



Thinning with MaxCel & Growth Control with Apogee

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Outline

MaxCel ®

- Differences with Accel ®
- Suggested use patterns
- Research Results

Growth Control with Apogee

- Apogee and how it works
- Expected results and benefits
- What does it cost?
- Factors to help decide whether to use Apogee

PGR

Responses

Auxin

Cell enlargement, Apical dominance, Rooting promotion, Fruit thinning, Fruit drop prevention

Gibberrellin

Firmness, cell enlargement, seedlessness, cause fruit set, flower induction, flower reduction (thinning), break dormancy, Increase seed germination, delay of senescence, modify sex expression, skin finish

Cytokinin

Cell division, Counteract apical dominance, Branching agent, Delay of senescence, Cause fruit abscission

Ethylene

Ripening agent, Causes leaf & fruit abscission, Promotes radical growth

Abscisic Acid

Promotes leaf & fruit abscission, Regulates dormancy in perennials, Controls water status through stomata opening control



Dr. Silvan Witwer

PGR usage in Apple Production

Function	PGR
Fruit Shape	GA ₄₊₇ (Promalin)
Russet	GA ₄₊₇ (Promalin)
Thinning	MaxCel, Carbaryl, NAA, NAD
Return Bloom - Non Bearing	Ethephon (Ethrel)
Return Bloom - Bearing Trees	Ethrel (E) or NAA (N)
Vegetative Growth Control	Prohexidione-CA (Apogee), Ethrel
Delay fruit maturity	AVG (ReTain), MCP
Reduce Preharvest Drop	AVG (ReTain). NAA, 1-MCP
Reduce Preharvest Drop	AVG (ReTain) + Pre-load NAA
Enhance fruit ripening/loosening	Ethephon (Ethrel)
Promote uniform red colour	Ethephon (Ethrel)
Enhance storage	1-MCP



Features of MaxCel

- 🍏 Active ingredient in MaxCel® is 6-benzyadenine (6-BA).
- 🍏 a cytokinin - promotes cell division.
- 🍏 Does not contains gibberellic acid (GA_{4+7})

	MaxCel®	Accel®
Percent active ingredient: 6-BA, GA₄₊₇	6-BA: 1.9 % (w/w) ----	6-BA:1.8 % (w/w) GA ₄₊₇ : 0.18 % (w/w)
Amount of 6-BA per L of product	19.9 g/L	19.0 g/L
Cost of product (per liter)	\$112 – 126 per Litre ^{[1],[2]}	\$112 per Litre ^[1]
Container size	5 L bottle	1 L bottle
Cost per gram of 6-BA	\$5.63- \$6.33 ^{[1],[2]}	\$5.89 ^[1]
Maximum number of sprays per season	2 for thinning, 4 for fruit size enhancement	2
Amount of product/hectare per season as stated on label	0.5 to 22.5 Liters (10- 446 grams 6-BA)	1.5 to 4 Liters (28.5 - 76 grams)
Range in application rates stated on product label	10-200 mg/L (ppm)	28-75 mg/L (ppm) (based on above at 1000 L/ha)
Pre-harvest interval	86 days	28 days
Compatibility with Sevin and other pesticides	Labels states “compatibility with Sevin and other pesticides”	Label indicates “No information is available on spray tank-mix compatibility with other control products”

MaxCel® - What's New

- 🍎 **Rates and number of sprays:** MaxCel® is limited to two sprays if used for thinning, and four sprays if used for fruit size enhancement.
- 🍎 The total amount of product applied per season cannot exceed 446 gram 6-BA/ha (22.5 Litres/ha), which is nearly six times more 6-BA than was permitted under the Accel® label.

MaxCel® - What's New

- 🍏 **Using Maxcel® to size fruit:** The product label states that Maxcel® can be used to enhance fruit with mild or no thinning.
- 🍏 Two to four applications, beginning at petal fall and repeating every 3-10 days, are required
- 🍏 Rates of 10-50 mg/L 6-BA (ppm) are suggested

MaxCel® - What's New

- 🍏 **Using Maxcel® to Thin:** The product label states that MaxCel® can be used at rates of 75 to 200 mg/L 6-BA.
- 🍏 Our experience has shown that 6-BA at concentrations ranging from 50-75 mg/L 6-BA, is a mild thinner. However, if used alone at rates up to 200 mg/L or combined with Carbaryl for harder to thin cultivars, the spray becomes much more aggressive.

Suggested rates of MaxCel® to use with or without Sevin®.

