

PGR's for Harvest Management: Options, Pros, and Cons

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Overview

- What are they?
- Principal PGR's used in Harvest Management in apple
- How they work/pros/cons of each
- Factors that influence PGR uptake
- What happened in 2016?
 - Discussion
- Conclusion







Plant Growth Regulators (PGR's)

• What are PGR's?

Plant hormones are produced naturally by plants and are essential for regulating their own growth. They act by controlling or modifying plant growth processes, such as formation of leaves and flowers, elongation of stems, development and ripening of fruit.

- In modern agriculture, people have established the benefits of extending the use of plant hormones to regulate growth of other plants. When natural or synthetic substances used in this manner, they are called Plant Growth Regulators.
- PGR's used for harvest management and stop-drop are all synthetic.



Principal PGR's used in Harvest Mgmt

- ReTain[™] (AVG aminoethoxyvinylglycine hydrochloride)
- Harvista[™] (1-MCP 1-Methylcyclopropene)
- PoMaxa, Fruitone N (1-NAA 1-Napthalene acetic acid)
- Ethrel, Ethephon[(2-cholorethyl) phosphonic acid]
- Combinations ReTain + NAA, Retain + Harvista











NAA (1-Napthalene acetic acid)

- For preharvest drop control
 - Can see effects in 1-3 days after application, for up to 2 weeks
 - Can advance maturity, soften apples
 - NAA controls genes that prevent drop but stimulates ethylene production and ripening.
 - Only recommended for use alone as a "rescue" treatment, storage potential reduced





Ethrel[™] -Ethephon[(2-cholorethyl) phosphonic acid]

- Promotes ripening
- Promotes internal ethylene synthesis
- Promotes coloring
- Loosens apples



 Primarily for early market windows on Paula Red and Jonamacs, for earlier harvest





ReTain[™] - (AVG - aminoethoxyvinylglycine hydrochloride)

- Widely used in apples
- Rates and use timings vary widely by variety and other factors
 - Normal rates delay color in Gala & others
 - Timings 1-4 weeks before anticipated normal harvest date
 - Closer to harvest to take into account better weather forecast
 - Closer to harvest allows better stop-drop effect
 - Further from harvest increases color delay
 - Delays harvest 7-14 days





Biological responses

- Ethylene production reduced
- Starch to sugar conversion slowed
- Fruit softening slowed
- Fruit drop reduced/delayed
- Watercore reduced/delayed
- Cracking reduced/delayed
- Internal bleeding reduced/delayed
- Greasiness reduced/delayed
- Delays background color shift (e.g., Gala)
- Delays red color development in some varieties



Practical Impacts - 1

- Harvest management:
 - Promotes orderly harvest of large acreage of single varieties by treating portions of the crop with different rates/timings of ReTain, delaying maturity and subsequent harvest of those blocks, allowing growers to harvest fruit of optimum quality over longer periods
 - In PYO situations: extend the availability of popular varieties over more weekends
- Labor management:
 - More efficient use of smaller crews to harvest fruit at optimum quality
 - ReTain can help eliminate the "crunch periods" for more orderly harvest.



Practical Impacts - 2

- Maintenance of fruit quality (holds firmness, reduction of watercore, reduction of greasiness)
- Protection of yield through drop control
- Increased fruit size due to harvest delay (\rightarrow incr. yield)
- Improved fruit color due to harvest delay (→ impr. packout)
- Preconditions fruit to optimize response to postharvest 1-MCP (SmartFresh, FYSIUM) by keeping ethylene levels in check, resulting in more uniform response across all fruit



Harvista[™] (1-MCP - 1-Methylcyclopropene)

- Sprayable 1-MCP
- Can be applied closer to harvest than ReTain[™]
 - 3-14 days
- Allows more accurate weather forecasts prior to application
- May be difficult to apply (specialized equipment)
- Only used in larger volumes in NY last 2 seasons
- Delays harvest 7-14 days

ReTain[™] + NAA



- More effective in Macs for stop-drop than either PGR alone Cornell recommends 2 different use patterns:
- •1. Single Spray of Retain and NAA. In this use pattern, Retain (either full rate or ½ rate) is tank mixed with 10-20 ppm NAA at 2-3 weeks before expected harvest.

•Normal years

•2. Split Retain and NAA. In this use pattern, Retain (half rate) + 10-20ppm NAA is applied 4 weeks before expected harvest and followed
2 week later by another spray of Retain (half rate) + 10-20ppm NAA
•Best in hot years (August)

•A possible mechanism for the synergistic effect of NAA and AVG is that NAA controls genes associated with abscission while the addition of Retain blocks the production of ethylene caused by the NAA.



Precision Application of Plant Growth Regulators by Byron Phillips (National Tree Fruit Crop Specialist, Valent, pres. At IFTA MI ,Feb 2016, and in Compact Fruit Tree, April 2016)

- PGR's vs. Pest Management Materials (PMM)
- PMM's DON'T make you money, they PROTECT your crop and investment, they don't add value
- PGR's are an investment, nothing is LOST if a PGR isn't applied, the crop value stays the same, but PGR's could increase the potential value of your crop
 - By improving quality (crop size, color, higher grade, etc.)



