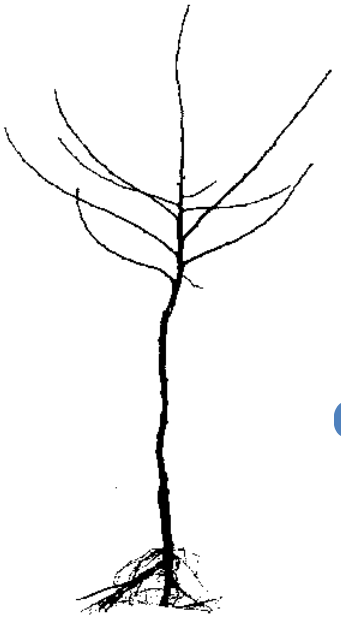
Use of PGRs to Induce Branching in the Nursery



Precision Crop Load Management and Plant Growth Regulator Use in Apple, Syracuse, March 26-27, 2019

Mario Miranda Sazo

Cornell Cooperative Extension, Lake Ontario Fruit Program

Outline

- Introduction
- Tiberon (CYC)
- CYC-apple research, label
- Maxcel work (2010/11/12)
- Macoun stunting
- Benefits of Maxcel and special considerations for high rates, drift issues
- Ambrosia (2012)
- Application Technology
- Conclusions
- Suggested Maxcel use for a nurseryman

Desired product

- Planting well-branched (feathered) apple trees

Challenge for US nurserymen

- Most deciduous fruit tree cultivars do not produce acceptable lateral branching in the nursery

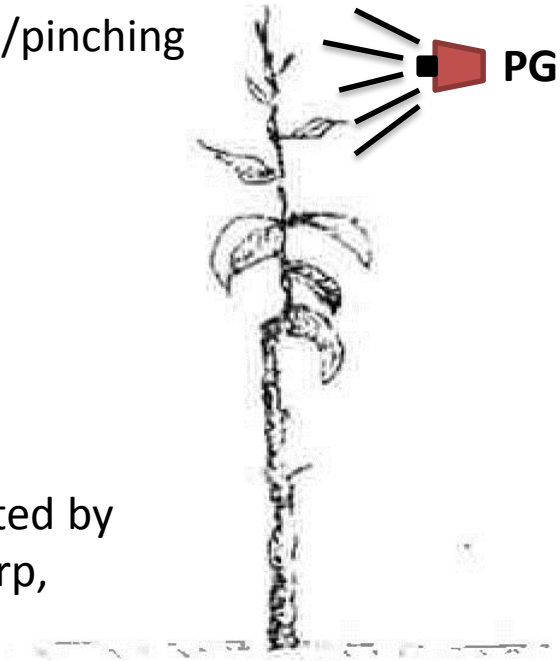
Apical dominance

- It must be **interrupted** so we can produce a well-branched, highly marketable plant

Leaf removal/pinching

PGRs

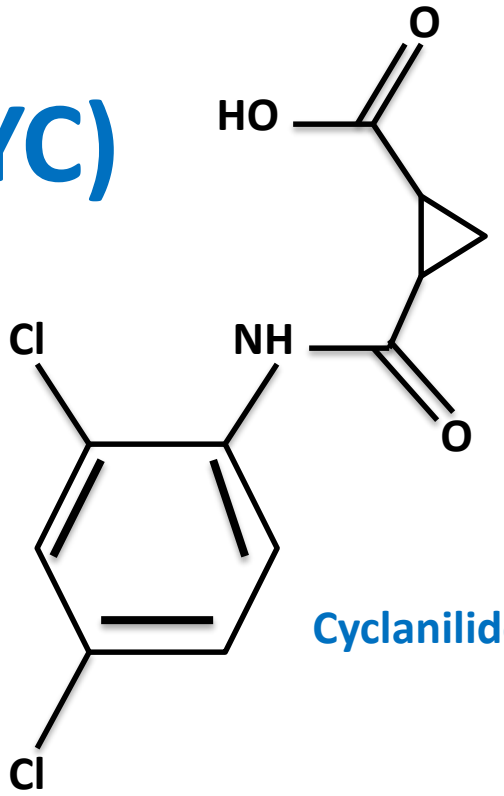
Promalin
MaxCel
Tiberon



First studies (1970's) conducted by S.J. Wertheim, Wilhelminadorp, Netherlands

Tiberon 2.8% SC (CYC)

- Bayer product
- CYC vs. Apogee
- Daminozide, paclobutrazol, uniconazole, chlormequat, ancymidol
- Registered in cotton (2005)



Cyclanilide (CYC)

CYC + MEPIQUAT CHLORIDE
STANCE™
used for vegetative growth control

CYC + ETHEPON
FINISH™
used to accelerate defoliation and boll opening

CYC (continued)

- CYC blocks apical dominance (apple[1], beans[2])
- Possible CYC mode of action is described with corn coleoptiles, zucchini hypocotyls, and tomato roots (2008[3])
- Registered on fruit trees for use in outdoor nurseries in 2009
- Introduced at the IFTA meeting (2010)

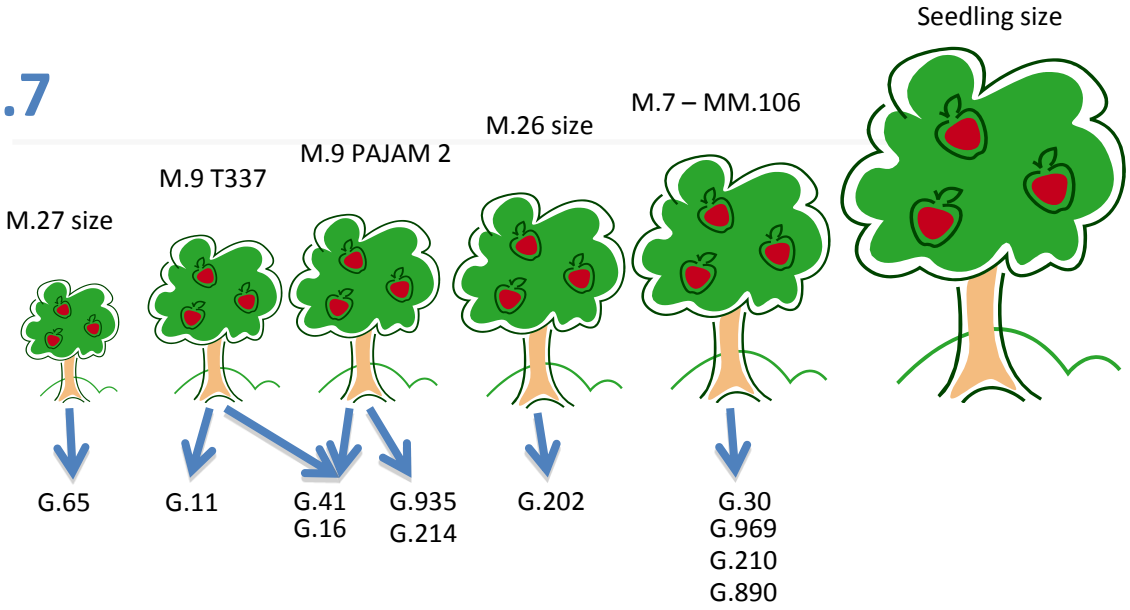
[1] Elfving, D.C. and D.B. Visser. 2005. Cyclanilide induces lateral branching in apple trees. HortScience 40(1):119-122.

