increased maturity at harvest
- Enhanced by higher storage temperature
- Suppressed by DPA?
- Controlled by low oxygen
- Controlled by 1-MCP

Senescent breakdown



Senescent breakdown

- Somewhat variety-dependent
- Increases with increased maturity
- Enhanced by higher storage temperature
- Suppressed by DPA?
- Controlled by low oxygen
- Controlled by 1-MCP

Watercore

High light/warmth, cool nights
Variety-dependent
Increases with maturation

Watercore

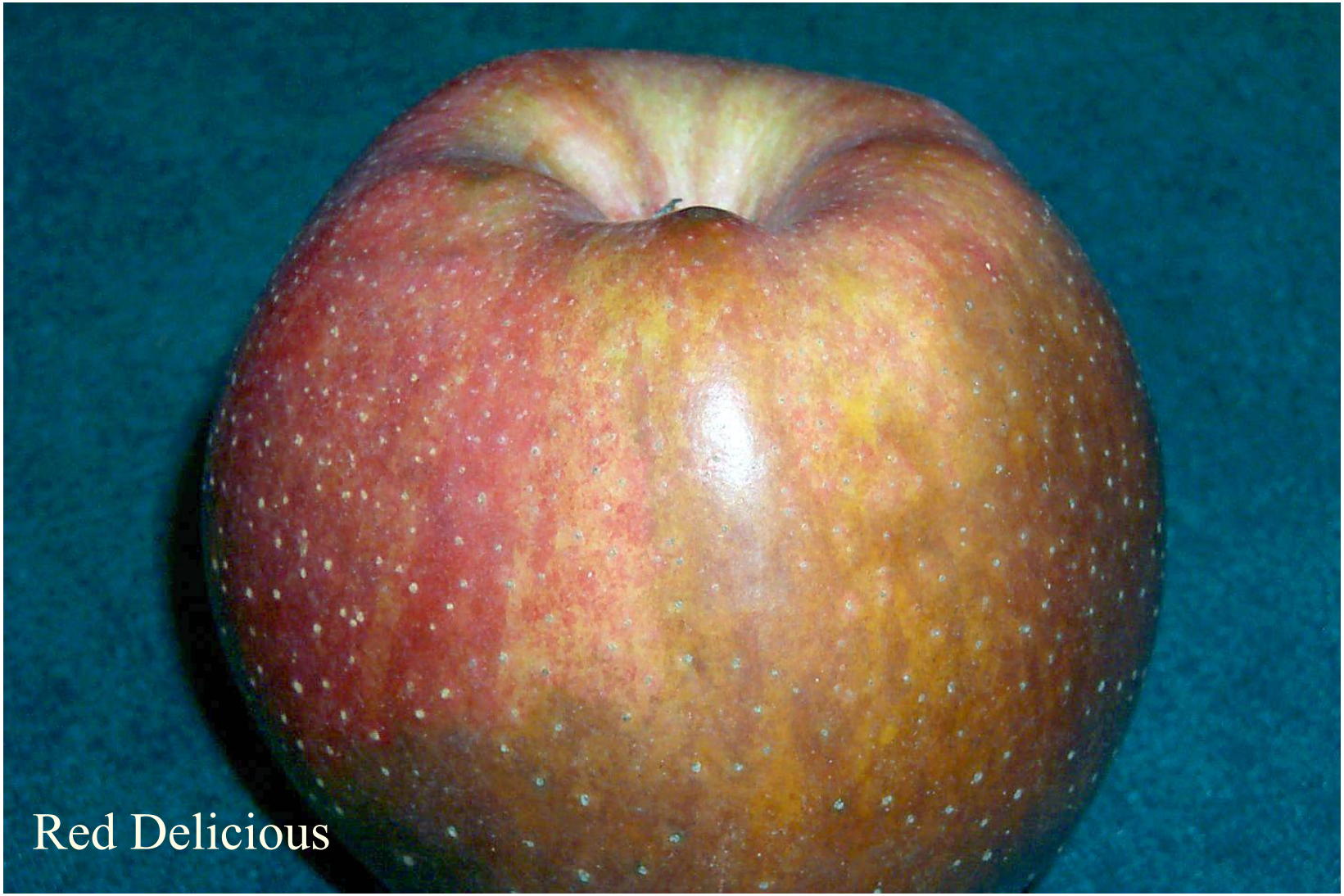
High light/warmth, cool nights
Variety-dependent
Increases with maturation
Can lead to internal browning