Phillips 2016 (Continued)

Plant Responses to PGR's can be highly variable

- Outside factors
 - Cultivar, Rootstock, training system, tree age, tree vigor, crop load, tree nutrition, application equipment
 - Once you approach the short application window, these factors can't be controlled
- There can be stronger influences, some you can control
 - Environmental conditions
 - Application timing, rate, and volume
 - Coverage, water quality, adjuvants



• Environmental Conditions

- Temperature, humidity, sunlight, and rain before, during, and after application can have a great influence on plant response to PGR applications
 - These tend to be more important during post-bloom thinning sprays
- Extreme heat (for comparison, that causes sunburn necrosis of fruit) can reduce response to subsequent PGR applications
- PGR absorption temps
 - Range 60-90F
 - Optimum 70-75F
- Higher temps following application tend to :
 - Increase fruit ripening response to NAA & Ethephon
 - Decrease stop-drop response to AVG



- High Humidity increases absorption of AVG
 - By slowing drying time of the spray droplet
 - The dried deposit can later rehydrate the cuticle membrane
- Sunlight can increase absorption of NAA & Ethephon on lower leaf surfaces
- Rain
 - Significant rain within 2 hours of most PGR applications will usually reduce uptake and response
 - In heat-stressed trees, response to AVG, others? is greatly diminished
 - A timely rain event or overhead irrigation prior to application can reduce plant stress and allow greater uptake
- Knoche & Petracek (2013) showed each time dried deposits of AVG were re-wetted, additional penetration through the cuticle membrane occurred, even 2 weeks after application



- Timing
 - ReTain[™] Can work 1-4 weeks before normal harvest
 - 1-3 weeks allow to work around weather
 - Best stop-drop potential is closer to harvest
 - The longer the application to harvest, the greater the color delay
 - Harvista[™] can be applied 3-14 days before harvest
 - Pros/Cons of application timings still being investigated
 - Overall, even though timing is critical, the windows of opportunity are much broader than once believed, and take into consideration both physiology and environment
- Application Rate
 - In low volume applications (high density planting systems), dose (rate/Acre) is much more important than concentration (ppm solution strength) for ReTain and NAA (and assuming Harvista)
 - Assumes coverage is adequate and solution concentration is within recommended limits
 - Both dose and solution concentration are important for Ethephon 17



- Application Volume
 - The movement from low density systems with 400-1000 gallons water/A (spraying to run-off) to high density systems with 80-200 gallons/A.
 - High density considerations
 - There is no runoff (spraying to "wet" or "first drip")
 - Drying time faster
 - Absorption may be reduced
 - Droplet size critical for drying time
 - Very critical to use the proper rate/A based on crop load, variety, weather, timing, desired response, etc.
- Coverage
 - Critical to plant response and PGR performance
 - Many PGRs have limited/no movement
 - Surfactants can help
- Water quality
 - Stagnant surface water not recommended
 - Clean water preferred
 - pH of 5.5-6.5 in final tank mix recommended



2016

- Worst drought in over 50 years
- The season started with below normal soil moisture
- Frost event April 5-6
- Rainfall totals from 34-71% below normal for June-August in Western NY LOFP Counties
- July-November all LOFP Counties in Severe Drought (only categories exceptional & extreme are worse)
- As of 1/31/17, Niagara & Northern Erie Counties still in moderate drought, rest of LOFP Counties are abnormally dry





2016 (continued)

- Growers were waiting for size and color development
 - Size improved very little, despite more normal rainfall in September & October
 - Color was sub-par due predominately above normal night temps and cloudy daytime weather
 - Many made the decision to "buy time" by applying multiple applications of PGR's many in combination
 - Retain + Retain
 - Retain + Harvista
 - Retain + Retain + Harvista
 - Harvista + Harvista



2016 (continued)

- Results of Multiple PGR's
 - Highly variable, questionable storage potential
 - Example in Galas
 - Maturity delayed by drought stress + PGR's
 - PGR's maintained firmness to a point (but drought-stressed fruit had lower firmness than they should have had)- then rapid decline
 - Background color change occurred rapidly
 - Starch hydrolysis conversion occurred rapidly in most cases





Quality

- A lot of questionable fruit were packed early
- Some is being monitored closely
- Others may show problems in the coming months
- Packer/Shippers will finish earlier than normal
- We don't know the effects of multiple applications of combinations of different PGR's
 - Little research
- Discussion?



Conclusions

- Drought increases the potential for fruit drop.
- NAA controls genes which cause drop but stimulates ethylene production and ripening.
- Retain blocks ethylene synthesis, ripening and drop but in hot years, it does not completely stop the abscission zone formation.
- Harvista works by binding to the ethylene receptor sites



Conclusions (continued)

- There are many factors that can effect plant responses to PGR's
 - Outside factors (Cultivar, Rootstock, training system, tree age, tree vigor, crop load, tree nutrition, application equipment
 - Environmental conditions
 - Application timing, rate, and volume
 - Coverage, water quality, adjuvants
- 2016 was a Record drought for Western NY
 - Tree stress had to be a factor in influencing the lack of response to PGR's
 - More research needs to be done on the effects of multiple applications/different PGR's on:
 - maturity and quality indicators
 - storage potential
 - storage disorders