[2] Pedersen et al., 2006. Effect of cyclanilide, ethepon, auxin transport inhibitors, and temperature on whole plant defoliation. Crop Science 46:1666-1672.

[3] Burton et al., 2008. Effect of cyclanilide on auxin activity. J. Plant Growth Regul. 27:342-352.

Previous CYC-apple research

- Cameo/Gala/**M.26, M.7**
- TAC114 Fuji/**M.26**
- Scarletspur Delicious/**B.118**
- Scarletspur Delicious/**M.7**



CYC-USE ON FRUIT TREES

Sweet cherry and Apple varieties: 1 to 2 applications of **50 to 100ppm**. If using a two spray regime, make the second application about 1 week later

Pear and Plum varieties: 1 application of **5 to 20ppm**. Typically 10 to 20ppm provides acceptable branching

Treatments to **nectarines** have not been effective

On-Farm Nursery School, March 2010

- NY growers (Motts) interested to grow their own nursery trees
- We wanted to help them to make sure they understood the potential pitfalls
- We also wanted to help the growers who did decide to grow their own trees to do the best job possible to end up with good profitable orchards
- We covered the many reasons not to embark on an on-farm nursery venture. We wanted to convince most growers that purchasing high quality nursery trees from a reputable nursery is the best and most profitable course for them.
- Today we have NY growers who mainly buy trees from commercial nurseries but also a few (10-12) who produce their own nursery trees for the Tall Spindle system.

Chemical branching study - 2010

Variety/height	Less → Difficult to branch → More
Sun Fuji (31”)	✖
Empire Royal (29”)	✖
Linda Mac (31”)	✖
Macoun (29”)	✖