Anthocyanin bleeding

Variety-dependent
Increases with maturation

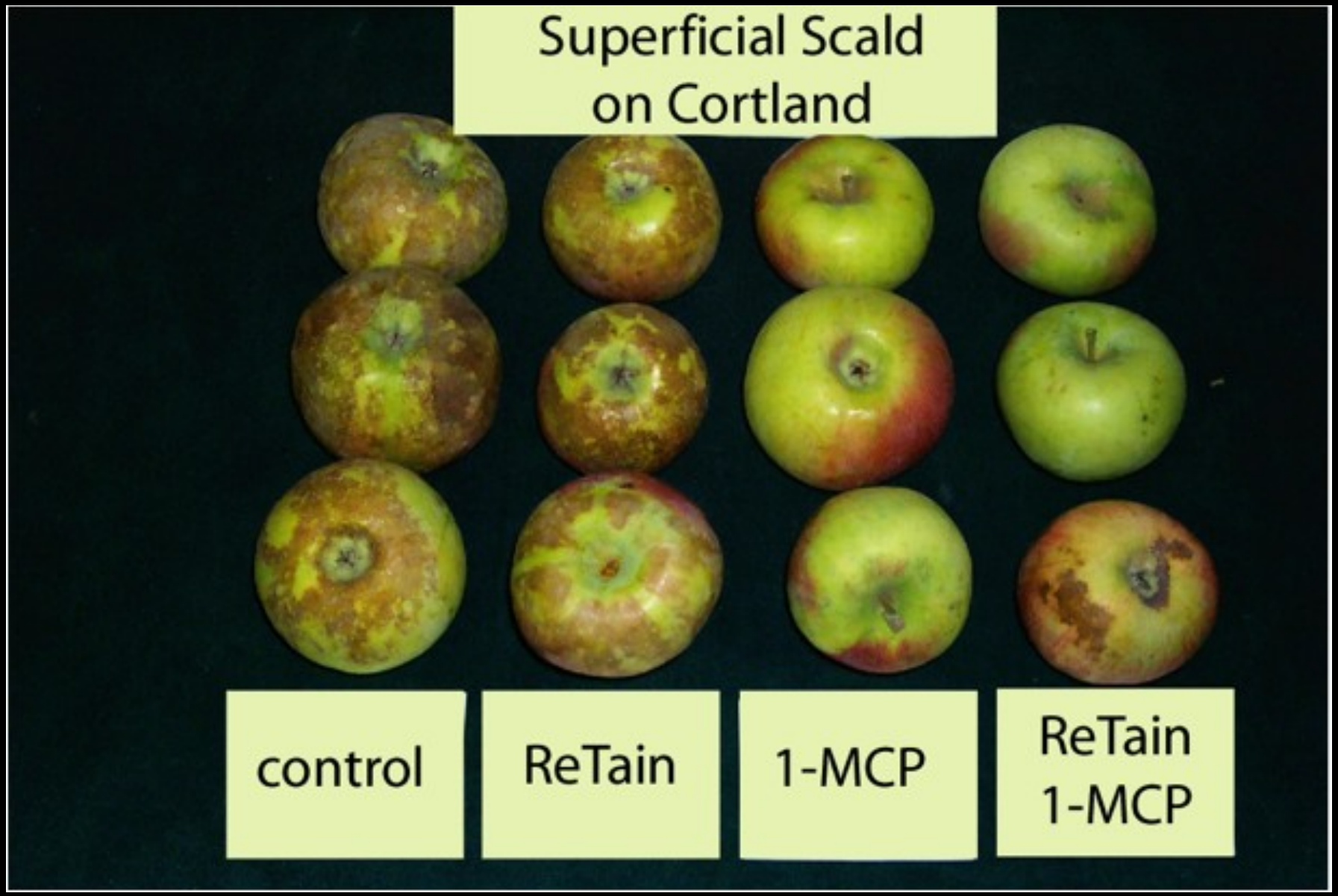
Superficial scald

Superficial Scald

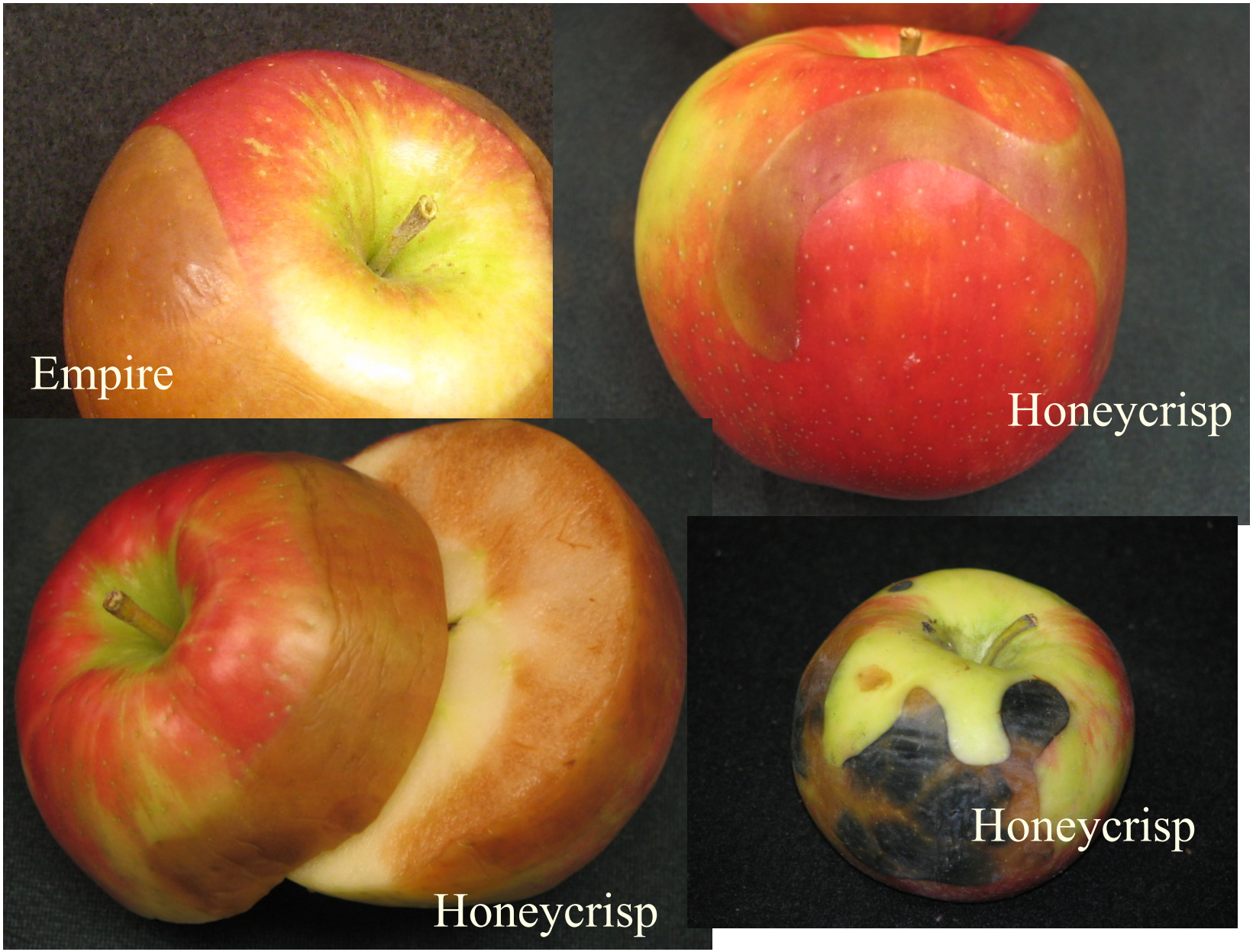


Superficial Scald

- Highly variety-dependent
- Decreases with maturation
- Controlled by low oxygen and initial low oxygen stress
- Controlled by DPA
- Controlled for some varieties by 1-MCP
- Fruit insensitive to control treatments 2-4 weeks after storage


Superficial Scald
on Cortland
control
ReTain
1-MCP
ReTain
1-MCP

Soft scald (ribbon scald, deep scald)



Softscald

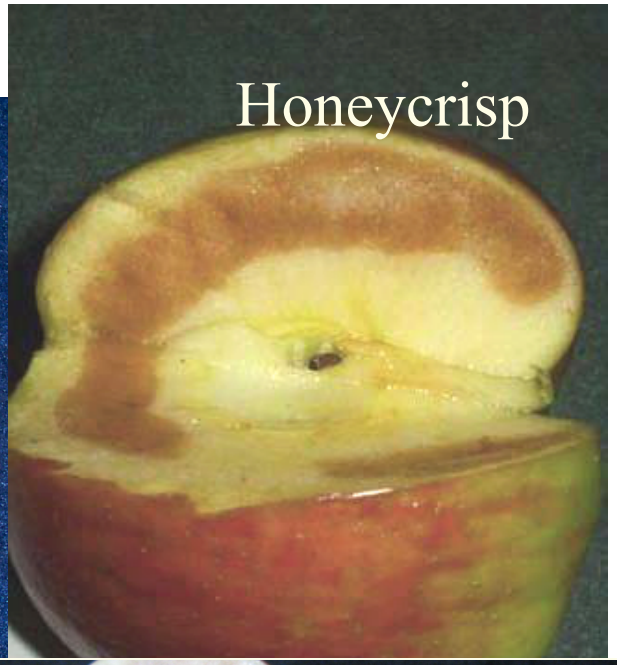
Storage chilling/frost injury

Freezing injury

Soft Scald

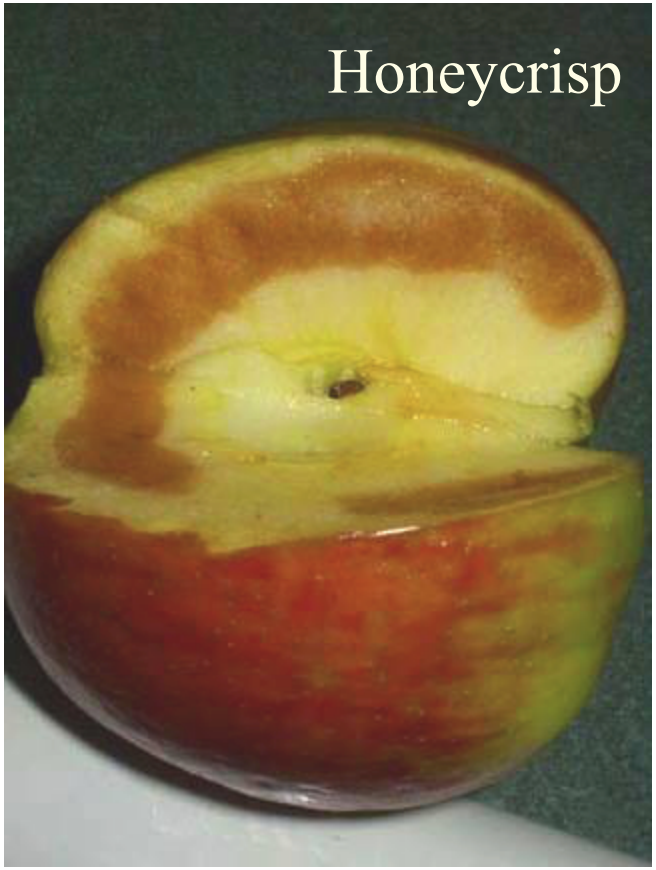
- Highly variety-dependent
- Increases with maturation
- Reduced slightly by DPA
- Reduced in some cases by 1-MCP
- Suppressed by elevated storage temperatures
- Suppressed by preconditioning (5-7 days at 50 to 70F)
- Not controlled by CA
- May or may not occur with soggy breakdown