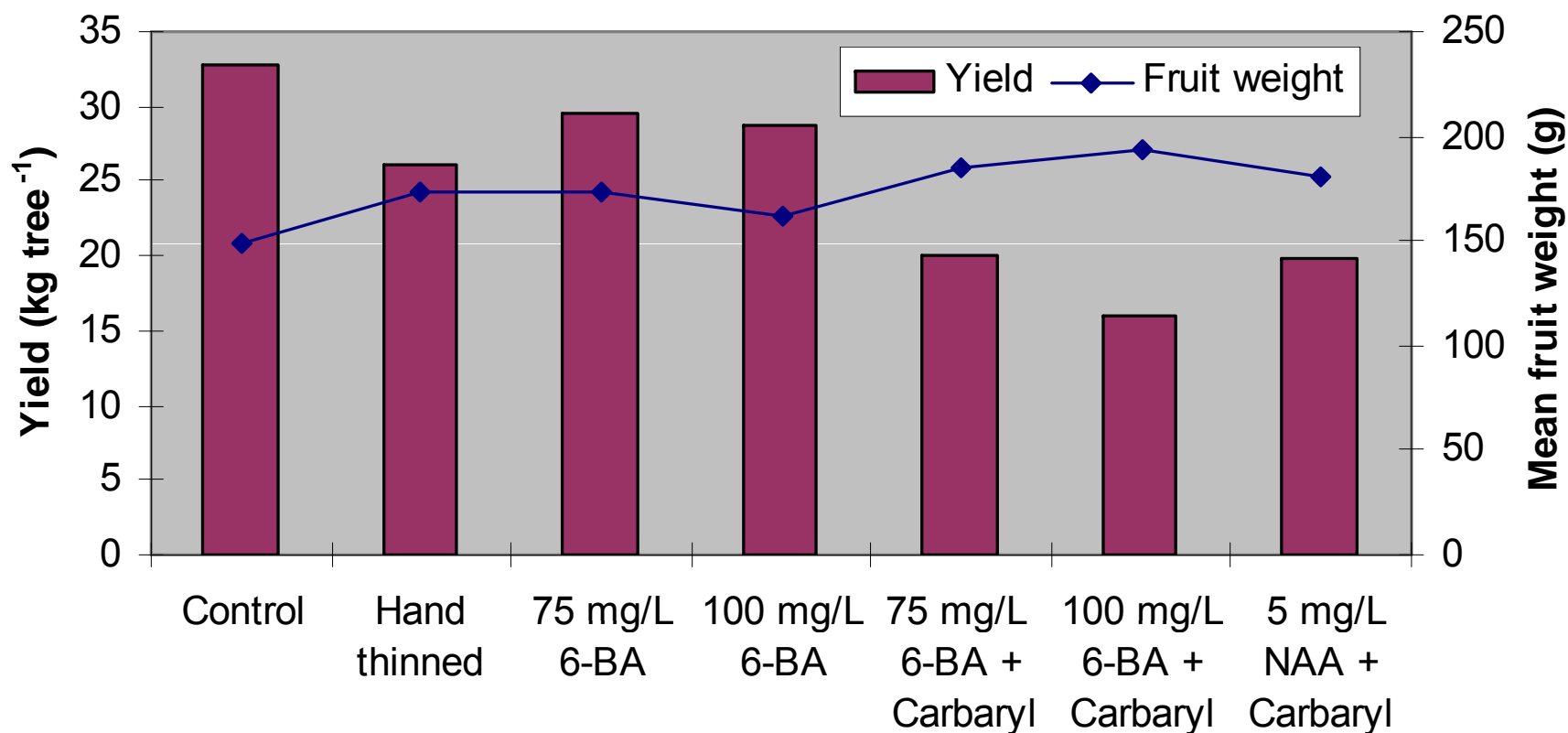
Desired Response ^[1]	Concentration of 6-BA (ppm) ^[2]	Concentration rate of Carbaryl (ppm) ^[2]	Number of Applications	Amount of MaxCel® per 1000 Litres water. Apply to 1 hectare	Amount of Sevin® XLR Plus per 1000 Litres water. Apply to 1 hectare	Approximate cost of treatment per single application (\$/ha) ^[3]
Enhance size only ^{[4],[5]}	10 to 50	-	2 to 4	0.5-2.5 L	-	\$56 - \$280
Mild thinning and sizing	50-75	-	1 to 2	2.5-3.75 L	-	\$280 - \$420
Moderate thinning and sizing	75-100	-	1 to 2	3.75 - 5.0 L	-	\$420 - \$560
	50-75	500	1 to 2	2.5-3.75 L	1 Litre	\$296 - \$436
Aggressive thinning and sizing	100-150	-	1 to 2	5.0 - 7.5 L	-	\$560 - \$840
	75-100	500 - 1000	1 to 2	3.75 - 5.0 L	1 - 2 Litres	\$436 - \$593
Very Aggressive thinning and sizing	150 - 200	-	1 to 2	7.5 - 10 L	-	\$840 - \$1,120
	100 - 125	1000	1 to 2	3.75 - 5.0 L	2 Litres	\$453 - \$593

Effect of MaxCel and Carbaryl on yield, thinning and fruit size of 5-yr-old 'Royal Gala'/Bud.9 apple trees in 2008.

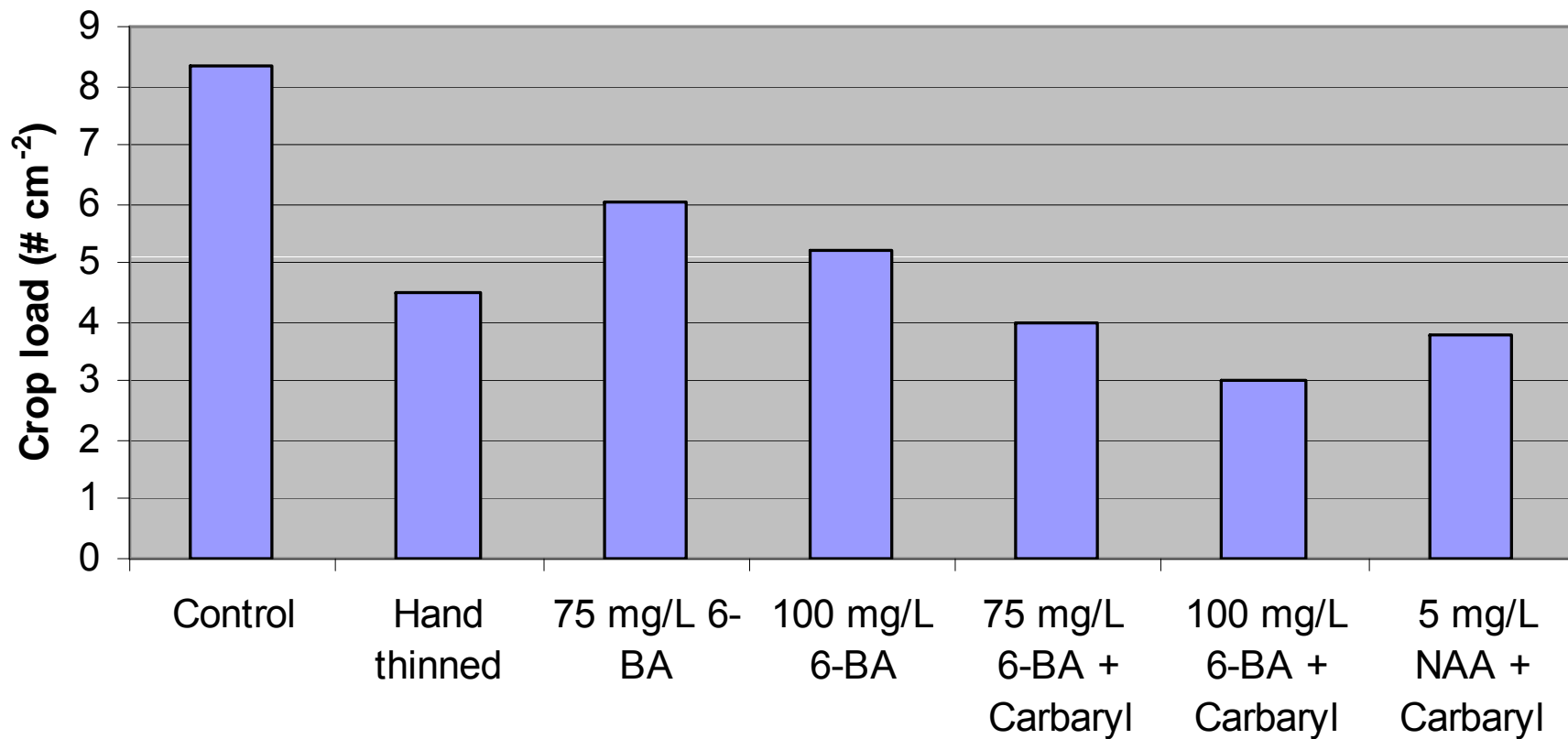
Treatment	Rate (mg/L)	Yield (kg.tree ⁻¹)	Number of fruitlets thinned	Total number fruit per tree	Mean fruit weight (g)	Crop density (#.cm ⁻²)
1. Hand thinned control		17.2	89	99	173	7.5
2. Maxcel	20 x4	15.8	79	90	177	6.3
3. Maxcel	40 x4	17.1	84	99	173	7.2
4. Maxcel + Carbaryl	80,750	12.0	43	70	173	5.2
5. Treatment 2+4		14.0	48	82	172	6.1
6. Treatment 3+4		14.2	42	78	182	5.1
significance ^z		ns	***	ns	ns	ns
LSD (P=0.05)		4.12	27.80	23.85	9.41	1.82
P value		0.1087	0.0009	0.0860	0.2466	0.0515