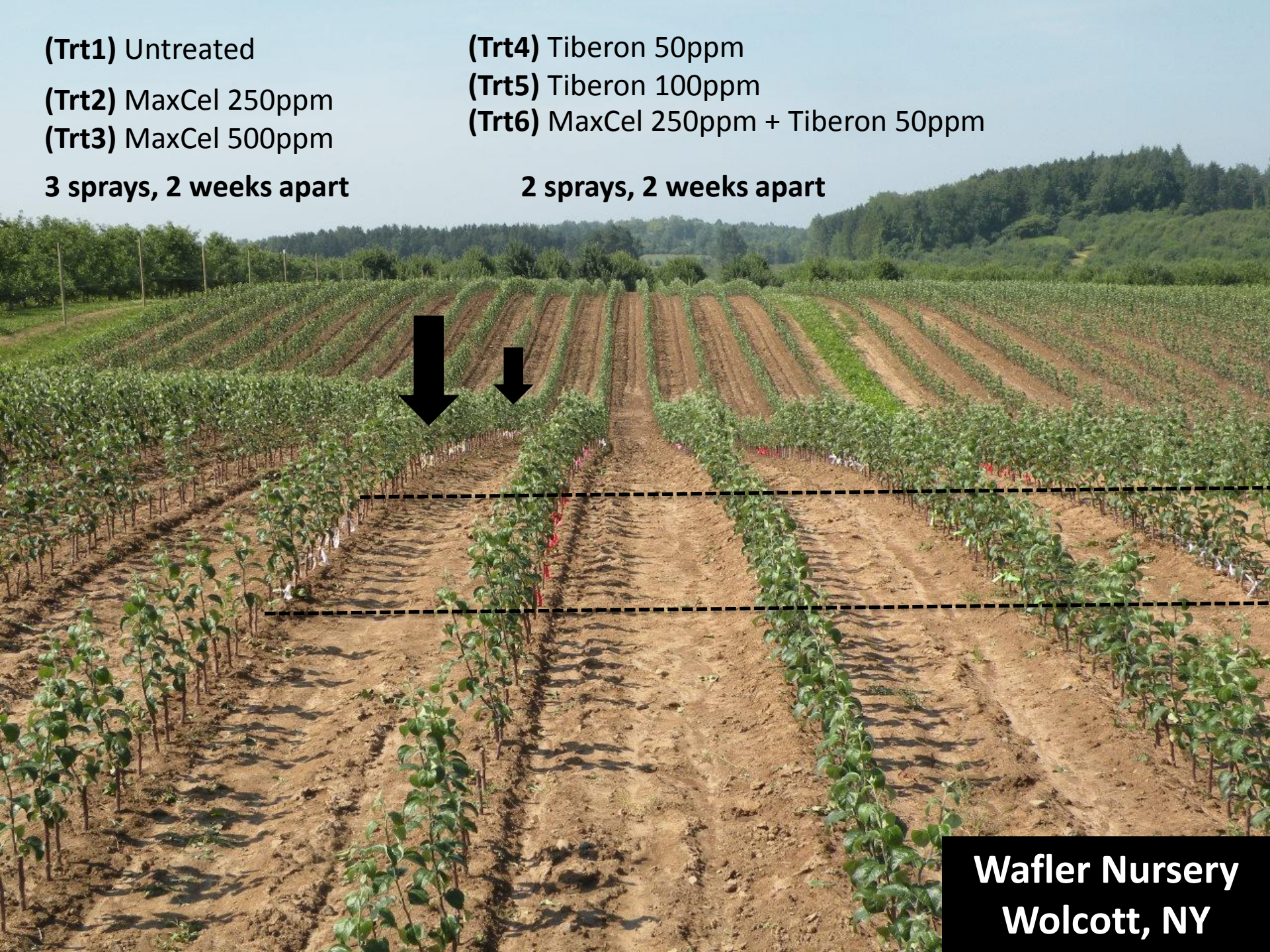
(Trt1) Untreated

(Trt2) MaxCel 250ppm
(Trt3) MaxCel 500ppm

3 sprays, 2 weeks apart

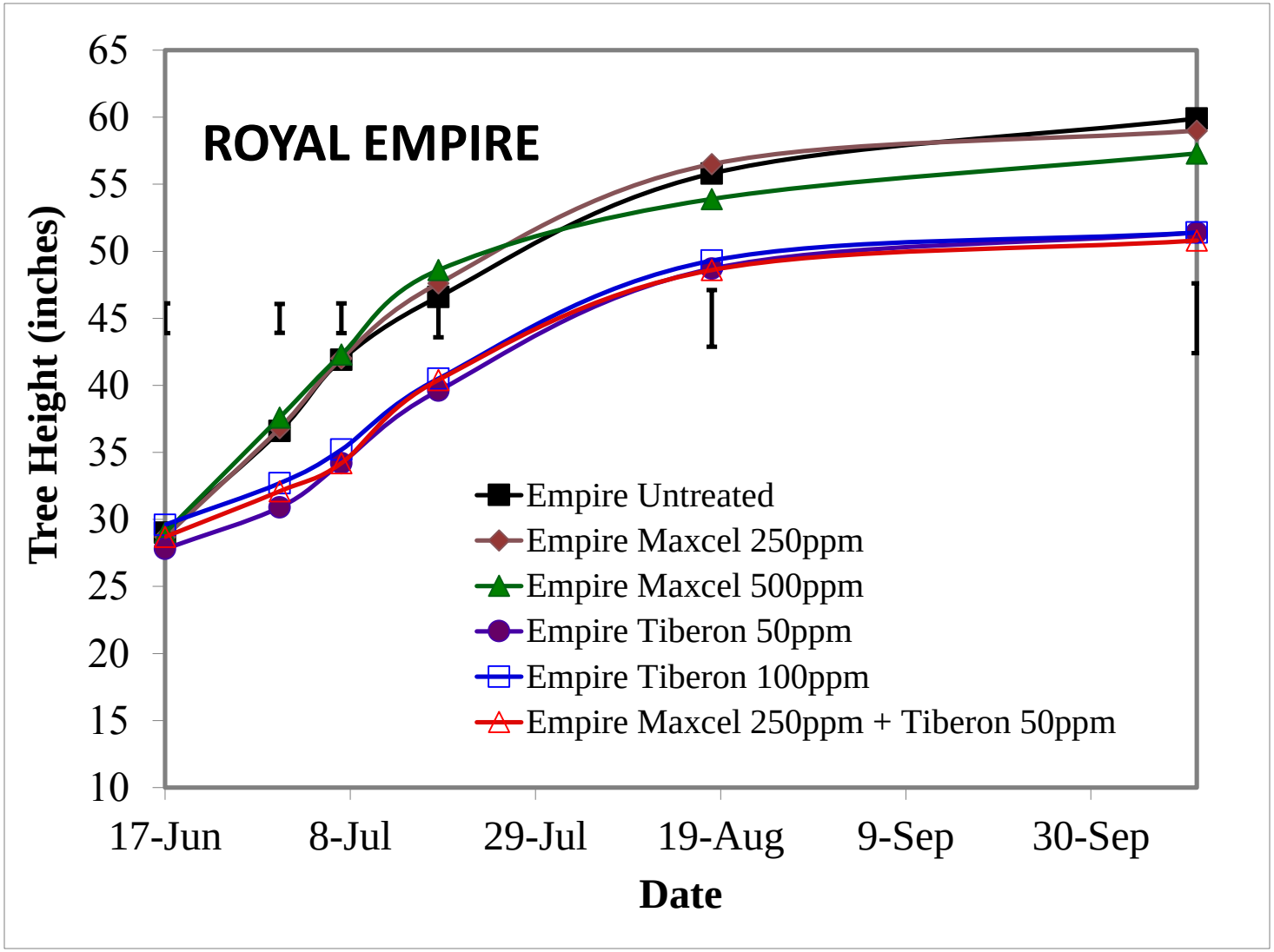
(Trt4) Tiberon 50ppm
(Trt5) Tiberon 100ppm
(Trt6) MaxCel 250ppm + Tiberon 50ppm