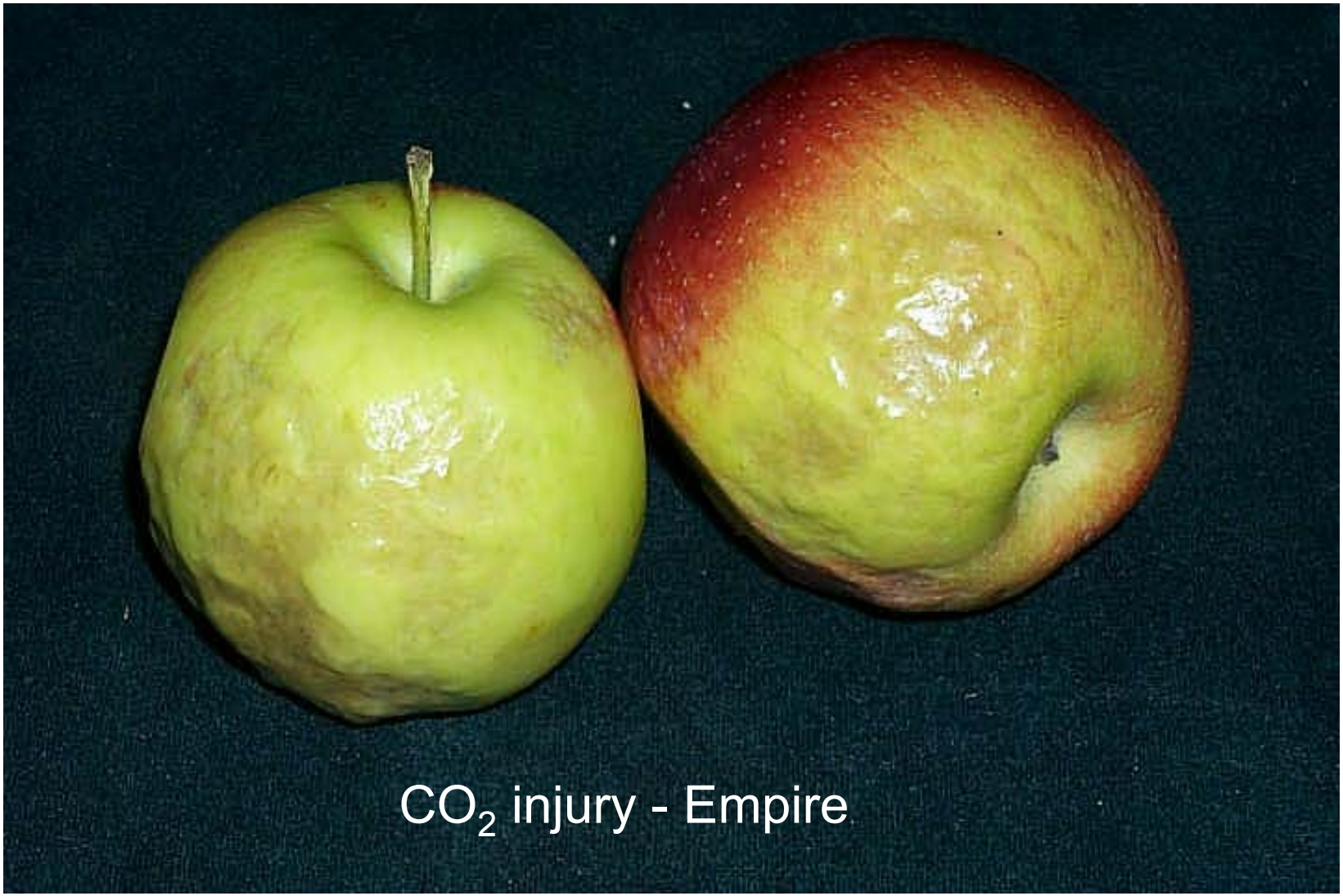
Soggy Breakdown



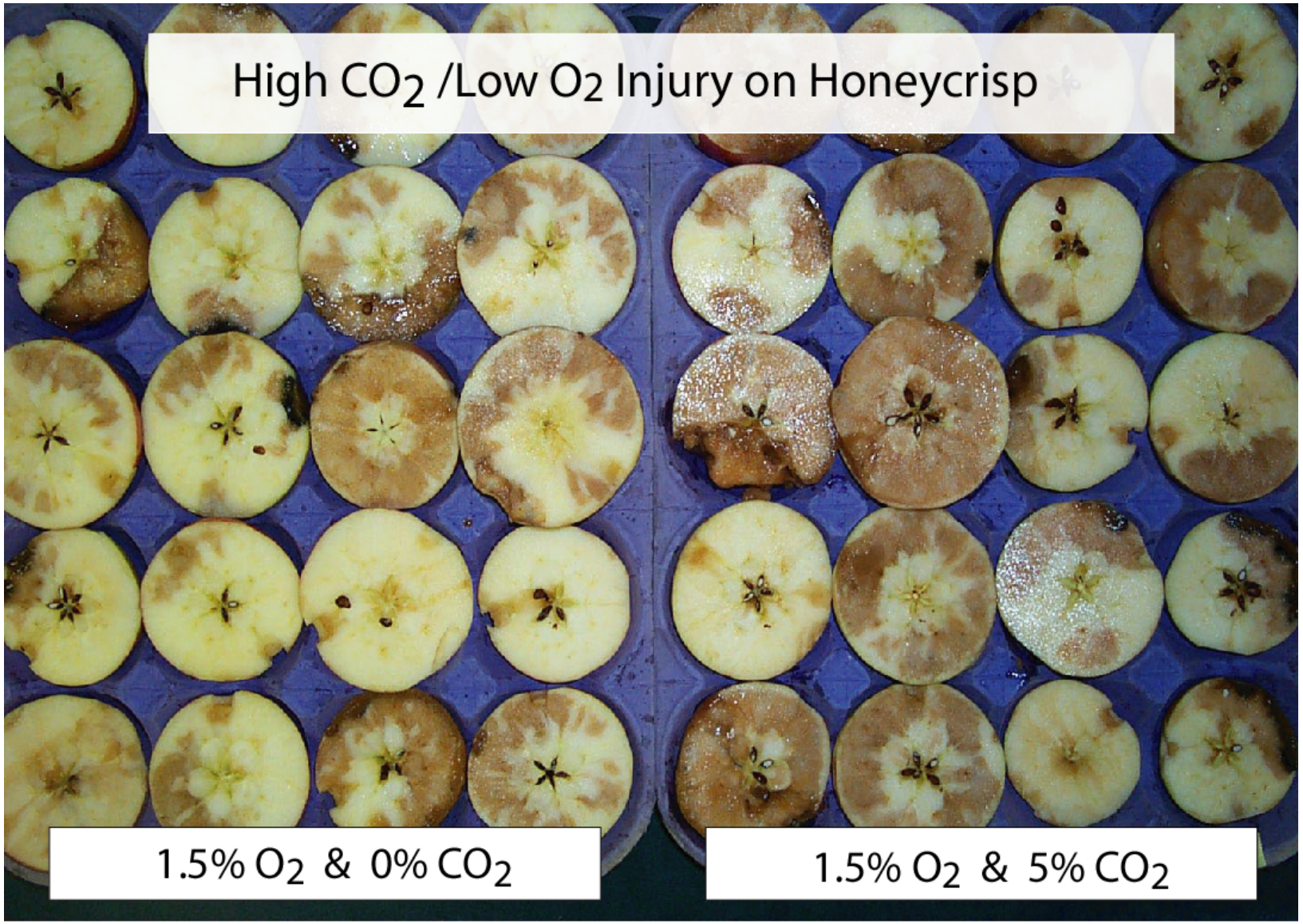
Soggy Breakdown

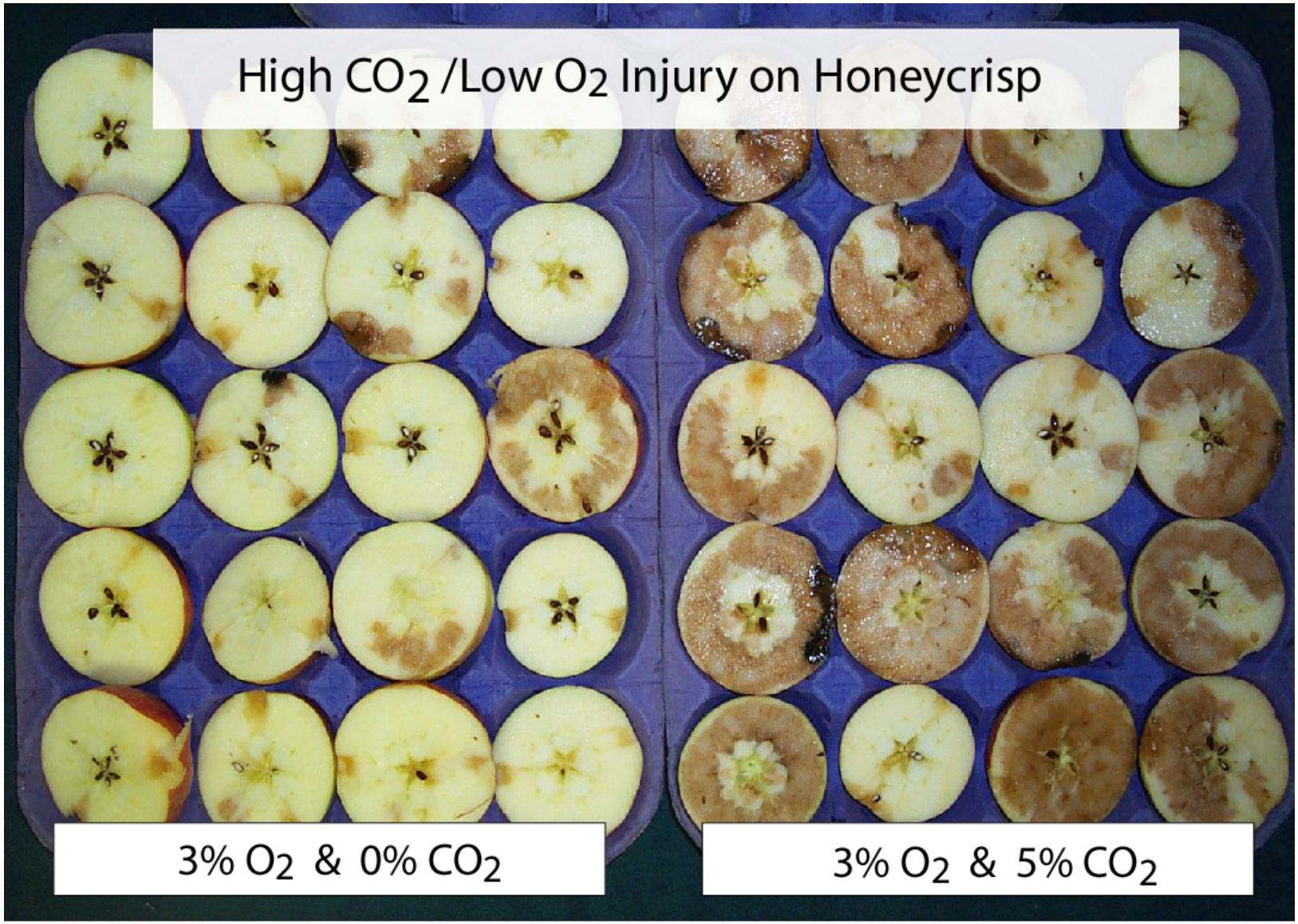
- Highly variety-dependent
- Increases with maturation
- Reduced slightly by DPA
- Not affected by 1-MCP
- Suppressed by elevated storage temperatures
- Suppressed by preconditioning (5-7 days at 50 to 70F)
- Not controlled by CA
- May or may not occur with soft scald




