Pre-harvest Plant Growth Regulators in Pears

Focusing on physiology & applications of NAA, AVG, 1-MCP for:

1. Controlling pre-harvest fruit drop
2. Extending harvest window
3. Increasing storability

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Commercially registered pre-harvest PGRs in pears

- **NAA** (1-Naphthaleneacetic Acid): **Fruit Fix**
  
  *Function:*
  
  Reducing/delaying pre-harvest fruit drop

- **AVG** (Aminoethoxyvinylglycine): **ReTain®**
  
  *Functions:*
  
  1. Delaying on-tree maturation
  2. Reducing/delaying pre-harvest fruit drop

- **1-MCP** (1-Methylcyclopropene): **Harvista™**
  
  *Functions:*
  
  1. Delaying on-tree maturation
  2. Reducing/delaying pre-harvest fruit drop
I. Control Pre-harvest Fruit Drop
Physiology behind fruit drop

- Fruit drop directly results from expression of genes and activity of enzymes associated with cell wall degradation in the abscission zone (AZ)
  - Cellulose and polygalacturonase

- Expression of the genes is triggered by the interplay between **auxin** and **ethylene**

- **Auxin** must fall below a certain threshold in the AZ to be sensitive to **ethylene**

- Therefore, pre-harvest fruit drop is actually a result of reduced auxin + increased ethylene in AZ
Physiology behind fruit drop control by PGRs

- **NAA** – a synthetic auxin
- **AVG** – an inhibitor of ethylene biosynthesis
- **1-MCP** – an inhibitor of ethylene action

Therefore,

- Applications of NAA/AVG/1-MCP can balance auxin/ethylene in AZ and therefore reduce/delay abscission
Our research indicated that
- NAA > AVG ≈ 1-MCP?
- NAA+AVG > NAA
- Results on pears may not be the same on apples
  - Pears produce less ethylene on-trees
NAA & pear storability

Physiologically, auxin-type PGRs generally increase ethylene production and ripening of tree fruit

Our research indicated that

- NAA may reduce storability in pears

  NAA at 33ppm (label rate)
  - 3 WBAH: No effect on ethylene
  - 2 WBAH: Increase ethylene production

  NAA at 15ppm
  - 2 WBAH: No effect on ethylene
  - 1 WBAH: Increase ethylene production

The increased ethylene production reduced storability
To reduce negative effects of NAA on storability without reducing its efficacy on stop-drop in European pears

1. **Application rate**
   - 20ppm on Bosc and Anjou
   - 15ppm on Bartlett

2. **Application timing**
   - Do not apply NAA less than 2 weeks before harvest
   - NAA becomes effective in 2-3d after application and controls drop for 2 weeks

3. **Combo of NAA + AVG**
   - Increases efficacy on stop-drop
   - Counteracts the negative effect of NAA on storability
II. Extend Harvest Window

- **Harvest maturity** is the single most important pre-harvest factor affecting pear storage potential, postharvest loss, and quality at consumption.
  - *Bartlett: 19-17 lb*
  - *Anjou: 15-13 lb*
  - *Bosc: 15-13 lb*
  - *Comice: 13-11 lb*

- However, it is sometimes a challenge to harvest a large portion of pear fruit in a short period of time as a result of faster maturation (i.e., 2015) or shortage of labor.
Our research on Bartlett indicated that

Applied AVG 1wbah/FF=20-21lb

- AVG did not affect fruit maturation reaching FF=19lb
- AVG slowed on-tree maturation from FF=19-17lb
- Therefore, AVG extends harvest window for ~5d (2013, 2014)

- A reduced efficacy if applied >2wbah1
Some commercial field trials on Bartlett

Pearson, T. and Y. Wang. 2015
1-MCP delayed on-tree firmness reduction of Bartlett

Efficacy may not be consistent

Villalobos-Acuña et al., 2010. HortScience 45:610-616
III. Increase Storability of Summer Pears

Significant storage/export losses due to senescent disorders in ‘Bartlett’ and ‘Starkrimson’ each year