2 sprays, 2 weeks apart

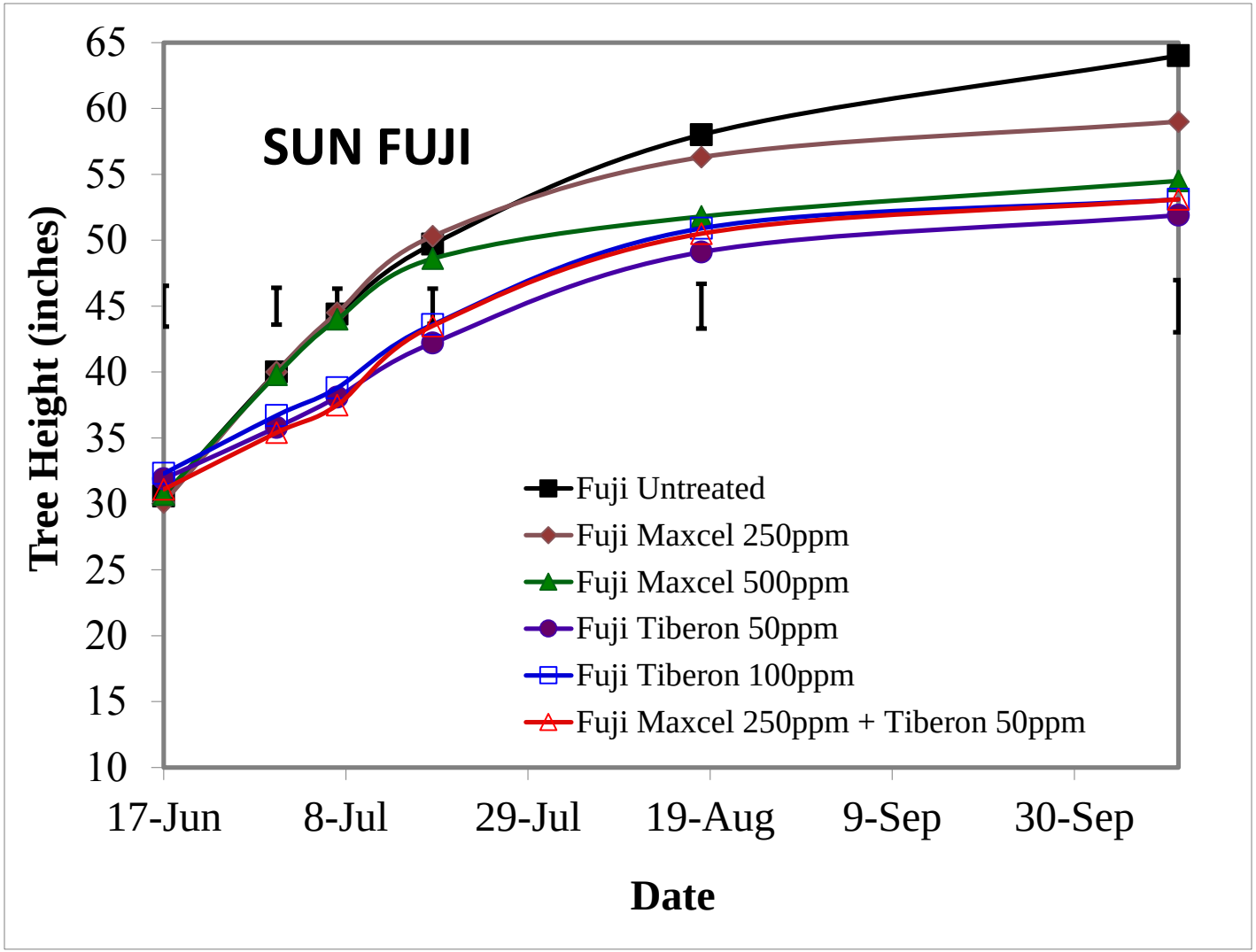


Wafler Nursery
Wolcott, NY

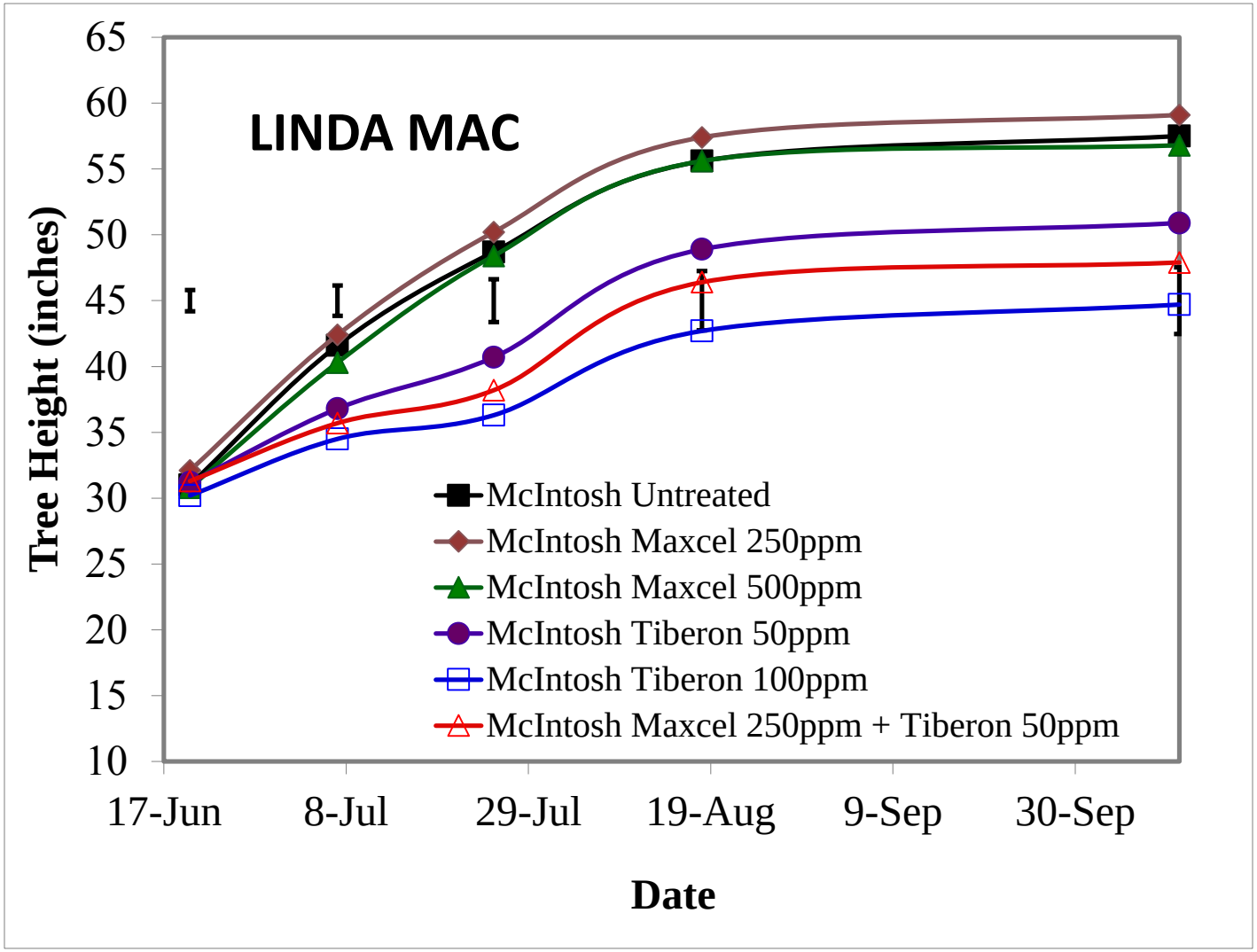
Effects of cyclanilide (CYC) and/or benzyl adenine (Maxcel) on seasonal central leader growth (inches) in 'Royal Empire'/B.9 apple trees in the nursery during 2010 growing season (Wolcott, NY)



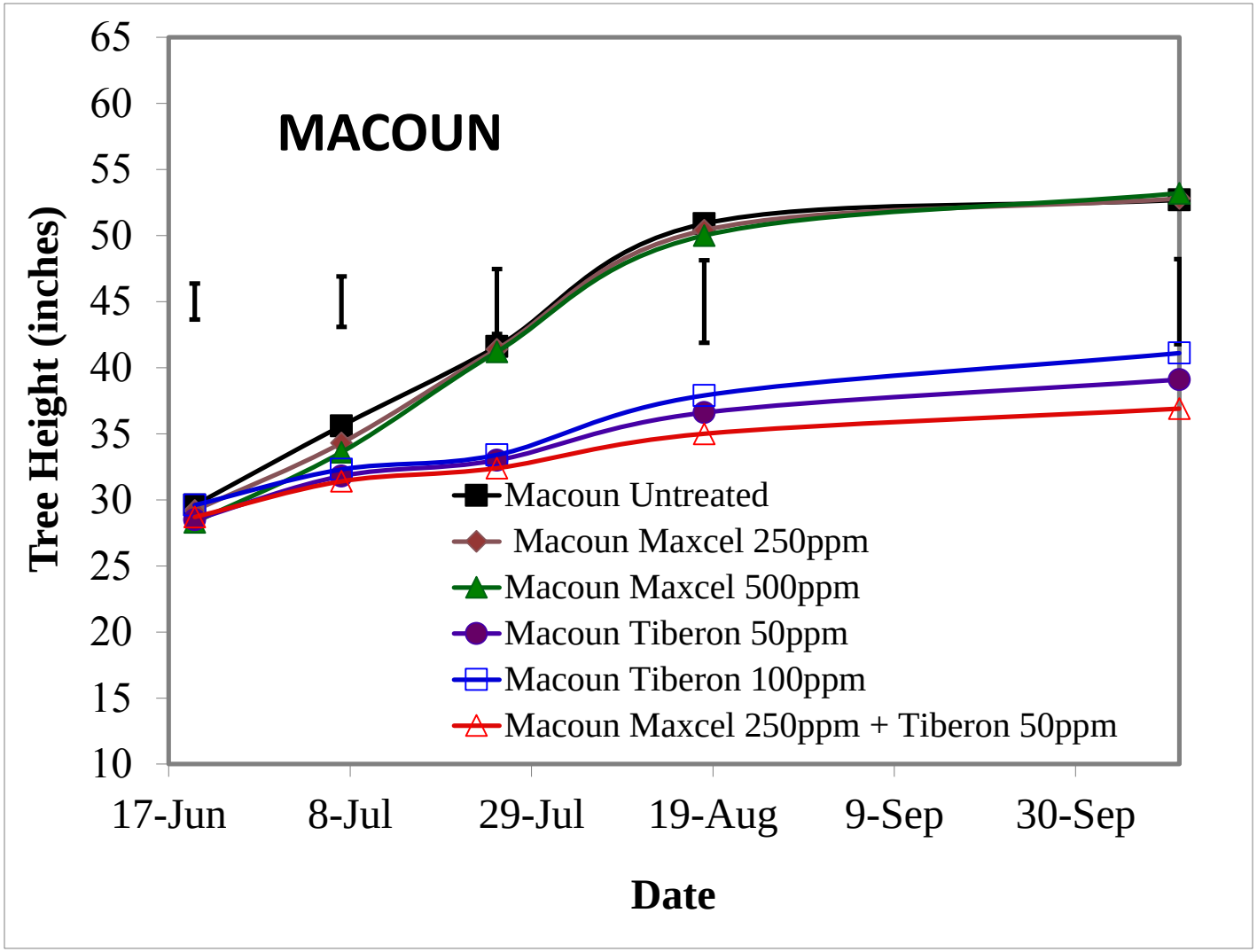
Effects of cyclanilide (CYC) and/or benzyl adenine (Maxcel) on seasonal central leader growth (inches) in 'Sun Fuji'/B.9 apple trees in the nursery during 2010 growing season (Wolcott, NY)



Effects of cyclanilide (CYC) and/or benzyl adenine (Maxcel) on seasonal central leader growth (inches) in 'Linda Mac' /B.9 apple trees in the nursery during 2010 growing season (Wolcott, NY)