CO_2 injury - Empire

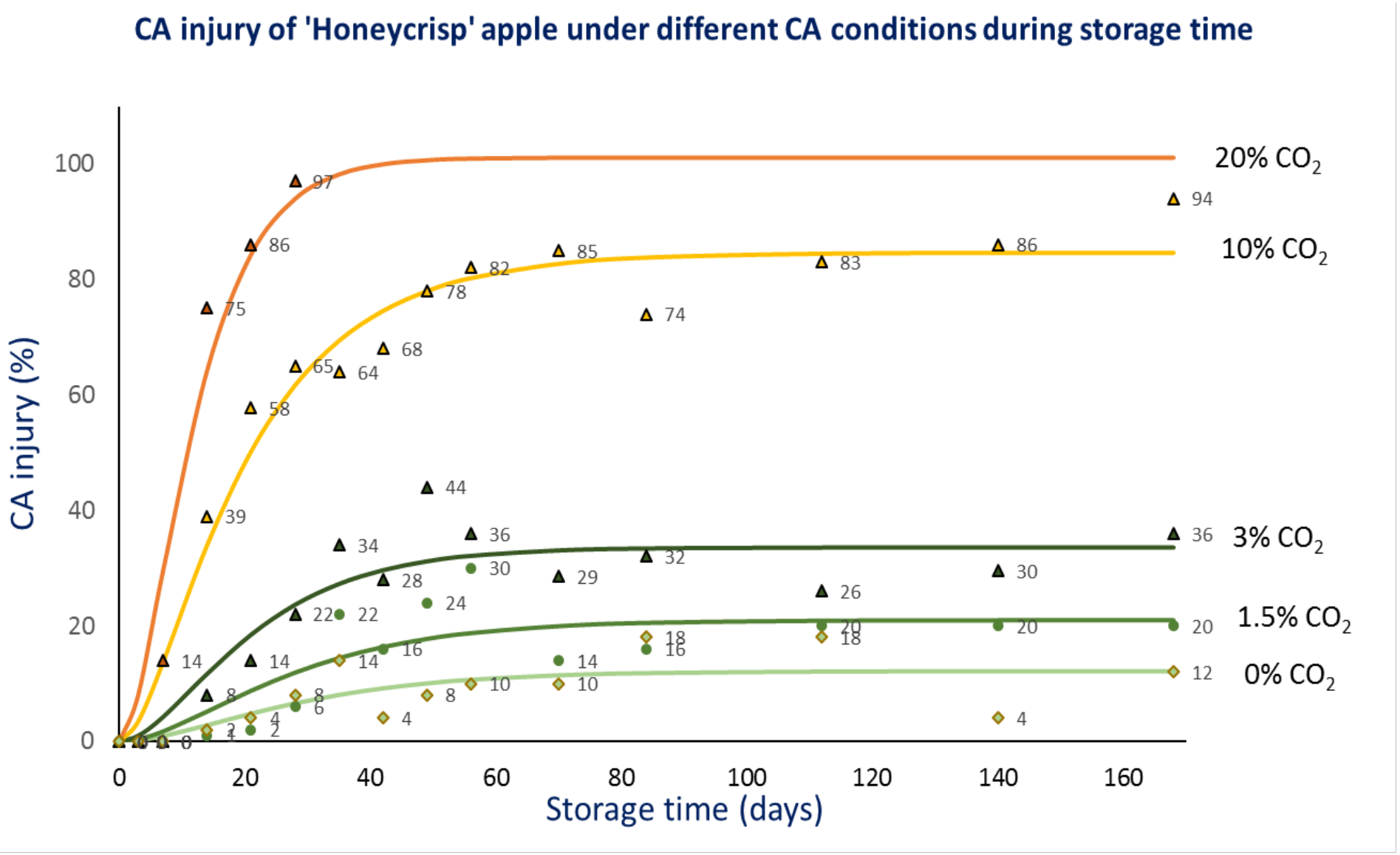
CO_2 injury


High CO_2 /Low O_2 Injury on Honeycrisp
1.5% O_2 & 0% CO_2
1.5% O_2 & 5% CO_2


High CO_2 /Low O_2 Injury on Honeycrisp
3% O_2 & 0% CO_2
3% O_2 & 5% CO_2

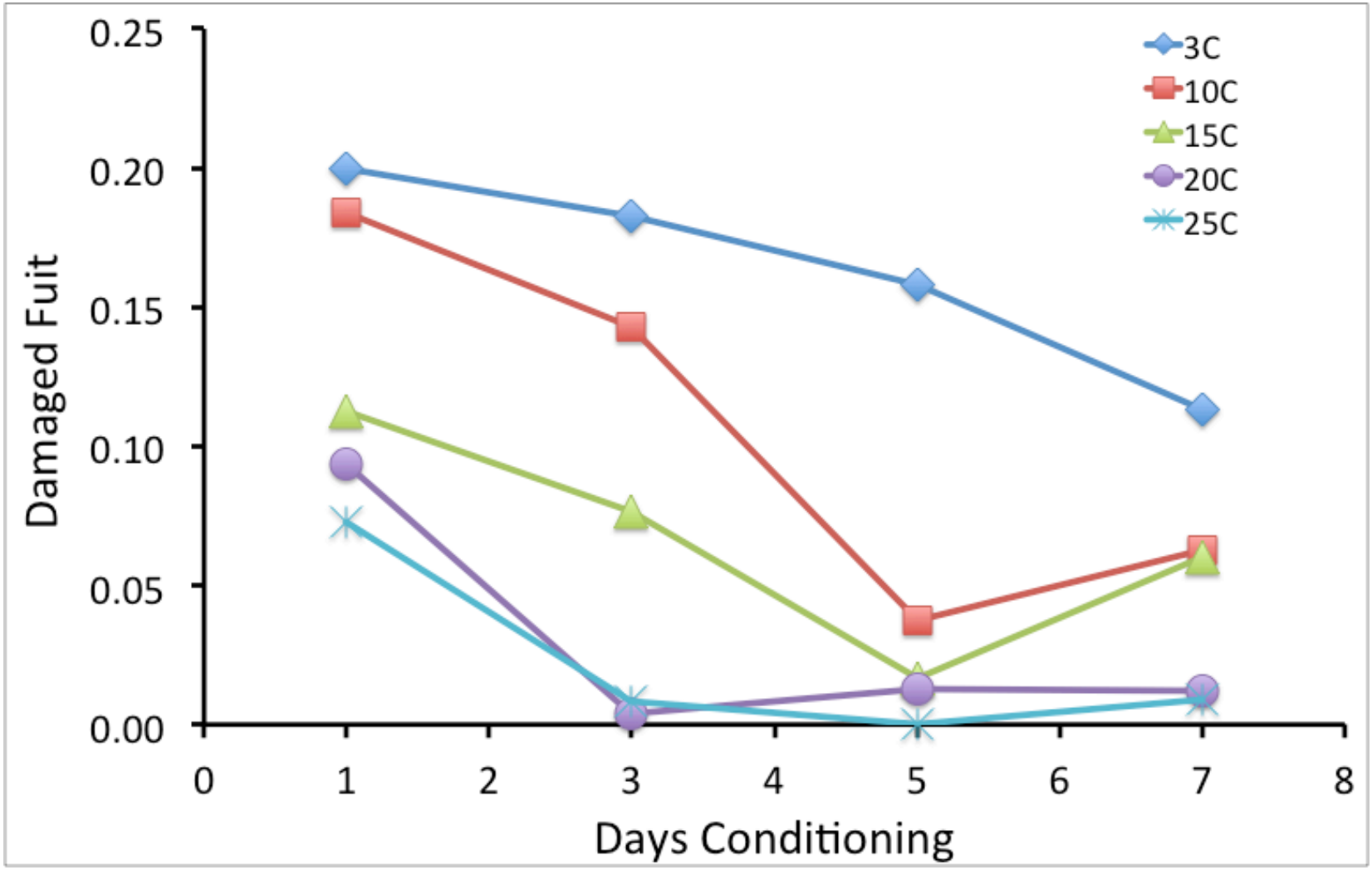
CO_2 Injury

- Highly variety-dependent