^z ns, ***, **, *, indicates non significance and statistical significance at P=0.001, P=0.01, and P=0.05, respectively

Effect of 6-BA and Carbaryl on Empire



Effect of 6-BA and Carbaryl on Empire



MaxCel® - Summary

- 🍏 MaxCel has worked well on Empire, McIntosh, Idared, and Gala and many other varieties.
- 🍏 MaxCel® thins as well as can increase fruit size
- 🍏 The thinning response to 6-BA is concentration dependant
- 🍏 MaxCel® at 100 to 150 ppm 6-BA will provide a stronger thinning response than what might be expected from Accel at an equivalent rate

MaxCel® - Summary

- 🍏 The MaxCel® label will permit a range of rate options from mild through aggressive thinning
- 🍏 If mild thinning is desired, similar to the results obtained with Accel®, then 75 ppm MaxCel® is a good starting point.
- 🍏 For moderate thinning with easy to moderately difficult cultivars, 75-100 ppm is acceptable, while 100-150 ppm might be used for more difficult to thin cultivars.

MaxCel® - Summary

- 🍏 Apply for thinning between 5 and 15 mm fruit size.
- 🍏 Apply dilute (do not concentrate more than 2X)
- 🍏 Uniform and thorough coverage is essential.
- 🍏 Concentrations below 50 ppm 6-BA are ineffective for thinning and single applications of at least 50 ppm are necessary for improving fruit size.
- 🍏 Do not apply MaxCel® in combination with NAA or NAD (either tank mix or separate sprays) during the same growing season to Delicious or to Fuji, as this combination may result in the formation of miniature fruit.

Overview of Presentation

- 🍏 What is Apogee and how it works
- 🍏 What are the benefits and expected results?
- 🍏 What does it cost?
- 🍏 Factors to help decide whether to use it



Fruiting is a natural form of growth control

Table 1. Effect of Fruit on Growth of Vegetative Components of Apple Trees Compared to Growth of Defruited Trees.

Tree component	Percent reduction in annual new growth of component brought about by fruiting
Leaves	– 30
New shoots	– 35
Structural wood (branch and trunk thickening)	– 48
Roots	– 76

Source: Maggs, 1963. J. Hort. Sci. 38:119–128

Pruning is a invigorating process

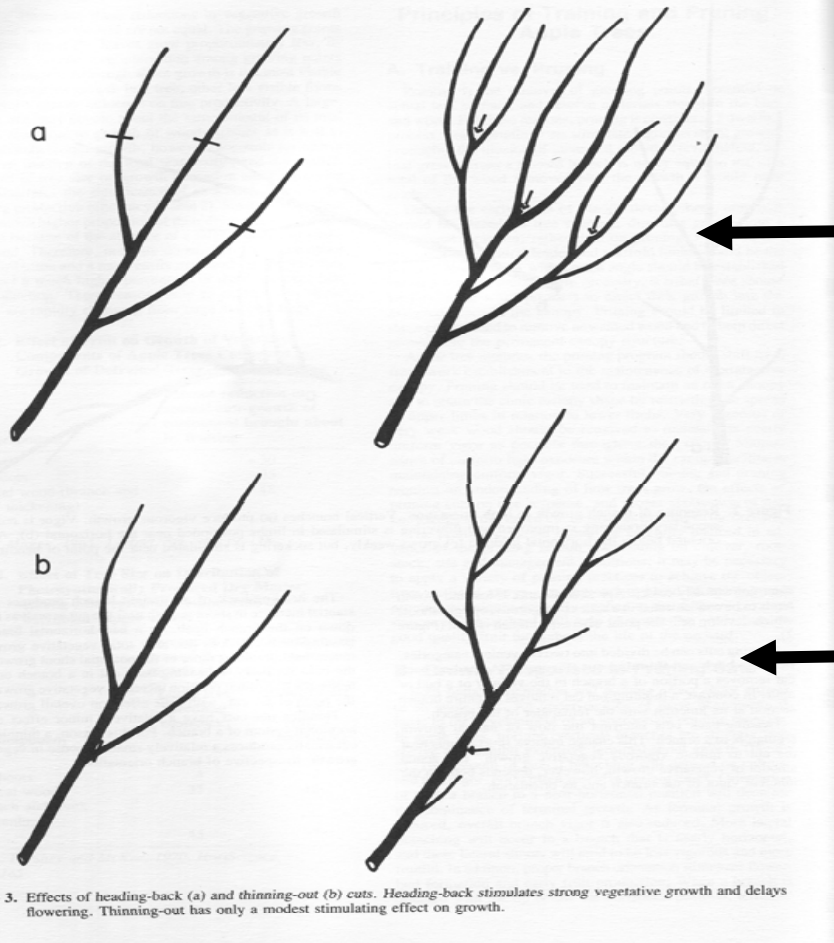


Figure 3. Effects of heading-back (a) and thinning-out (b) cuts. Heading-back stimulates strong vegetative growth and delays flowering. Thinning-out has only a modest stimulating effect on growth.