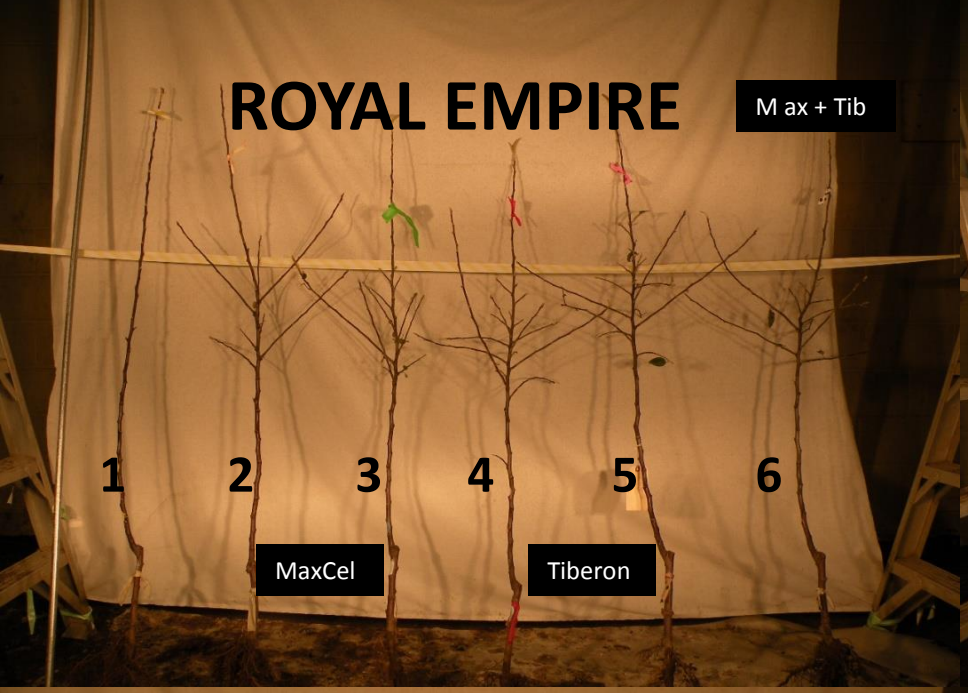


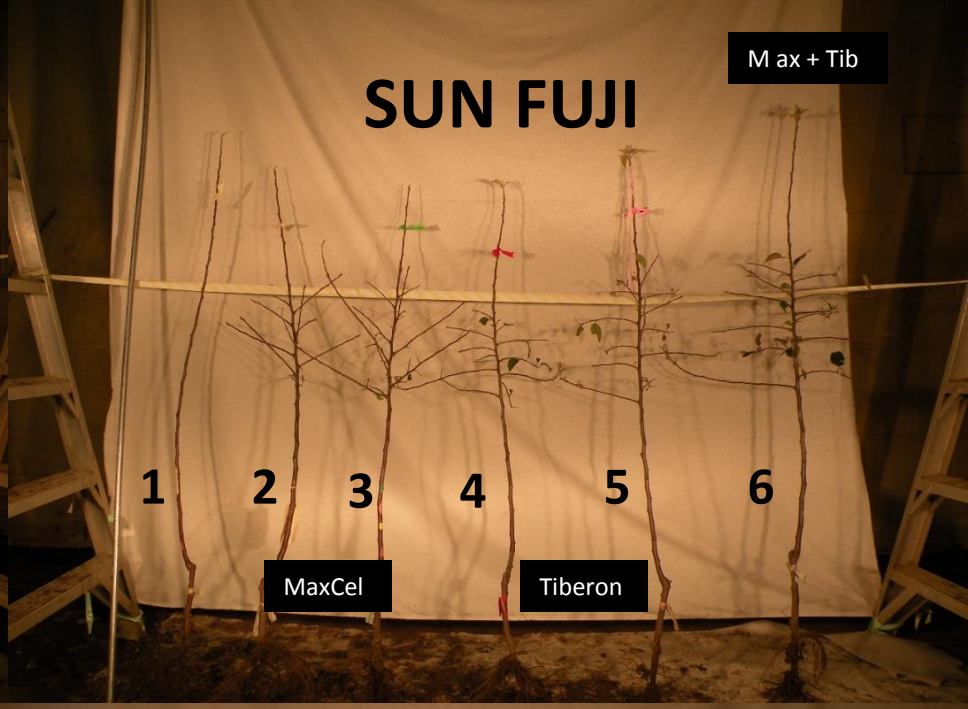
Effects of cyclanilide (CYC) and/or benzyl adenine (Maxcel) on seasonal central leader growth (inches) in 'Macoun'/B.9 apple trees in the nursery during 2010 growing season (Wolcott, NY)