- Increases with maturation
- Can be worse under low oxygen
- Controlled by DPA
- Can be enhanced by 1-MCP (but not always!)
- Damage usually occurs in first 2 - 6 weeks of storage



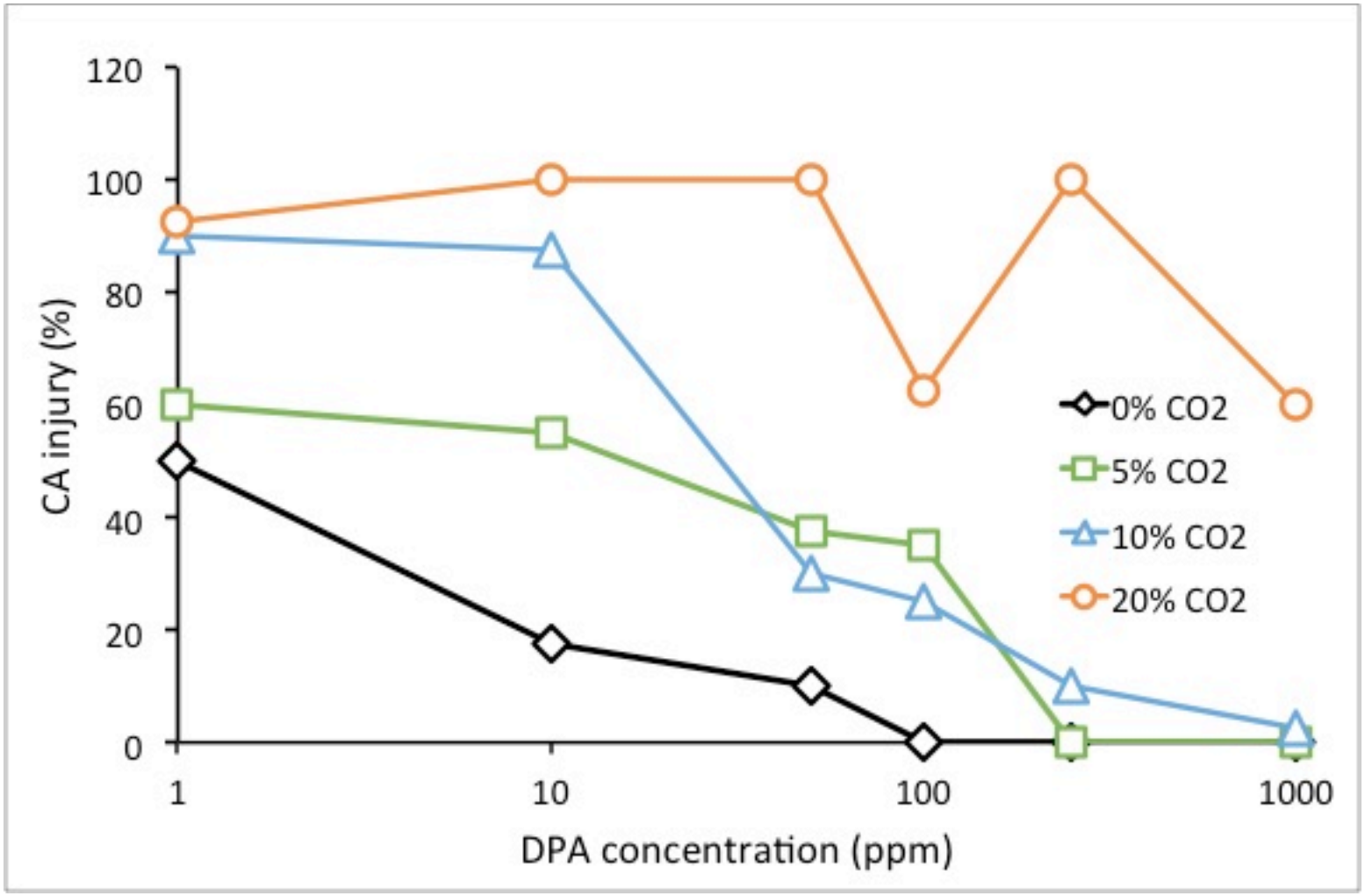
The degree of injury is dependent upon the concentration of CO_2.