Pruning

Apogee



Our early experiences (1999) with Empire and Delicious

Apogee sprayed 4 x 63 ppm on...

- Provided limited extension shoot growth control
 - 14% ↓ shoot growth of Empire ($P=0.01$)
 - 15% ↓ shoot growth of Red Delicious ($P=0.05$)
- Reduced the # of seeds per fruit
 - Empire 46% ↓ ($P=0.05$)
 - Red Delicious 21% ↓ (ns)
- Increased return bloom
 - Empire 13% ↑ (ns)
 - Red Delicious 7% ↑ ($P=0.01$)

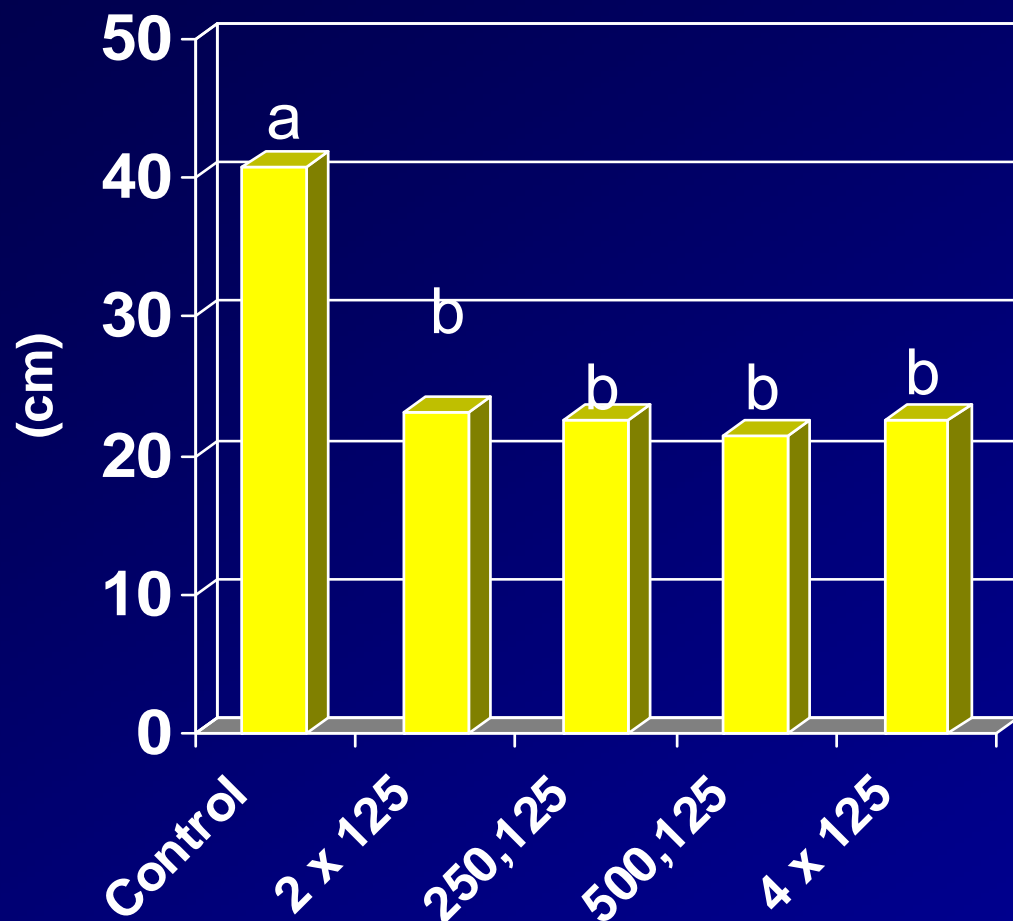


Our early experiences (1999) with Empire and Delicious

Apogee sprayed 4 x 63 ppm did not affect...

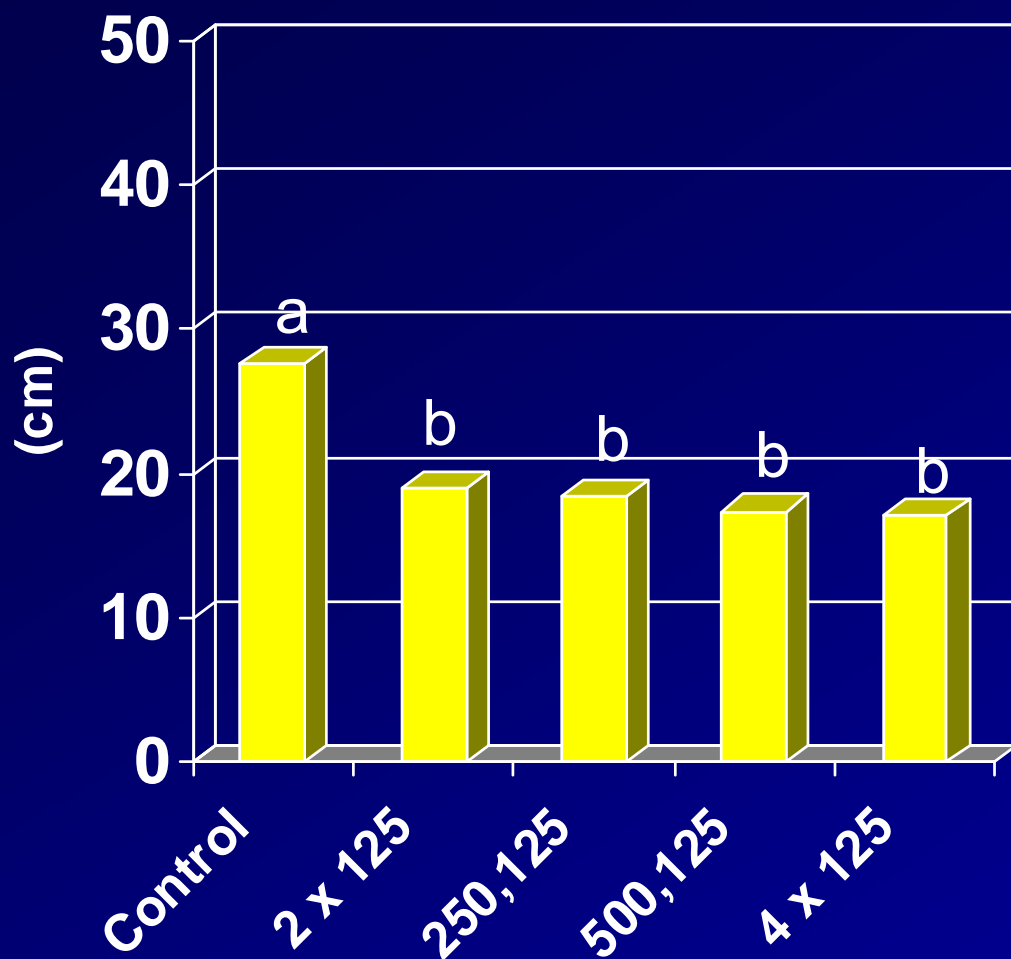
- 🍏 Yield, crop Load
- 🍏 Fruit weight
- 🍏 Fruit quality (firmness, %BRIX, colour, maturity, russet)
- 🍏 Fruit size distribution
- 🍏 Leaf and fruit mineral concentrations (N,P,K,Ca,Mg,B)