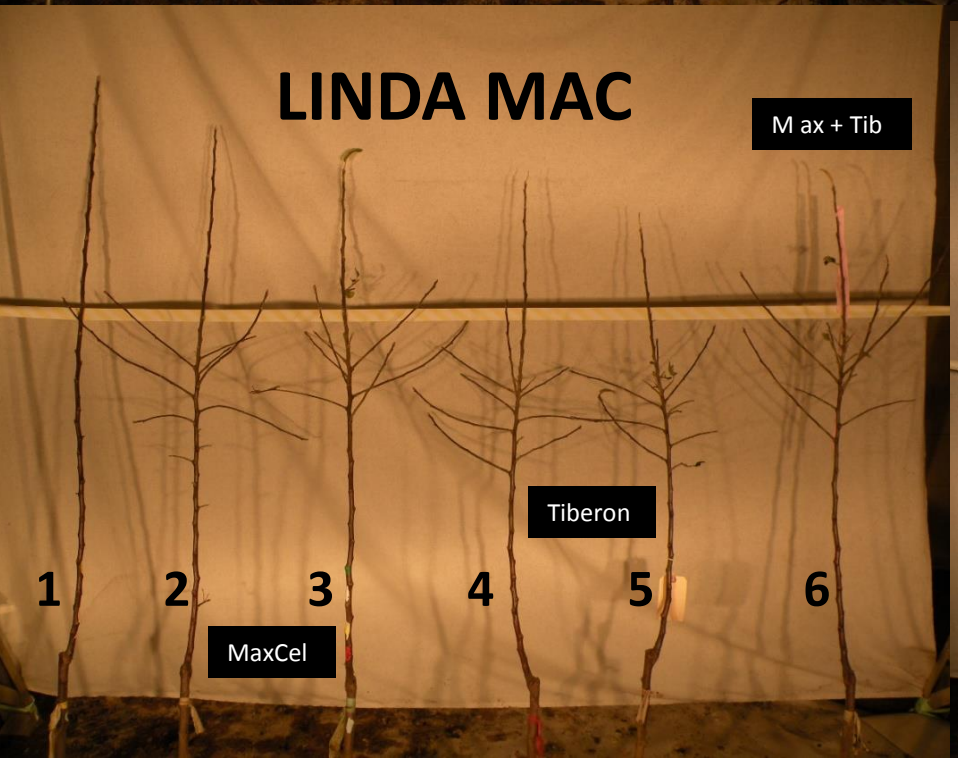


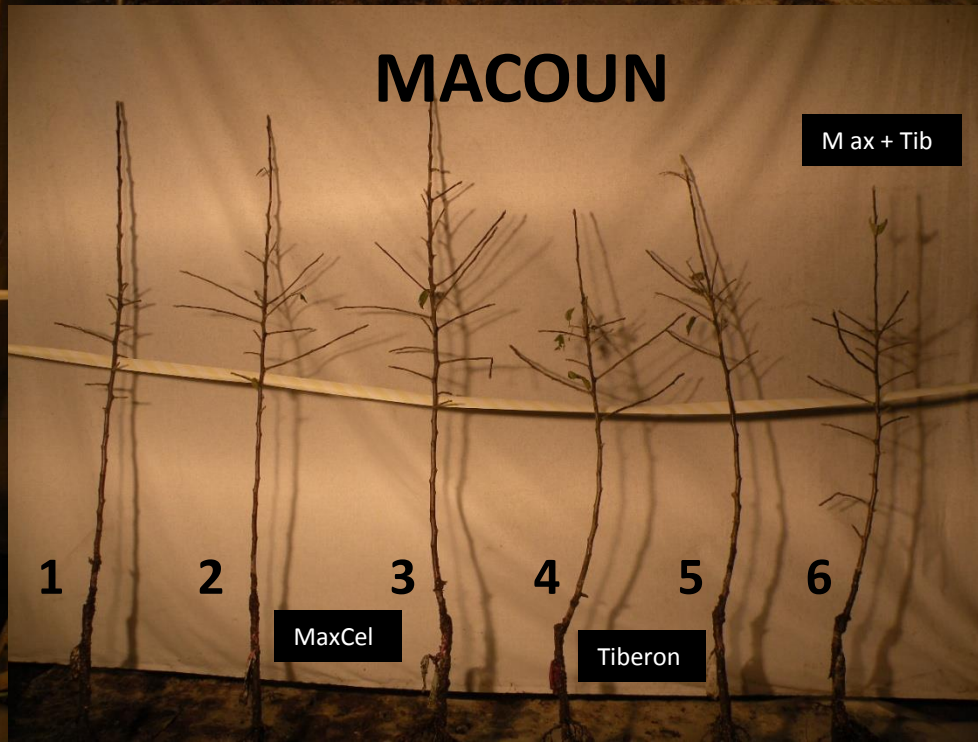
Growth Measurements in the Fall

- Trunk caliper measured 5 inches above bud union
- Length of central leader above ground level to tip
- Total number of feathers (any lateral shoot > 4 inches)
- Distance from the ground level to each of the induced feathers
- Length of each feather
- Crotch angle of each feather