Preconditioning to reduce CO_2 injury in Honeycrisp



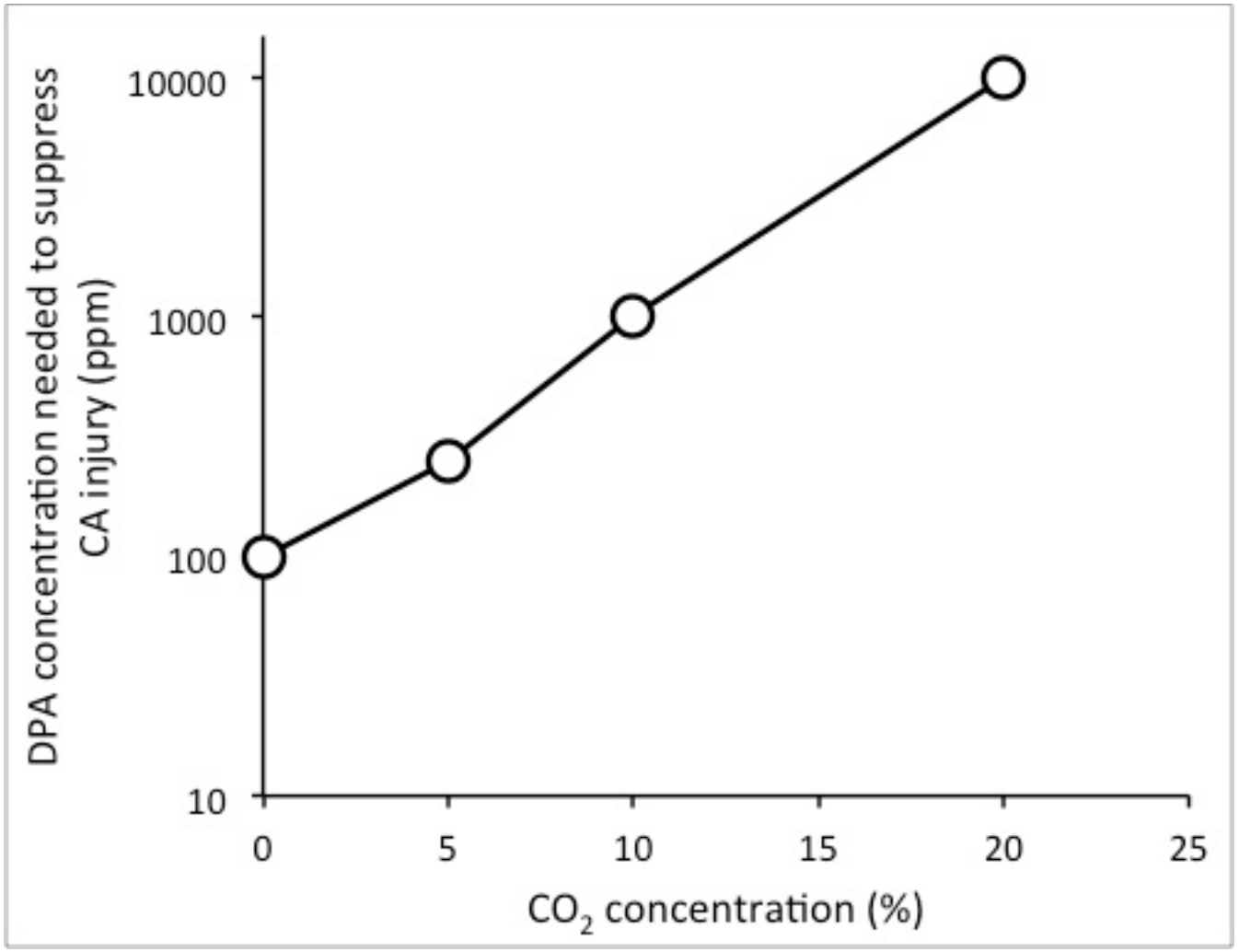
3 days conditioning minimum is required at 68 to 77 (yes 77!) °F

DPA to reduce CO_2 (CA) injury in Honeycrisp



CA injury declines as DPA concentration increases

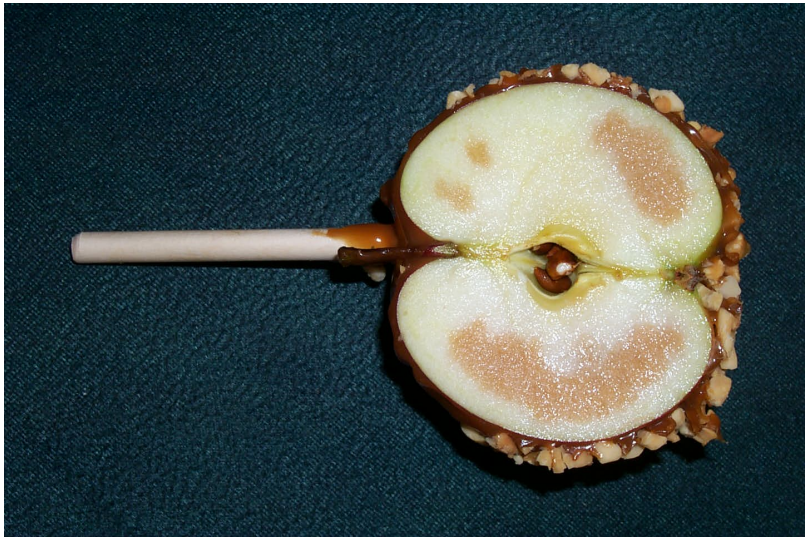
DPA to reduce CO_2 (CA) injury in Honeycrisp



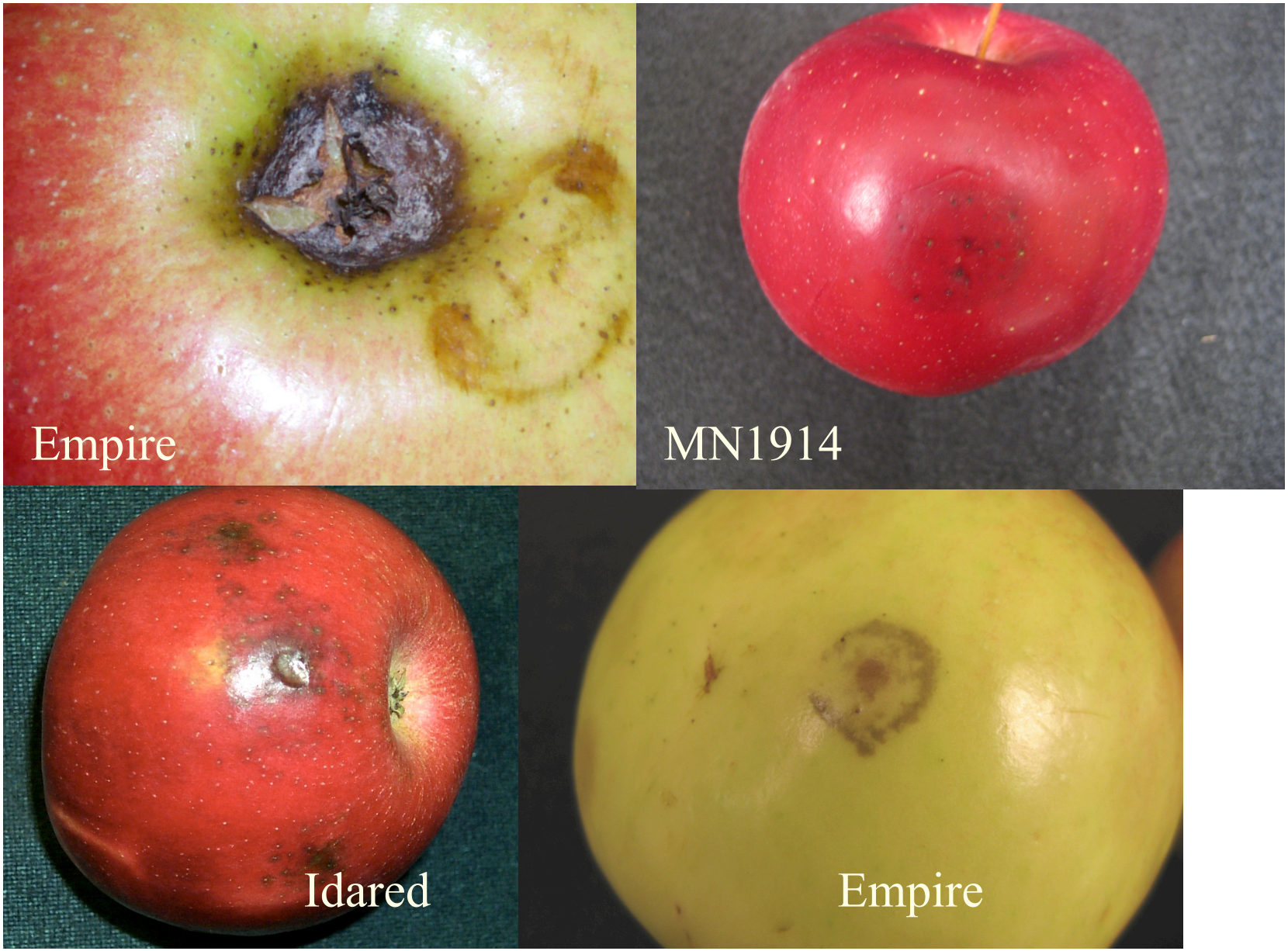
Minimum dose required to prevent CA injury increases from 100 to approximately 10,000 as CO_2 increases from 0 to 20% in an atmosphere of 3% O_2.

