PREHARVEST GROWTH REGULATOR IN APPLE:

Faubion, D.F.

dfaubion@agrofresh.com

AgroFresh, Yakima, USA

KEYWORDS
senescence, ripening, abscission, stress, fruit softening, climacteric, auxin, ethylene, gibberellic acid, cytokinins, aminoethoxyvinylglycine, 1-methylcyclopropene

ABSTRACT
Over the last several years Honeycrisp has demonstrated that high quality fruit at the consumer level can enhance dollar return per acre. Optimization of consumer fruit quality is now, more than ever, within our control. Uniformity of planting material and systems, combined with uniform crop loads and chemical application technologies, allow new levels of on-farm control of quality.

Prior to harvest, metabolic changes affecting fruit quality, like ripening, can happen quickly. These metabolic changes are not always predictable and are influenced by many factors including environment, past stresses, crop load, and others. Plant growth regulators can be used to modify the plant’s perception and response to these metabolic changes.

Preharvest plant growth regulators (by class) will be discussed in relation to their impact on various aspects of metabolism with emphasis on final fruit quality.

<table>
<thead>
<tr>
<th>PGR Class</th>
<th>Example effect</th>
<th>Example product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxin</td>
<td>fruit drop</td>
<td>K-salt</td>
</tr>
<tr>
<td>Gibberellins</td>
<td>reduce russet</td>
<td>Provide</td>
</tr>
<tr>
<td>Cytokinin</td>
<td>cell division</td>
<td>Promalin</td>
</tr>
<tr>
<td>Ethylene promoter</td>
<td>ripening</td>
<td>Ethephon</td>
</tr>
<tr>
<td>Ethylene inhibitor</td>
<td>delay ripening</td>
<td>Harvista</td>
</tr>
</tbody>
</table>
Preharvest Growth Regulators in Apple

November – 2015

Dana Faubion, AgroFresh
Plant hormones

• What is a hormone – chemical messenger

• The main five plant hormones
  > Abscisic Acid – growth inhibitor (dormancy), moves freely,
  > Auxin -- cell elongation, meristem, top down, apical dominance
  > Cytokinins – stimulates cell division, inhibits senescence, roots, bottom up,
  > Ethylene – promotes senescence, ripening, gas
  > Giberellins – induces cell division, cell elongation, moves freely,
  > Others
Plant hormones

• What is a hormone – chemical messenger

• The main five plant hormones
  > Abscisic Acid – growth inhibitor (dormancy), moves freely,
  > Auxin -- cell elongation, meristem, top down, apical dominance
  > Cytokinins – stimulates cell division, inhibits senescence, roots, bottom up,
  > Ethylene – promotes senescence, ripening, gas
  > Giberellins – induces cell division, cell elongation, moves freely,
  > Others
Thale cress, Arabidopsis thaliana. Photo: MPI for Developmental Biology

FIGURE 17.12. Cabbage, a long-day plant, remains as a rosette in short days but can be induced to bolt and flower by applications of gibberellin. In the case illustrated, giant flowering stalks were produced. (Photo courtesy of S. Withwer, Michigan State University.)
## Labeled preharvest PGRs for apple in Washington

<table>
<thead>
<tr>
<th>Hormone class</th>
<th>Ingredient</th>
<th>Registrant</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auxin</strong></td>
<td>indole-3-butyric acid (IBA)</td>
<td>PBT</td>
</tr>
<tr>
<td></td>
<td>NAA sodium salt</td>
<td>Amvac</td>
</tr>
<tr>
<td></td>
<td>naphthalene-acetamide (NAD)</td>
<td>Fine</td>
</tr>
<tr>
<td></td>
<td>naphthaleneacetic acid (NAA)</td>
<td>Amvac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valent</td>
</tr>
<tr>
<td><strong>Cytokinnin</strong></td>
<td>cytokinnins</td>
<td>PBT</td>
</tr>
<tr>
<td></td>
<td>benzyladenine</td>
<td>GS Long</td>
</tr>
<tr>
<td><strong>Ethylene</strong></td>
<td>ethephon</td>
<td>Bayer</td>
</tr>
<tr>
<td><strong>Anti Ethylene</strong></td>
<td>aminoethoxyvinylglycine hydrochloride (AVG)</td>
<td>Makhteshim-Agan</td>
</tr>
<tr>
<td></td>
<td>1-methylcyclopropene (1-MCP)</td>
<td>Nufarm</td>
</tr>
<tr>
<td><strong>Gibberellins</strong></td>
<td>gibberellic acid</td>
<td>Valent</td>
</tr>
<tr>
<td></td>
<td>gibberellins (GA A4, A7)</td>
<td>AgroFresh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PBT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nufarm</td>
</tr>
</tbody>
</table>

*WSU PICOL*
Auxin – fruit abscission

- Example: NAA, Fruitone L, 3.1% NAA equivalent, Amvac
- What does it do?
  > Inhibits abscission
  > High levels can accelerate senescence
Gibberellins / Cytokinnins –

- Example: Gibberellins A₄A₇, and benzyladenine, Promalin, 1.8%, Valent
- What does it do?
  > Promotes cell division and expansion
  > Fruit size
  > Promotes bud break and lateral branching

Tree Fruit Physiology, WSU 1996
Ethylene

- Respiration
- Ethylene production
- Volatile production
- Chlorophyll degradation
- Skin and flesh changes
- Protein and membrane changes
- Softening
- Disorders and diseases (scald,…)
- Acidity
- Cuticle formation
- Carbohydrate metabolism
- Abscission (Drop)
- Firmness
- Starch
- Greasiness
- Cracking
- Bitterpit
SF Yang Cycle

**SAM**

- Inhibits the production of ACC, a rate limiting step in the biosynthesis of ethylene

**ACC**

- Ethylene (ethephon)
  - Is released after the spray is metabolized inside the plant

**Ethylene**

- Inhibits the perception of ethylene by receptors

**Ethylene receptor site**

- Physiological effects of ethylene

---

AVG (ReTain)

- Inhibits the production of ACC, a rate limiting step in the biosynthesis of ethylene

1-MCP (Harvista, SmartFresh)

- Inhibits the perception of ethylene by receptors
Plant Ethylene

- Ethylene production
  - Yang cycle
- Ethylene
  - gas
- Ethylene perception

Modified from Miyazaki and Yang (1987)
Ethylene

- Example: Ethrel, [(2-chloroethyl)phosphonic acid], 21.7%, Bayer
- What does it do?
Red Delicious — Ethrel® Treatments

* Applications of SmartFresh™ took place 8-9 days post harvest.
Anti Ethylene

- Example: AVG, Retain, 15%, Valent
- What does it do?
Retain data slide

Tree Fruit Physiology, WSU 1996

Brackmann, A. SCIENTIA AGRICOLA, Volume: 72, Issue: 3
Anti Ethylene – the ‘new one’

• Example: 1-methylcyclopropene, Harvista, 3.8%, AgroFresh
• What does it do?
Harvista Fruit Drop Rescue – McIntosh

Application Dates

Cumulative Fruit Drop %

Control
7-Sep
18-Sep
21-Sep


Chris Watkins – Cornell University
Harvista Impact on Storage

Red Delicious

Firmness (Kg)

Control Retain™ Harvista SmartFresh Harvista + SmartFresh

Regular Atmosphere 93 days + 7 days stress

Control Retain Harvista SmartFresh Harvista + SmartFresh

Controlled Atmosphere 188 days + 7 days stress

H H+7 H+14 H+21 H H+7 H+14 H+21

Regular Atmosphere 93 days + 7 days stress

Controlled Atmosphere 188 days + 7 days stress
Summary