Storage Recommendations
and New Methods for
Treating Apples with DPA

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Storage Guidelines

These apples should NOT be destined for long-term storage due to high risks of physiological disorders...

- Large fruit from lightly cropped trees
- Fruit from excessively vigorous trees
- Fruit from young trees just coming into bearing
- Fruit from interior portions of the tree that are heavily shaded
- Early picked fruit high in starch
- Over-mature fruit high in ethylene
- Fruit with low seed counts (< 5 per fruit)

Storage Guidelines

Follow harvest maturity guidelines
Over-mature fruit ripen and soften faster in storage
Cool fruit as quickly as possible
Maintain proper storage temperature and CA atmospheres
CA storage will not improve fruit quality

Storage Temperature = 3°C
Oxygen = 2.5%
CO₂ = 2.5% 1 mo., then gradually up to 4.5%
* If using SmartFresh and no DPA, keep CO₂ close to zero for 2 mo.

‘Mcintosh’

Storage Temperature = 3°C
Oxygen = 2.5%
CO₂ = 2.5% 1 mo., then gradually up to 4.5%
* If using SmartFresh and no DPA, keep CO₂ close to zero for 2 mo.

‘Empire’

Storage Temperature = 2°C
Oxygen = 2.5%
CO₂ = 2.0%
* If using SmartFresh and no DPA, keep CO₂ close to zero for 2 mo.

‘Cortland’

Storage Temperature = 0°C
Oxygen = 2.5%
CO₂ = 2.5%
* If using SmartFresh, then 2-3°C
* If using SmartFresh and no DPA, keep CO₂ close to zero for 2 mo.
‘Gala’

- Storage Temperature = 0°C
- Oxygen = 2.5%
- CO₂ = 2.5%
- * If using SmartFresh, then 2-3°C


- Storage Temperature = 0°C
- Oxygen = 2.5%
- CO₂ = 2.5%

‘Honeycrisp’

- Storage temperature at least 3°C
- • Cooling delay to reduce disorder development
  - 5-7 days at 10°C recommended
  - >10°C further increases ethylene production, shrivel, greasiness, and bitter pit
  - >15°C causes reduced acidity, as well as associated sensory attributes
    (i.e. astringency, bitterness)

Maturity vs. Soft Scald

- 2008 Harvest
- Simcoe orchard
- Sept. 15    Sept. 23
- Starch   6   6.7
- Firmness 18  15.2 lb
- SSC      13.3 13.0%
- 6 mo. Air 0°C
- Soft scald 7  47%

Effect of Storage Temperature on Soft Scald

- 2008 – 3 Months
- at 0°C
- at 3°C

Soft scald correlated negatively with SSC at harvest in Ontario

\[
\text{ONTARIO} \\
\begin{align*}
 y &= 334 - 22.7 \, x \\
 r^2 &= 0.49; \quad P = 0.0524
\end{align*}
\]
**Diphenylamine = DPA**

\[(C_6H_5)_2NH\]

- organic compound with antioxidant properties
- registered as a plant growth regulator
- used to control superficial scald development
- also reduces external CO\(_2\) injury

**Diphenylamine = DPA**

- applied postharvest, often as a drench
- usually 1000-2000 ppm
- No Scald (Decco)
- Shield DPA (Pace International)

**DPA thermo-fogging /aerosol technology**

*Pace Intl. - Thermo-fogging*
- submitted registration package for EcoFog 100 (DPA) in January 2010 and the package for EcoFog 160 (Primethanil) in April
- expected timeline is 12 to 18 months for the issuance of the labels

*Decco - Aerosol*
- registration US EPA in May 2008
- submitted registration package to PMRA in spring 2009 but was returned with request for efficacy data
- re-submitted earlier this year with data from ON and QC

**Thermo-fogging**

Technique for vapor application of chemicals to fruit in storage – Pace International

Chemical heated and droplets sheared to ≤ 1 µm

Used for 20+ yr in Europe, on apples and pears

Proven technology for DPA, ethoxyquin

Fungicides are now being used

Comparable cost and efficacy as drenching

**Ontario Trials**

- Research permit from PMRA for 2005 harvest
- Thermo-fogged DPA in two commercial rooms
- Empire (spaced) and Delicious (tight-stacked) - need 72 cm minimum top height void
- In combination with SmartFresh to investigate effects on CO\(_2\) injury as well as superficial scald
- Dr. Peter Sanderson, Pace International, LLC
- Apples must be treated when dry!
Results

- Fruit samples measured for residue ~2 weeks after application
  - no major differences compared to DPA drench
  - tighter stacked room made no difference
- Fruit evaluations after standard CA storage
- Delicious room opened early (3 months)
  - no damage observed due to fogging
  - very little superficial scald

DPA Injury on Empire

Can occur in the “line of fire” or along specific air flow patterns

DECCO Aerosol DPA

- Dry formulation, weighed according to weight of apples in room
- Fast application (about 500 bins/15 min)
- No loss of storage space
- No high voltage requirements
- No container disposal
- No drench water disposal
- Patent Pending
  - different process than “Fogging”

DECCO Aerosol DPA

- No problems with high residues
- Scald control has been excellent
- No CO₂ injury
- Good distribution of DPA within room and within bins
**Commercial Trials - 2009**

- Research permit from PMRA for 2009 harvest
- Decco DPA aerosol in two commercial rooms in ON and one room in QC
  - ON = Empire and Delicious
  - QC = McIntosh, with some Spartan
- DPA injury found on Empire in top bins, back corner
- Delicious, McIntosh and Spartan all clean
- Very few disorders found in non-DPA-treated apples, so difficult to compare efficacy
- No excessive DPA residue anywhere

DeEll, 2010

**Commercial Trials - 2010**

- Research permits from PMRA for 2010 harvest
- Decco DPA aerosol in 14 storage rooms
  - 1 in BC, 6 in ON, 5 in QC, 2 in NS
- Pace DPA EcoFog in 3 storage rooms
  - 1 in BC, 1 in ON, 1 in QC
- Results to follow...

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**Thank You!**