Low O_2 Injury

- Somewhat variety-dependent, damage occurs at levels below 0.5% to 3%
- Increases with maturation
- Can be worse under high CO_2
- May be reduced in some cases (Honeycrisp) by DPA
- Not affected by 1-MCP
- Damage can occur throughout storage period



DPA injury



DPA Injury

- Occasional, occurs on drenched fruit of many varieties
- Often found in calyx or at contact points between fruit or bin walls
- Can be reduced by allowing fruit to drain and dry after treatment
- Can be avoided by lower DPA levels

Honeycrisp

Chemical injury

Chemical injury

Chemical injury

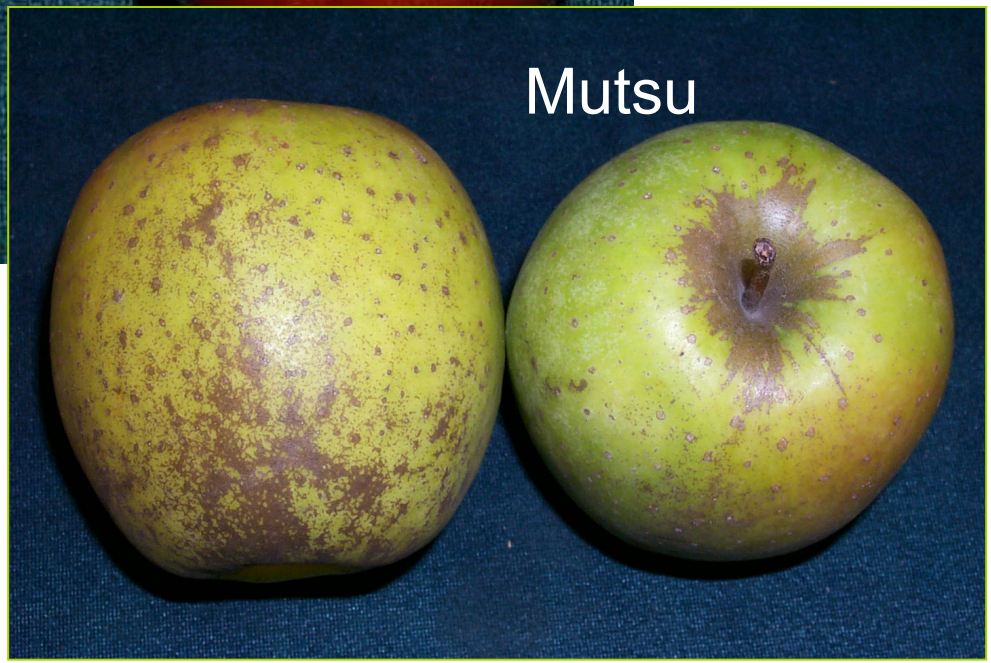
Chemical injury

Following exposure to ammonia (>220 ppm)

Range of injury

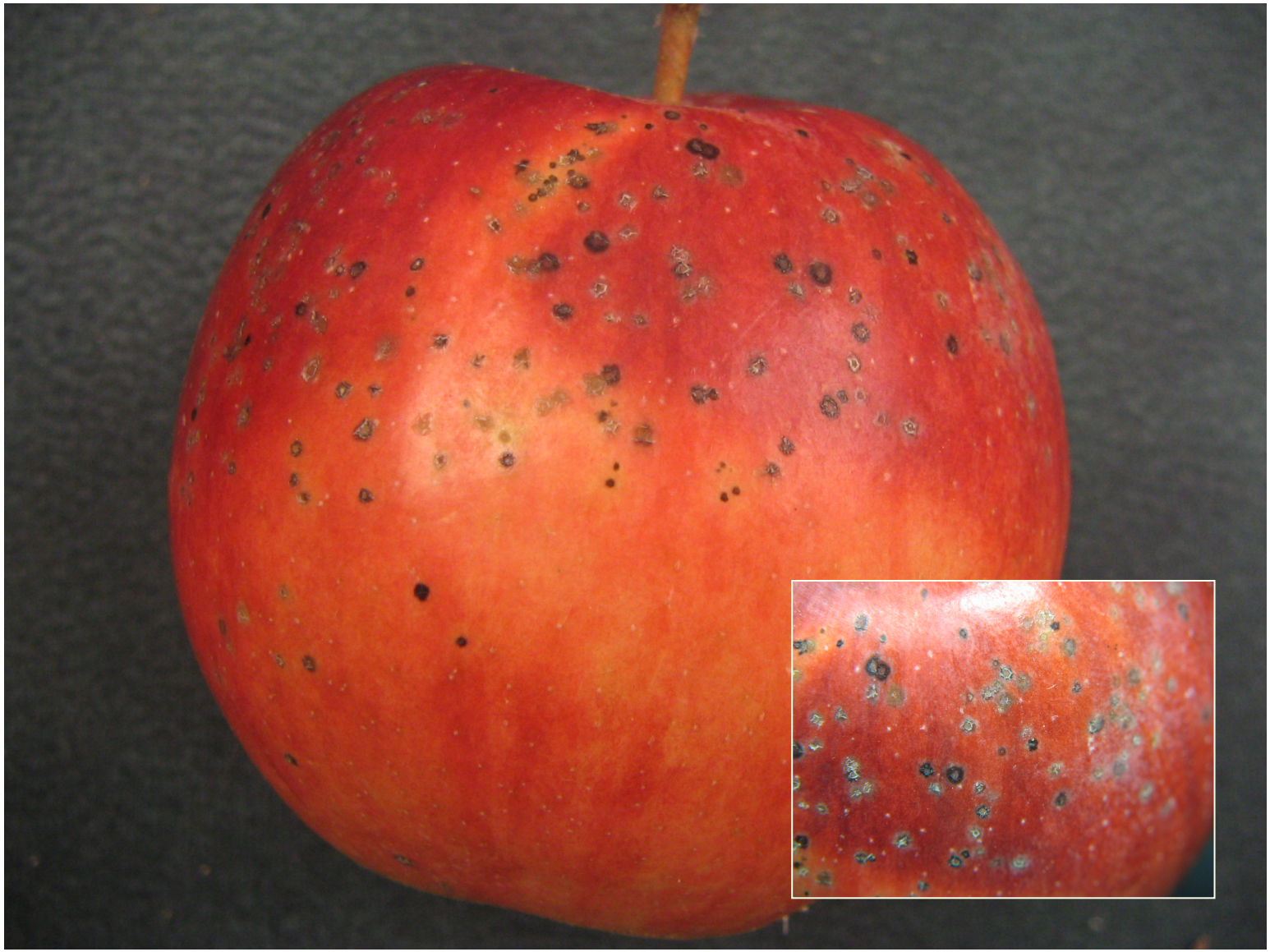
After venting damaged fruit for 48 h at room temperature

Chemical injury



Chemical injury

Storage scab (suspected)



Heat/chemical injury on packingline

Lenticel damage

“PLAIN TALK ABOUT APPLE LENTICEL BREAKDOWN”, Gene Kupferman:

Lenticel breakdown (LB) is a skin disorder of apples that appears largely after the fruit have been packed, thus it is a very expensive problem

Figure 1. Gala is the most susceptible to lenticel breakdown. Mild cases resemble chemical burn, and the lenticels turn black.

Figure 2. In more severe cases, like the Fuji pictured here, flesh under the lenticels sinks, resulting in craters under the skin.

