#### Apple Orchard Management with Plant Growth Regulators

Duane W. Greene University of Massachusetts

### **Growth Regulators**

- Vegetative growth control with prohexadione-calcium (Pro-Ca)
- Chemical thinning
  - Lessons learned last year
  - Thinning without carbaryl
  - Thinner update
  - What to look for in 2017
- Regulation of ripening with ReTain
- mmm

### Growth Control- Revisited

- Prohexadione-calcium was registered in 1997 but little grant-funded supported research has been done in the past few years.
- Most progress has been made in recent years through grower trials and observations.
- A review of the use of this compound is long overdue

#### Prohexadione-calcium

- There are now two formulations registered for use by apple growers in the US.
  - Apogee
  - Kudos
  - Both formulations are 27.5% formulations
- Both formulations have similar growth inhibition capabilities and they can be used interchangeably. For convenience only I will use Apogee rather than Pro-Ca.

### Keys to Successful Use

- A water conditioner or Mg sulfate equal in weight to the amount of Apogee used is recommended.
- A surfactant
- Antifoam agent may be useful
- No calcium-containing compounds should be included in the same tank.

#### Auvil Ranch



### Auvil Ranch- Different approach

- Use MARK rootstock
- Blossom hand thinning
- Management primarily using hand labor from a platform
- Apogee Application
  - Timing- Start application at pink
  - Concentration- Used 12 oz/ 100 gal

#### Reevaluate Apogee use

- The growth control achieved by the early applications and high rate of Apogee was impressive.
- In many respects it did made sense based upon the research done prior to registration.

#### Why does early application make sense?

2D Graph 1



## There is a lag time for Inhibition

- Apogee does not immediately stop growth once application has been made.
- It requires at least 10 to 14 days from the time Pro-Ca is applied for the growth control to be seen.
- During this time terminal shoots are growing very rapidly.
- Much growth retardation opportunity is lost if the first application is made after shoot growth starts.

## Time of Application

- Apply as early in the growing season as there is sufficient leaf area for absorption.
- To achieve the maximum amount of growth control, early application (in the season)is necessary.
- Official Apogee literature does not encourage early application but I think that this is an error, especially in the northern tier of states in the US.

#### Influence of location on growth rate and duration



#### Treatments

- Untreated Control
- Apogee (9 oz /100 Gal at TRV dilute) starting at **pink** as was done at the Auvil Ranch (May 9, June 3 and June 24).
- Apogee applied at 6 oz/100 at petal fall (May 18, June 3 and June 24)

#### **Cortland Untreated Control**





#### **Cortland- Pink**



#### Cortland at Pink



#### Cortland- Start at Petal Fall



### **Cortland at Petal Fall**



## Amount to apply?

- The amount to apply per application and the number of applications is somewhat vigor dependent.
- In the East we tend to use lower initial rates and more applications to avoid:
  - Increased fruit set
  - Difficulties achieving satisfactory thinning

# All rates of Apogee increased fruit sets on Fuji



#### **Does Apogee Increased Fruit Set**

- This is an open question.
- This is a question I raise as a result of recent research.
- The NY and NE spray manuals specifically suggests to use a more aggressive thinning program when Apogee is used.
- Yes, BUT not always.
- It is worthwhile to try to quantify this more precisely.
- It appears that we can't modify this by applying lower initial rates.

#### Does Apogee increase Fruit Set on Damaged Spurs?

- In an experiment this past spring this question was tested on Cortland apples.
- No Apogee treatment increase fruit set.
- There may have been too much damage or the environmental conditions favored fruit set (which appeared to be the case this year).
- It will be tested again if mother nature provides the opportunity.

#### Does Apogee Decrease Bitter Pit?

- It should, if applied early.
- Data collected last year confirms that Apogee reduced bitter pit when initial application was made at pink.
- Early application of Apogee brings about growth control at least 2 weeks early, thus favoring accumulation of calcium in the fruit earlier.

### Apogee Rates to Use?

- Use high rates (9 to 12 oz/100 gal) in the first application. Make a second application 2.5 to 3 weeks later- perhaps at a lower rate.
- Reduced rates may be used in subsequent applications.
- (3 to 6 oz/100 gal).

#### Can Apogee Rates Be too High?

- Perhaps?
- If you use the high rates throughout the season- 3 applications, it is possible.
- Cell division may be reduced- thus limiting fruit size.
- Growth control 3 weeks after bloom does not require very high rates.