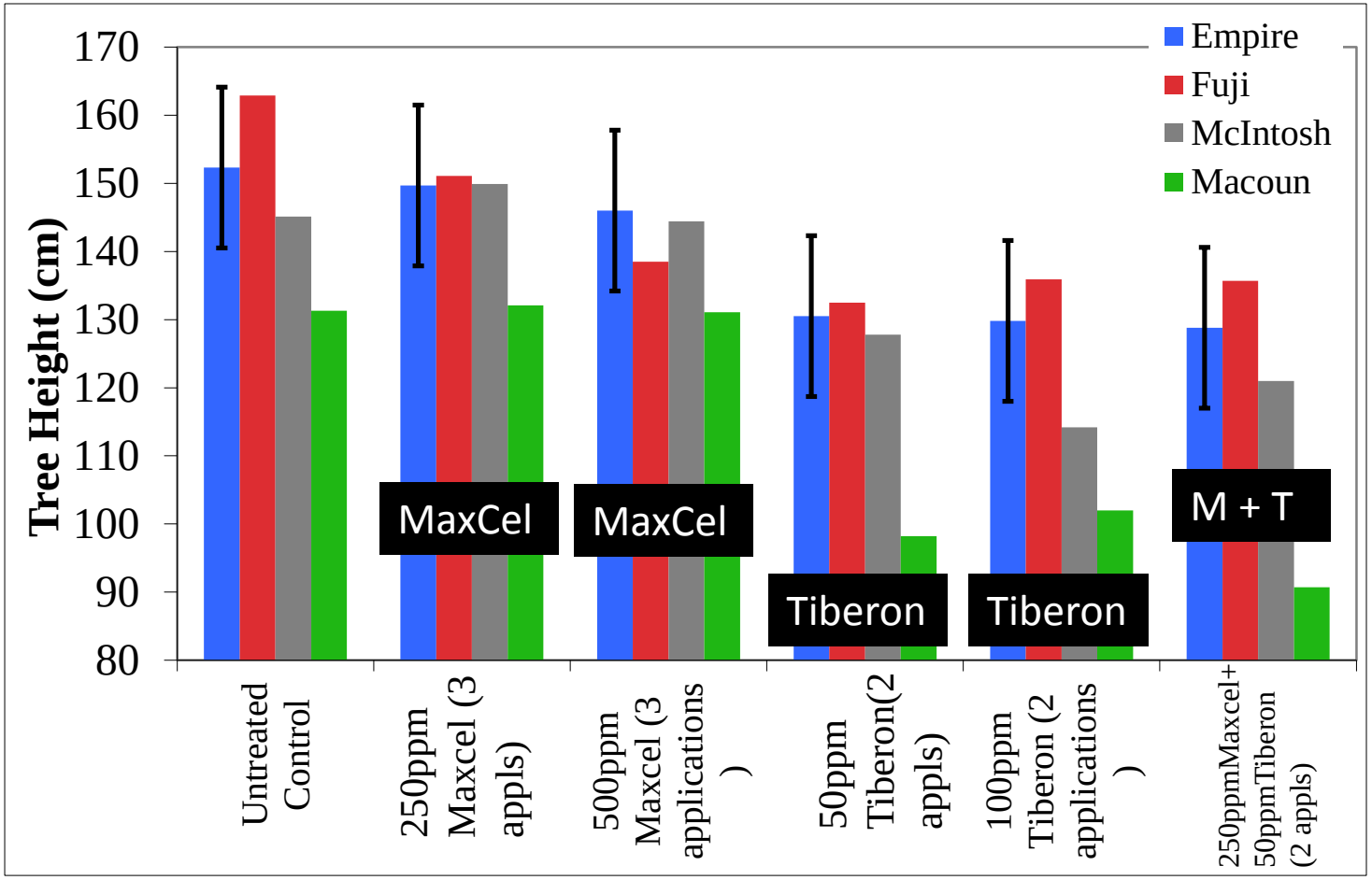

ROYAL EMPIRE
M ax + Tib
1
2
3
4
5
6
MaxCel
Tiberon


M ax + Tib
SUN FUJI
1
2
3
4
5
6
MaxCel
Tiberon

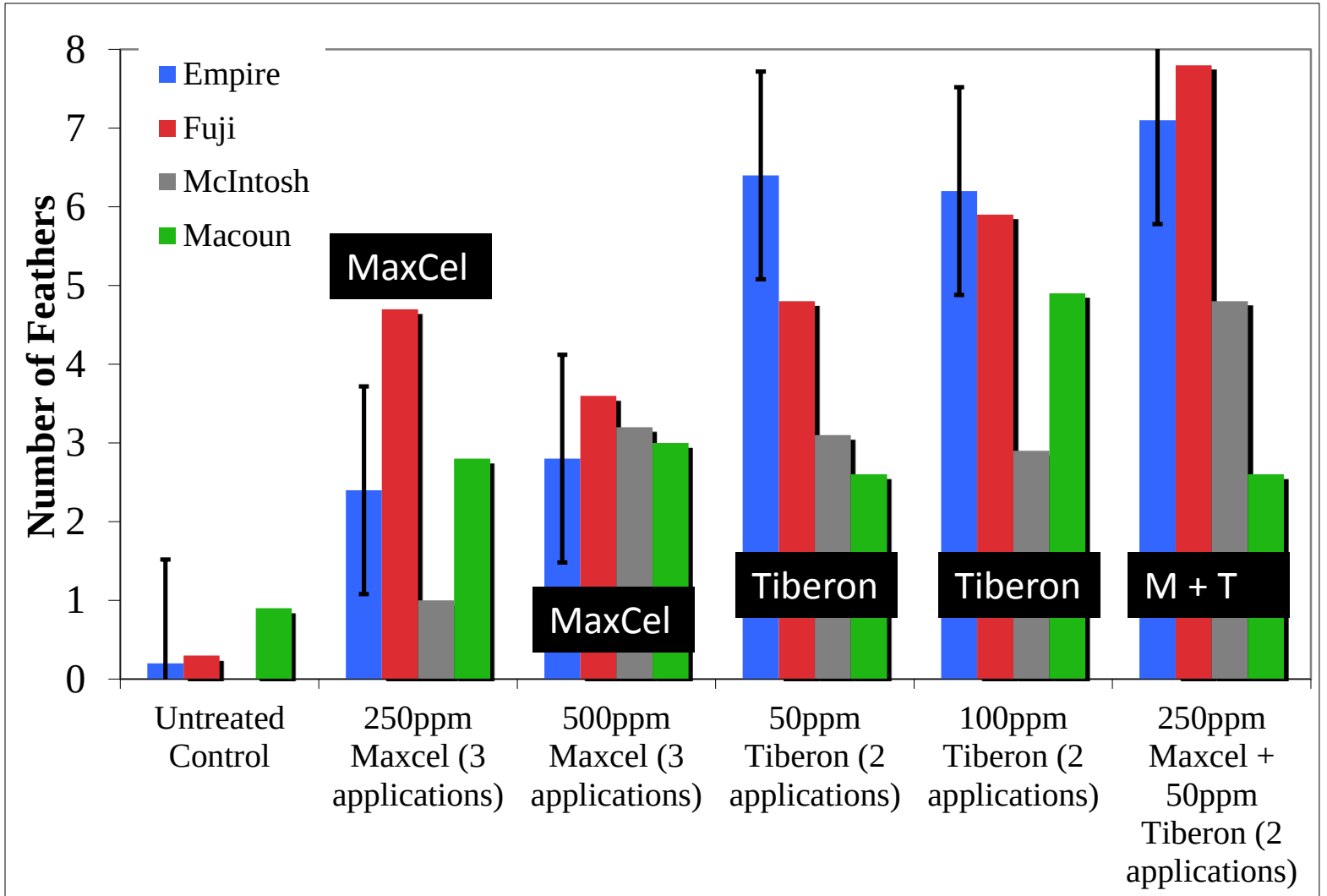

LINDA MAC
M ax + Tib
Tiberon
1
2
3
4
5
6
MaxCel


MACOUN
M ax + Tib
1
2
3
4
5
6
MaxCel
Tiberon

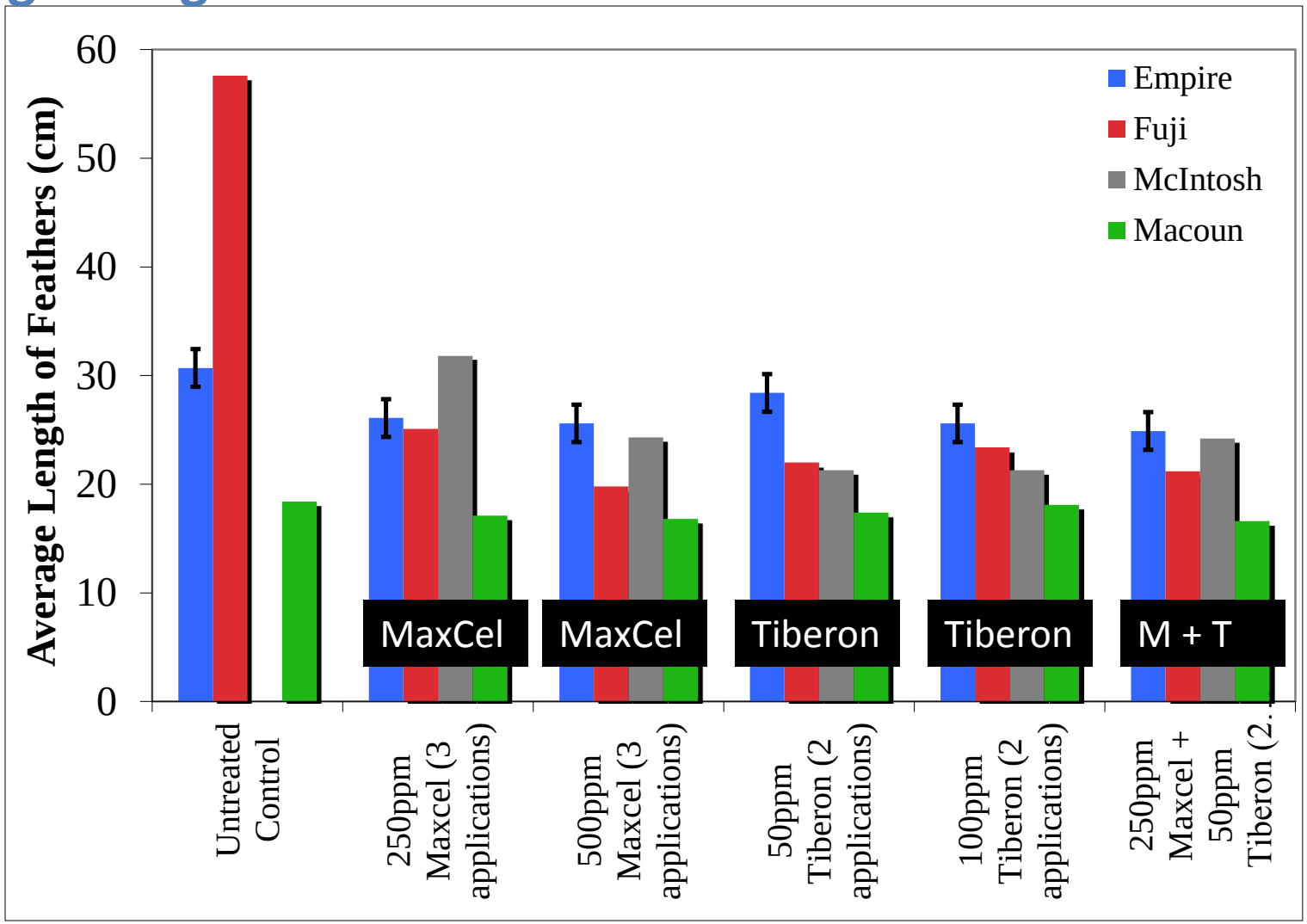
- **For all varieties, CYC treatments reduced final length of the central leader shoot by the end of the season (more than the Maxcel treatments).**