McIntosh Shoot Growth - 2000



- ◆ Apogee reduced shoot growth by approximately 40%
- ◆ 2 applications of 125 ppm at 14 d intervals were equally effective as other rates with higher concentrations or more frequent application

Northern Spy Shoot Growth - 2000



- ◆ Apogee reduced shoot growth by approximately 35%
- ◆ 2 applications of 125 ppm at 14 d intervals were equally effective as other rates

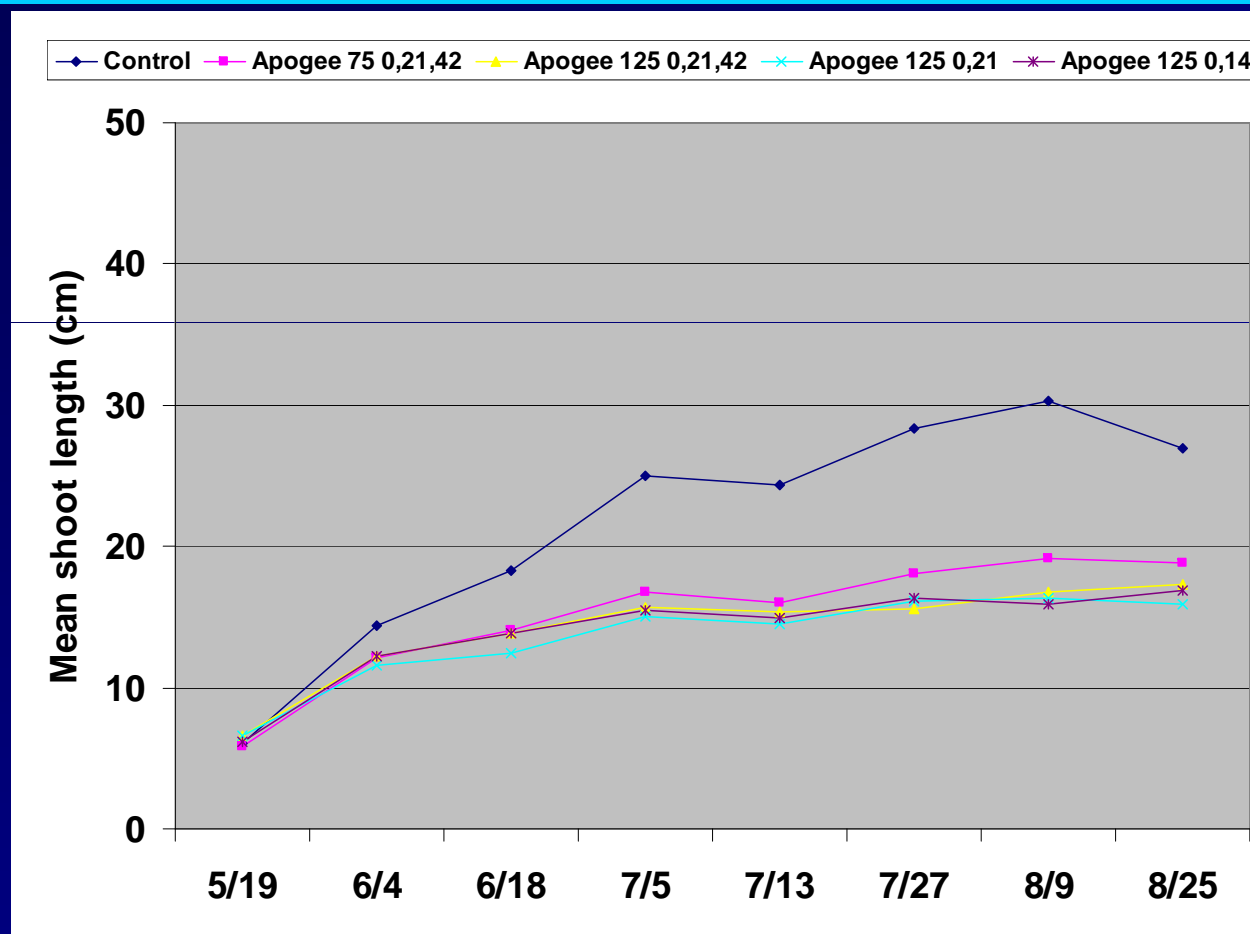
2000-2004 Studies

General Conclusions

- 🍎 Cultivars respond similarly in terms the % growth reduction
- 🍎 2 applications generally sufficient in Ontario
- 🍎 Apogee reduces secondary fireblight
- 🍎 Potential for increased return bloom
- 🍎 Reduced need for dormant and/or summer pruning
- 🍎 Labour savings
- 🍎 Improved light (spray) penetration