## **Chemical Thinning**

- This is probably the most important management activity a grower is required to do, but it is also the least understood and most intimidating activity.
- Many factors can affect fruit abscission

## The Weather

- In 2016 the results of the weather dominated the thinning discussion, although the extent of damage varied a great deal over the region.
- All can learn from this damage and use it to better prepare us to respond to a similar situation. For those that experienced it, it was a most unwelcome learning experience
- It may be your turn this year, thus information learned this year will help you make informed decisions in the future.

#### Cold damage



- Many flowers are either damaged or killed
- A few are marginally damaged but it was not possible to say for sure if they would set

#### **Decisions at Bloom**

- The weather following such frost events influences if the flowers will set or abscise.
- Given the uncertainties surrounding weather forecasting, it appeared prudent to be conservative in making thinning decisions at bloom or petal fall.
- At these stages you will always have another chance.

## What Did We Observe?

 Initial Set was Higher than Expected-Why? Williams and Edgerton "Chemical Thinning of Apples and Pears-289 Williams and Edgerton "Chemical Thinning of Apples and Pears- USDA Bull. 289 <u>Trees are difficult to thin when</u>:

- Cool periods follow bloom, without any tree stress
- Limbs and spurs have been slightly girdled following moderate winter injury

## Initial Set

- If fruit grow to 6mm diameter we know that flowers were fertilized and initial set and occurred.
- Uncertainties about continued fruit growth can be resolved by marking fruit and measuring growth for several days.
  - This will give you a definitive answer about how many will continue to grow.
  - You do not have to run the fruit growth model to get a good overview idea



## Thinning in 2017

- Be observant
- Spurs were stressed in 2016 and this may affect the quality of bloom.
- The lack of water, especially on small trees that were not irrigated or were subjected to water stress may be weak.
- Embryos may have a shorter viability period Thus vulnerable to a marginal pollination period.

## Thinning in 2017

- Makes sure you have adequate number of bee hives.
- Carefully observe early growth of fruit.

## Thinning Without Carbaryl

- There is a growing trend by retailers to either not accept or to pay growers a reduced price for apples that have been treated with carbaryl.
  - Whole Foods
  - Eco -apple
- Countries in Northern Europe have had this policy for some time. It is illegal in some countries
- Do you remember Meryl Streep?
- It is good to be prepared.

## Carbaryl

- Why is it so popular?
- Safe to use over a wide range of developmental stages and fruit sizes.
- It rarely over-thins
- It remains a thinner of choice and it has been so for many years.
- Risk is low.
- There are alternatives

### Amid-Thin

- An old and underused thinner
- Used a bloom and petalfall but not at the 10 to 15 mm stage (Pygmy fruit)
- Weak thinner
- Must be combined with another thinner to consistently thin apples to the level we are looking for.

## NAA

- NAA has real potential when used in a carbaryl replacement plan.
- It should be applied twice
- Double the rate used at petal fall that you would normally used at the 10 mm stage
- Apply at petal fall and again at 7-14 mm stages if needed.
- Sensitive to temperature.

## MaxCel

- When used by itself this is considered a weak thinner.
- It does not thin well at either bloom or petal fall.
- Best results are when MaxCel is combined with carbaryl.
- When used in a carbarly replacement program, it is helpful to increase fruit size.

## Suggestion for Trial

1. Apply NAA at petal fall and again at the 10 mm stage. Do not be timid when making the application at petal fall. Amount used depends on the cultivar being treated.

2. Apply Amid-Thin at petal fall at 50 ppm (8 oz/100 gal., nothing lower.

Apply NAA at petal fall at 12 to 15 ppm or at the highest rate suggested for the cultivar at the 10 mm stage. Evaluation of a thinner combination lacking carbaryl with a commonly used thinner combination. Macoun apples. 2016.

Treatment	Concn.	Timing	Fruit/cm LCSA
Control			10.1 a
Amid-Thin	50 ppm	Petal fall	6.3 b
NAA	15 ppm	Petal fall	
MaxCel	100 ppm	10 mm	6.9 b
Carbaryl	1 pt/100 gal	10 mm	

### New Chemical Thinner- Brevis

- Brevis is registered for thinning apples in Europe
- Brevis (metamitron) has been evaluated as a chemical thinner in the US for the past 6 years. Results so far look very good.
- Its probable mode of action is inhibiting photosynthesis, thus it is uniquely suited to act as a thinner, especially during periods of CHO deficit, especially at the 7-14 mm stage.