“FACTORS ASSOCIATED WITH APPLE LENTICEL BREAKDOWN”, Eric Curry:

Some relationship to mineral content (low calcium, high magnesium, high potassium)

May be related to the ability of the cuticle to repair itself

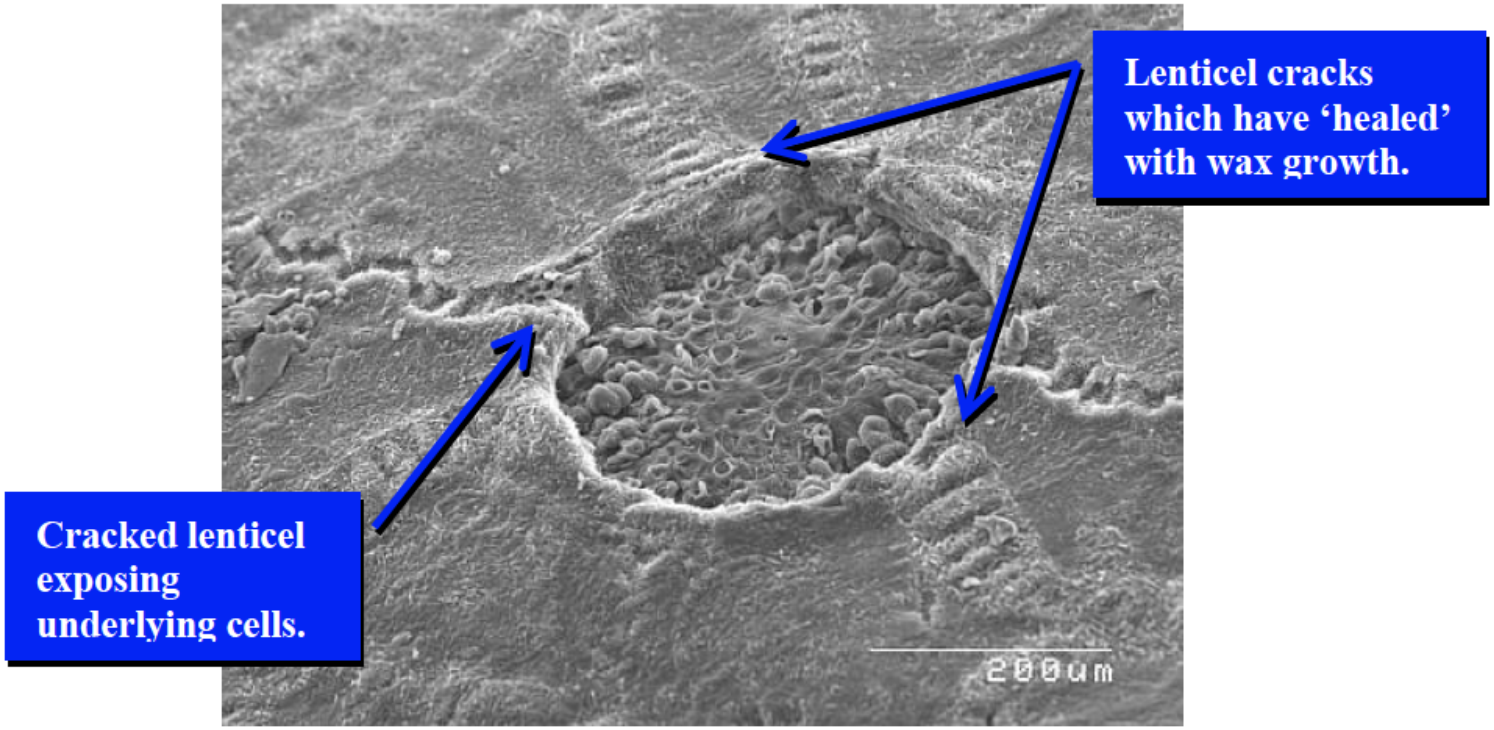


Figure 5. Fruit lenticel with cracks in the cuticle annulus at various stages of ‘healing’ or ‘curing’.

CONTROLLING LENTICEL BREAKDOWN", Eric Curry/Gene Kupferman:

Avoid Royal Gala

Consideration for hot years

Minimize storage duration

Harvest earlier, if possible

Not affected by 1-MCP

Presizing in water enhances LB.

On packing - cold fruit into warm water in the packing line also enhances LB. Soaps, waxes, and detergents enhance LB.

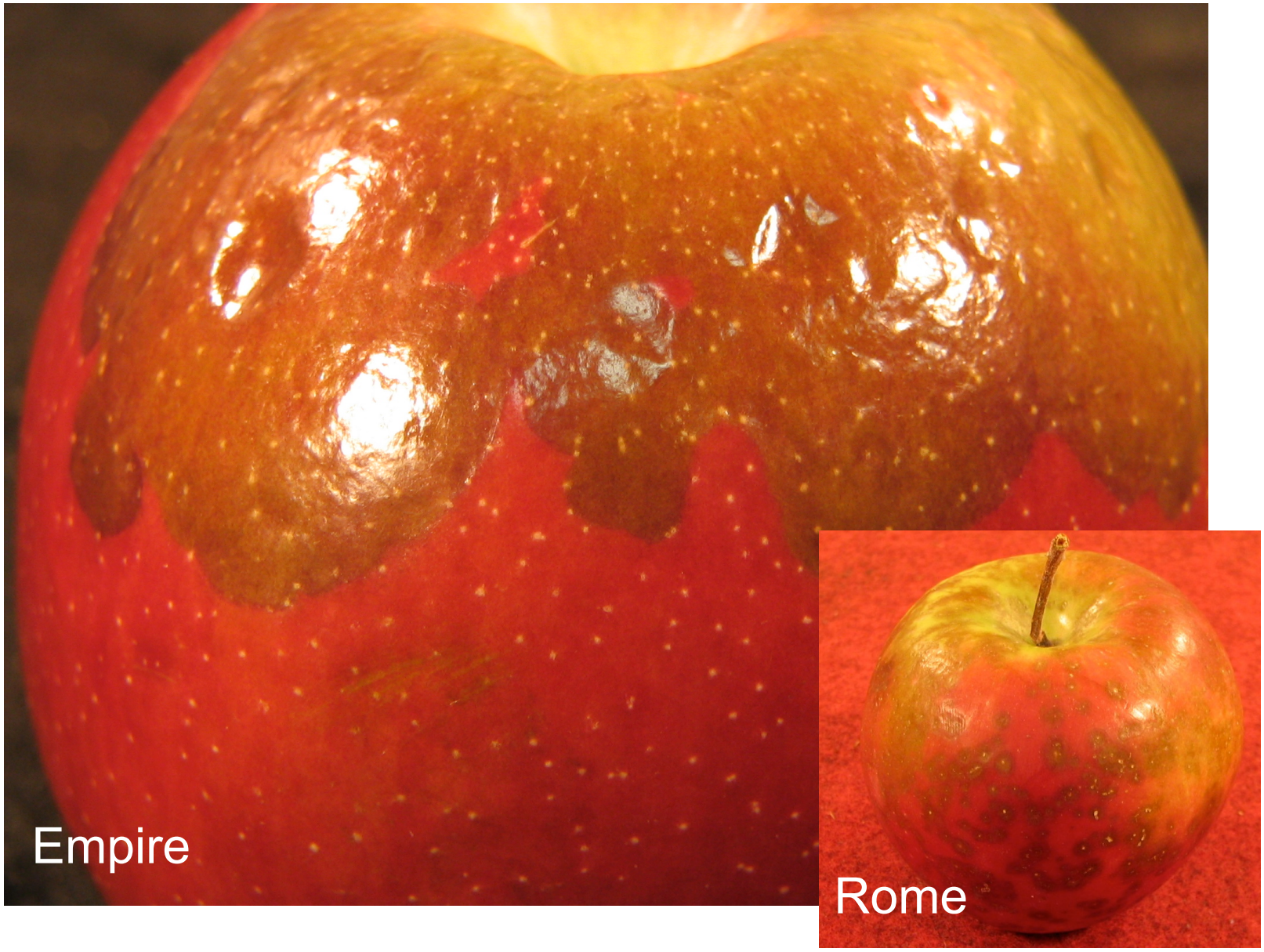
Consider re-evaluating soaps, waxes, 'severity' of packingline

Wax ‘whiting’

Minimize heat and moisture exposure post-packing

Carnauba wax may be less susceptible

?????


Empire
Rome

...and some preharvest disorders

- Frost ring
- Hail Damage
- Boron Deficiency
- Brown Marmorated Stink Bug

Stem loss damage

Frost Ring

Hail Damage

Honeycrisp

Brown Marmorated Stink Bug

Boron Deficiency

Honeycrisp

Thank you