Effect of Apogee on Shoot Length- Gingergold

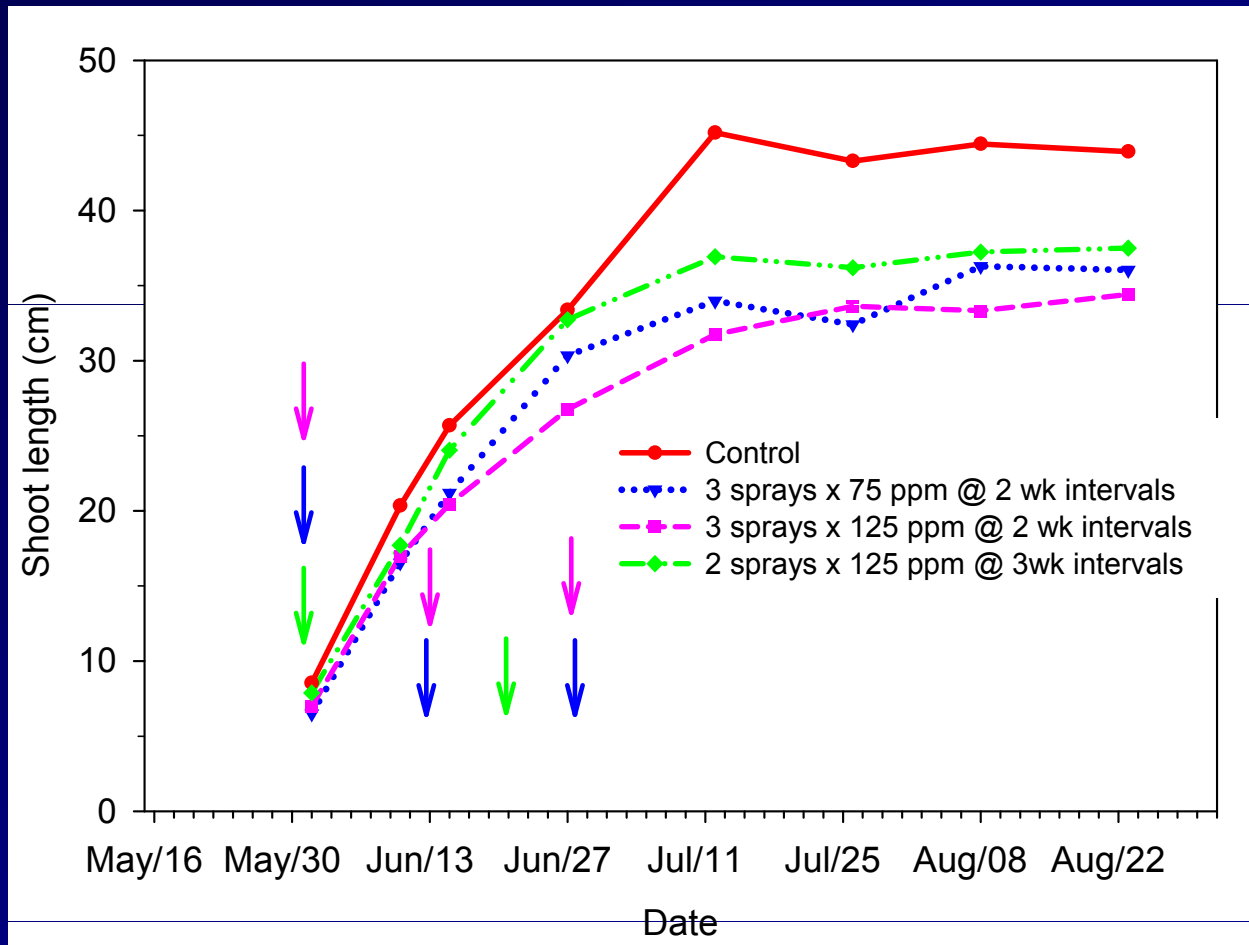


Results in 2005

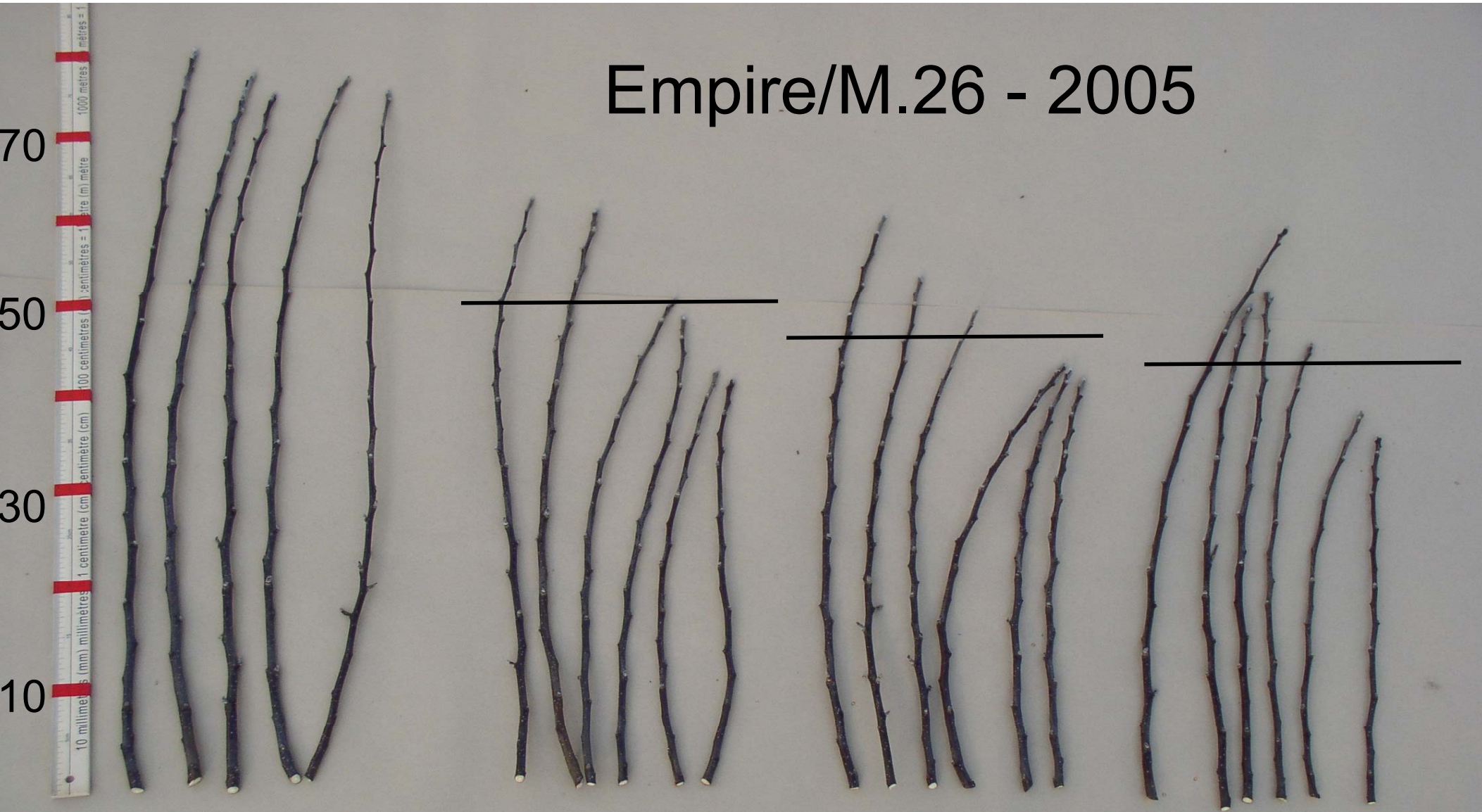
Applied to Empire and Gala



Average Shoot Growth of Empire - 2005



Empire/M.26 - 2005



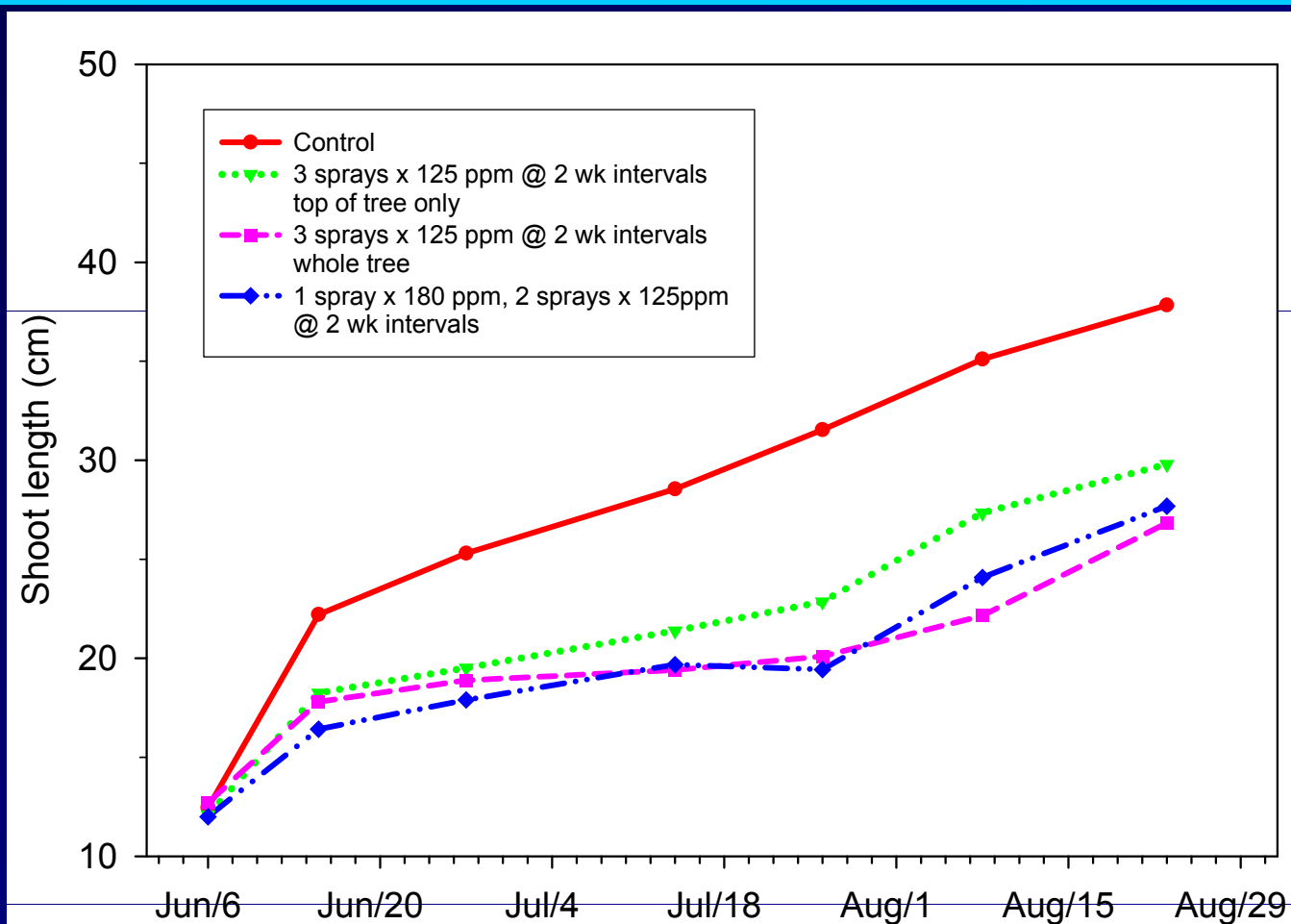
Untreated

3 sprays Apogee, 75 mg/L @
2wk intervals

3 sprays Apogee, 125 mg/L
@ 2 wk intervals

2 sprays Apogee, 125 mg/L
@ 3 wk intervals

Average Shoot Growth of Gala - 2005



GALA/M.9 - 2005

70

50

30

10



Untreated

3 sprays Apogee @ 125 mg/L

1 spray Apogee @ 180 mg/L
+ 2 sprays Apogee @ 125 mg/L

Table 1. Suggested Apogee rates and timings based on a tree-row volume dilute of 1000 L/ha (this chart is to be used in conjunction with the product label)

Level	Tree vigour ^[1]	1st Spray	2nd Spray	3rd Spray	4th Spray	Season total (g/ha) ^[2]	Product cost per season		
							(\$/ha) ^[3]	(\$/acre) ^[3]	
	Typical Date ^[4] →	25-May	8-Jun	22-Jun	6-Jul				
	Stage →	Petal Fall	Fruit set	June Drop	↓ growth				
		<u>(grams Apogee/ha based on 1000 L/ha TRV Dilute)^[5]</u>							
1	Low - 1 spray	450				450	\$ 124	\$ 50	
2	Low - 2 sprays	270	270	-	-	540	\$ 149	\$ 60	
3	Medium - 2 sprays [†]	450	450	-	-	900	\$ 248	\$ 100	
4	Medium/High - 3 Sprays	450	450	270	-	1170	\$ 322	\$ 130	
5	High - 3 sprays	450	450	450	-	1350	\$ 371	\$ 150	
6	High - 4 sprays	450	450	450	270	1620	\$ 446	\$ 180	

[†] - suggested base rate. Move to next higher or lower level based on factors listed below.