Influence of metamitron (Brevis) applied to Summerland McIntosh at the TRV rate of 100 gal/ acre at the 10 mm fruit size stage on final fruit set. 2016.

Treatment	Rate	Fruit /cm LCSA
Control Brevis MaxCel + carbaryl	 2 lb/acre 64 oz + 1 qt/100	8.1 ab 6.3 b 8.4 a

## High Rates of ReTain

- In this region many of the most popular and most profitable apples ripen over a short time span.
- Warm cloudy weather may happen during the harvest season.
- These situations may result in the harvest of poor or lesser quality fruit at harvest.
- Can we delay harvest of some fruit by delaying maturity of apples with ReTain?

## Similar Times of Ripening

- Gala, Honeycrisp, McIntosh, Cortland, Macoun
- Any of the above can ripen when weather conditions are unfavorable.
  - Poor color
  - Immature or over ripe
- It may be desirable to delay ripening and harvest fruit under more favorable environmental conditions.
- This will also aid in preharvest drop control.

## Background

- Cortland apples ripen at the end of September, after McIntosh.
- Because of the drop problem with McIntosh, it is harvested first, thus often leaving Cortland fruit on the tree too long resulting in losing condition.
- The objective of this work was to improve fruit quality of Cortland.

#### Observation

- Cortland served as pollinizers in a block of McIntosh I was doing drop control work in.
- Over the years I have increased the rate of ReTain applied and the pollinizers were sprayed with higher the higher rates as wellrecently 2 pouches per acre per year.
- The quality of Cortland receiving these higher rates was exceptional and they were soon recognized as undoubtedly the best in our orchard.

#### Experiment

- In a block of mature Cortland apples trees were selected and blocked to assure uniformity within a replication.
- Four weeks before normal harvest and again 2 weeks later trees were sprayed with a full rate of ReTain (333g/acre). Untreated control trees were not sprayed.

Influence of 2X applications ReTain (333g/acre) on fruit quality of Cortland. Harvest 2, October 6.

Treatment and	Flesh firm	Red color	Starch rating
Time	(lb)	(%)	(1-8)
ReTain 0 ReTain 2x	11.2 b 14 2 a	84 a 73 b	5.7 a 4 0 b
	17.2 U	100	1.0 0

Influence of ReTain and 1-MCP on flesh firmness of Cortland after regular storage.			
Treatment	Flesh firmness (lb)		
	December 1	January 5	
Control	9.5 c	8.9 c	
ReTain	9.8 c	8.8 C	
1-MCP	10.1 b	9.7 b	
ReTain + 1-MCP	12.1 a	11.2 a	
Significance			
ReTain	**	***	
1-MCP	**	***	
ReTain X 1-MCP	**	***	

## Fruit quality form used to assess Cortland following storage

Figure 1. Quality Evaluation Form

R & T

Visual and sensory evaluation:

Skin	tough		tender	
Crispness	low		high	
Acidity	bland		tart	
Flavor	dislike		like	
Desirable	dislike		like	

Influence of ReTain and 1-MCP on fruit sensory evaluation of Cortland apples after 10 weeks in air storage.

Treatment	Sensory evaluation (1-10)		
	Crisp	Desirable	Flavor
Control	1.5 c	2.2 c	2.4 c
ReTain (R)	2.5 b	2.8 c	2.7 c
1-MCP	3.3 b	4.1 b	4.1 b
R + MCP	7.0 a	6.6 a	6.7 a
Significance			
ReTain (R)	***	***	***
1-MCP	***	***	***
R + MCP	**	*	**

#### Conclusions

- 2X application of ReTain substantially delayed maturity allowing fruit to ripen under more favorable environmental conditions.
- The small reduction in red color was statistically significant but not apparent nor commercially important.
- The quality of fruit receiving ReTain followed by 1-MCP was much higher than untreated fruit or those that received just one of the growth regulators.

## Gala and Honeycrisp

- Due to a reduced crop full evaluation of ReTain on these cultivars was not possible.
- Blocks of trees of Gala and Honeycrisp received 2X applications of ReTain. Harvest of very high quality fruit was done during the second week of October.
- Treated Honeycrisp were the highest quality harvested from the farm showing minimal preharvest drop.

- While no major breakthroughs have been made lately in the use of plant growth regulators in the orchard, we have tweaked our current uses to better serve the fruit industry.
- You can expect continued improvement as we continue to try newer or different approaches to using these tools.