- **Bartlett**
  1. Pink end
  2. Senescent scald
  3. Senescent core breakdown (SCB)
  4. Yellowing

- **Starkrimson**
  1. Senescent core breakdown (SCB)
  2. Increased susceptibility to $O_2/CO_2$ injuries
ReTain & Bartlett storage

Our research indicated that

• **AVG inhibits ethylene production, therefore reduces senescence disorders and extends storage life of Bartlett**
  – Pink-send, senescent scald, core breakdown

• The keys for being efficient
  – **Timing: 1 WBH1** (H1=19lb)
    Application closer to harvest results in higher efficacy, however, PHI = 7d
  – **Rate: 60-120ppm** (0.5-1 pouch/acre)
  – **Harvest at 19lb**
ReTain & Starkrimson storage

Our research indicated that

• **AVG inhibits ethylene production, therefore reduces senescence disorders, decays, and extends storage life**

• The keys for being efficient
  
  – **Timing:** 1 WBH1
  
  – **Rate:** 60-120ppm (0.5-1 pouch/acre)
  
  – **Harvest at 15-14lb**
Harvista & Bartlett storage

- No effect on color
- Little effect on firmness
- **Reduced senescence disorders**

Villalobos-Acuña et al., 2010. HortScience 45:610-616
Compared to pre-harvest Harvista or ReTain, **postharvest SmatFresh** is more efficient on increasing storability of European pears.
SmartFresh & Bartlett

Benefits of 1-MCP at 300ppb
• Maintain green color, reduce senescence disorders
• Recover ripening capacity after 4 months

Challenge
• Non-consistent efficacy in commercial application

We identified the following factors:
• Harvest maturity
• Production elevation,
• Time elapsed between harvest and treatment
• Exogenous ethylene in the treating room
SmartFresh & Starkrimson

- 1-MCP at 300 ppb extends Starkrimson storage life to 4 months at 30°F
- However, it takes 2 weeks at 68°F to ripen following cold storage >2 months
SmartFresh & Bosc

- 1-MCP inhibited ethylene production
- Retained FF, SSC, TA, greener color, higher eating quality by sensory panelists
- Reduced decay: *Bull’s eye rot*, *Phacidiopycnis rot*, *Cladosporium rot*
SmartFresh & Anjou

Benefits
• Postharvest 1-MCP at 150-200ppb
  – Shuts down ethylene synthesis
  – Controls superficial scald
  – Extends storage life

Challenge
• Recovering ripening capacity following cold storage

We have identified:
• Elevated storage temperature + CA
• Simultaneous of 1-MCP + ethylene
• Post-storage ethylene conditioning
SmartFresh & Anjou (Cont.)

Long-term storage 8 months

Ethoxyquin + low $O_2$:
6% scald
6% speckling + PBC
3% decay

1-MCP + Ethoxyquin + low $O_2$:
0% scald
0% speckling + PBC
0% decay
Ripened by PSEC
SmartFresh & Anjou (commercial application at 100ppb)
Summary

• **Controlling pre-harvest fruit drop**
  – NAA+AVG > NAA > AVG ≈ 1-MCP
  – NAA may have negative effects on storability
    • Application rate and timing are critical
    • AVG counteracts NAA’s negative effect

• **Extending harvest window**
  – ReTain (≈ Harvista?), ~5d for summer pears
  – Winter pears: under research

• **Increasing pear storability**
  – ReTain and Harvista may increase storability of summer pears
    • ReTain: Application timing and harvest maturity are important to be efficient
    • Winter pears: under research
  – Postharvest SmartFresh
    • Postharvest smartfresh >> preharvest Harvista
    • Rate, timing, and fruit maturity are important for consistent efficacy
Thank you for your attention and research support!

- Washington Tree Fruit Research Commission
- NW Pear Research Commission
- Pear Bureau NW
- Columbia Gorge Fruit Growers
- AgroFresh
- Diamond Fruit Growers, Inc.
- Duckwall-Pooley Fruit
- Stadelman Fruit
- Underwood Fruit
- Stemilt Growers
- Blue Bird
- Blue Star Growers