Orchard and Environmental Factors to Adjust Apogee Rates and Number of Sprays

- Heavy dormant pruning increase rate by 10-20 % per hectare per spray
- Longer growing season add 3rd or 4th spray
- Low crop load move Apogee Program to next higher level (ie, tree size)
- Questionable coverage move Apogee Program to next higher level (ie, tree size)
- Fire blight supression move Apogee Program to next higher level (ie, tree size)

What does it cost?

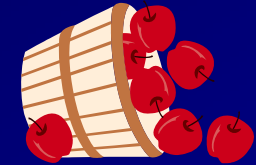
- 🍎 The 2008 MSRP for Apogee® in Canada is \$275/kg
- 🍎 Two applications at the 'standard' rate for 1000 L/ha (TRV dilute) trees will cost \$ 248/ha or \$100/acre (excluding AMS or Surfactant)

Has Wide Utility for Various Orchard Systems

- 🍎 Apogee® is also suitable for central leader, intensive orchard systems.
- 🍎 For orchards in the establishment phase:
 - 🍎 Use lower rates
 - 🍎 Perhaps target the top of the canopy
 - 🍎 Provide fireblight control



Key Points on Use



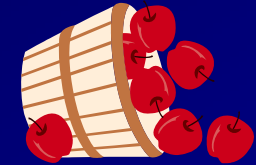
Precautions

- 🍏 Avoid the use of hard water
- 🍏 High rates can increase fruit set
- 🍏 Use a adjuvant and Ammonium Sulfate
- 🍏 Do not tank mix with calcium sprays
- 🍏 Can cause cracking on Empire and York (but not observed in Simcoe)

Apply

- 🍏 Early (petal fall) as extension shoot growth is beginning
- 🍏 2 x 125 ppm at 14 day intervals adequate

Decision Making Process



- 🍏 Known your dormant and summer pruning costs
- 🍏 Know your tree vigour and how much growth reduction is desired
- 🍏 Is fireblight suppression required?
- 🍏 Is poor fruit colour an issue?
- 🍏 Is spray penetration an issue?
- 🍏 Is increased return bloom desirable?

Future - Apogee...

- Use will expand to other tree fruits (cherries, pears)
- Carry-over effects from year to year need further documentation
- Large scale orchard block comparisons
- Recent literature reveals that Apogee stimulates the plant defense system (phytoalexins) against fireblight and other plant pathogens (Rademacher)
- Interaction with fruit Calcium and storage potential needs further investigation



Further Information

OMAF Pub 360 Fruit Production Recommendations
OMAF Crop Technology Specialists
Orchard Network Articles – Spring 2005
OMAFRA Fact sheet

FACTSHEET



ORDER NO. 06-045

MAY 2006

AGDEX 24/211

 Ontario Ministry of Agriculture,
Food and Rural Affairs

APOGEE® —

A NEW PLANT BIOREGULATOR FOR APPLES

J.A. Cline

INTRODUCTION

This Factsheet provides technical information on the use and benefits of prohexadione-calcium, a new growth-retardant compound for apples, produced commercially as Apogee®. This product was registered in Canada by BASF in the spring of 2005 (PCP #28042). Consult the product label for recommended use patterns and precautions, as well as the latest version of OMAFRA Publication 360, *Fruit Production Recommendations*, which may have more current information. The product label can be found online at the BASF Canada Inc. website (www.agsolutions.ca) or by searching the PMRA website (www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp).

Research in both Canada and the U.S. and grower use in the U.S. since 2001 have confirmed that Apogee® can provide several benefits when applied to apple trees. Apogee® use reduces terminal shoot growth (ranging from 20%–60%), thus reducing the time required to dormant prune and/or summer prune and, in some instances, can negate the need to summer prune (see Figure 1, right). As a result, fruit colour can be improved on red-coloured cultivars. Trees treated with Apogee® often have the same number of shoots as untreated trees, but shoots from treated trees can be thicker (greater in diameter) and have compressed internodes. In addition, Apogee® use can reduce the incidence and severity of fire blight on shoots (shoot blight). A high number of Michigan growers have reportedly integrated Apogee® into their program, in part, because of the high risk of secondary fire blight in their region on the cultivars grown (i.e., Royal Gala). Furthermore, growers have cited improved spray coverage and reduced disease pressure as benefits of Apogee®, primarily attributed to reduced growth and the reduction in canopy volume and density.

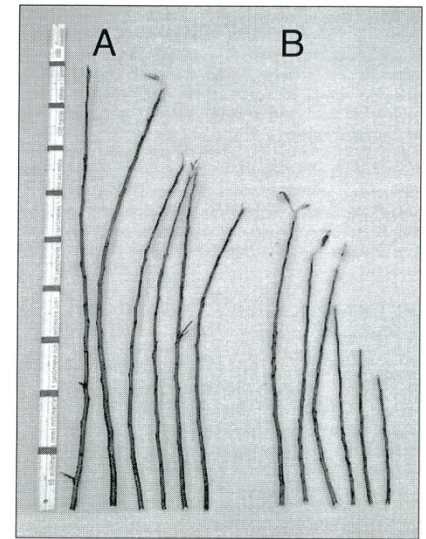


Figure 1. Six representative extension shoots taken from Royal Gala trees. Group A was untreated. Group B was treated with 3 sprays of Apogee® at 125 mg/L at 2-week intervals beginning at petal fall (right). (Metre stick marked at 10-cm intervals).

Recent evidence also indicates that trees sprayed with Apogee® develop phytoalexin-like properties. It appears that Apogee® induces changes in the spectrum and level of flavonoids within the plant, resulting in greater resistance to insects and disease.

Bringing the **Resources** of the **World** to Rural Ontario

 http://www.omafra.gov.on.ca/french/crops/hort/news/orchnews/2006/on_0406a4.htm

 <http://www.omafra.gov.on.ca/english/crops/facts/06-045.htm>

Engage – Spring 2009 PGR Meetings, Simcoe,

Fruit Production Recommendations

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Chapter 7: Apples

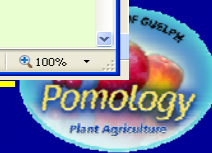
Chapter 10: Tender Fruit

Chapter 12: Pesticide Tables

<http://www.plant.uoguelph.ca/treefruit>



Engage – Spring 2009 PGR Meetings, Simcoe, Ontario



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