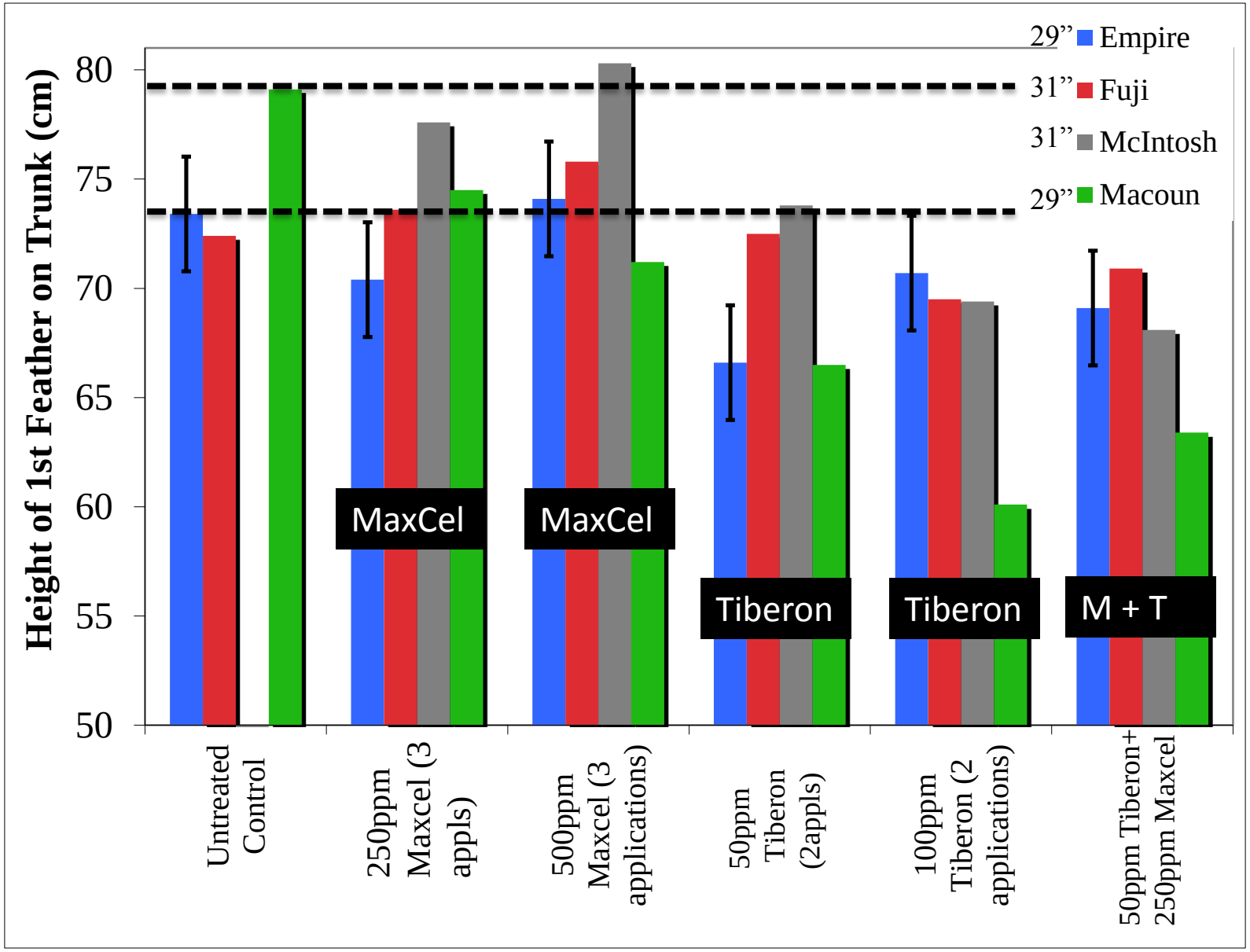


- We counted more feathers in the CYC treated trees.
- The number of induced feathers and their density were both increased by the CYC treatments.

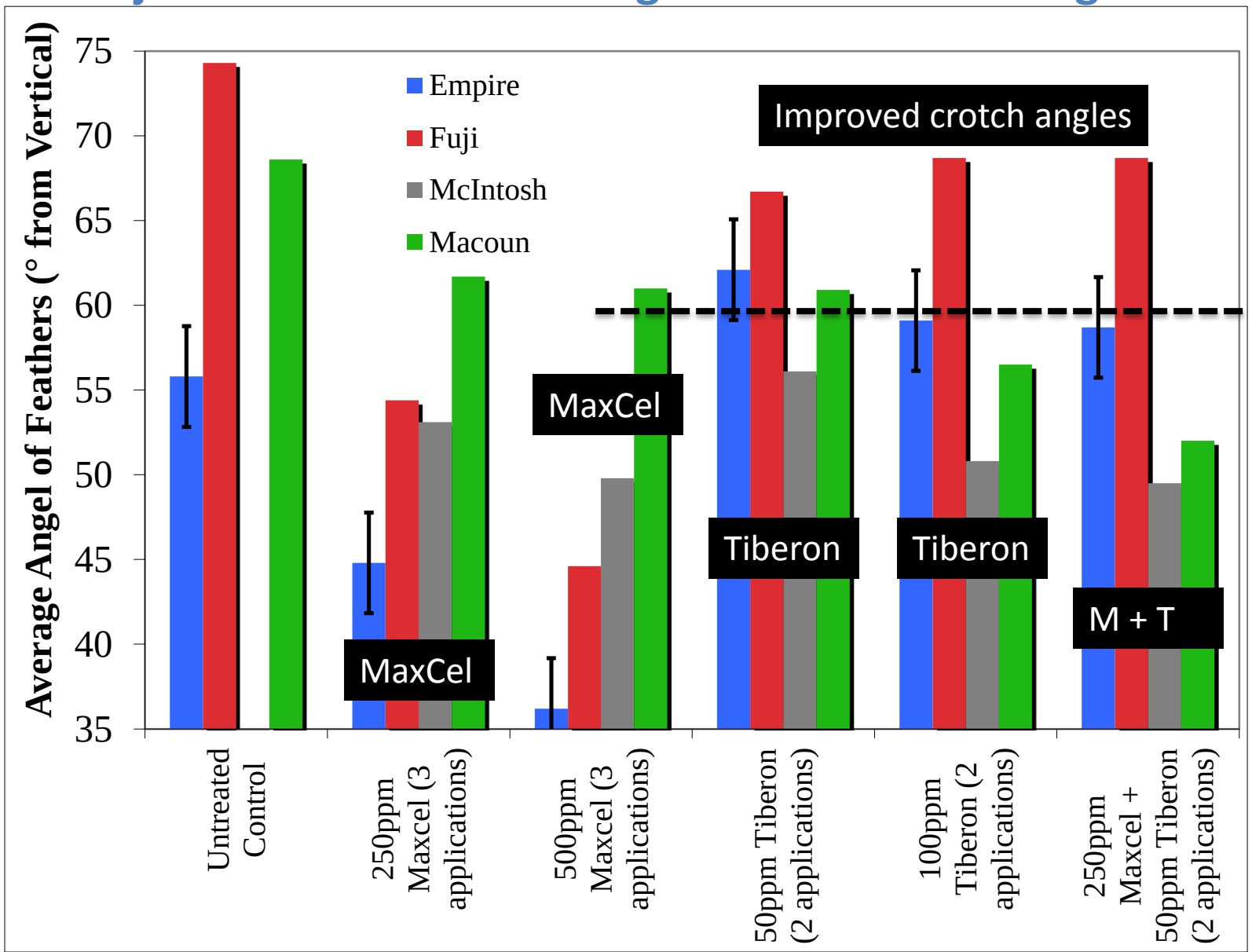


- All PGR treatments resulted in shorter feathers than in untreated trees.
- Induced feathers were well-developed by the end of the growing season.

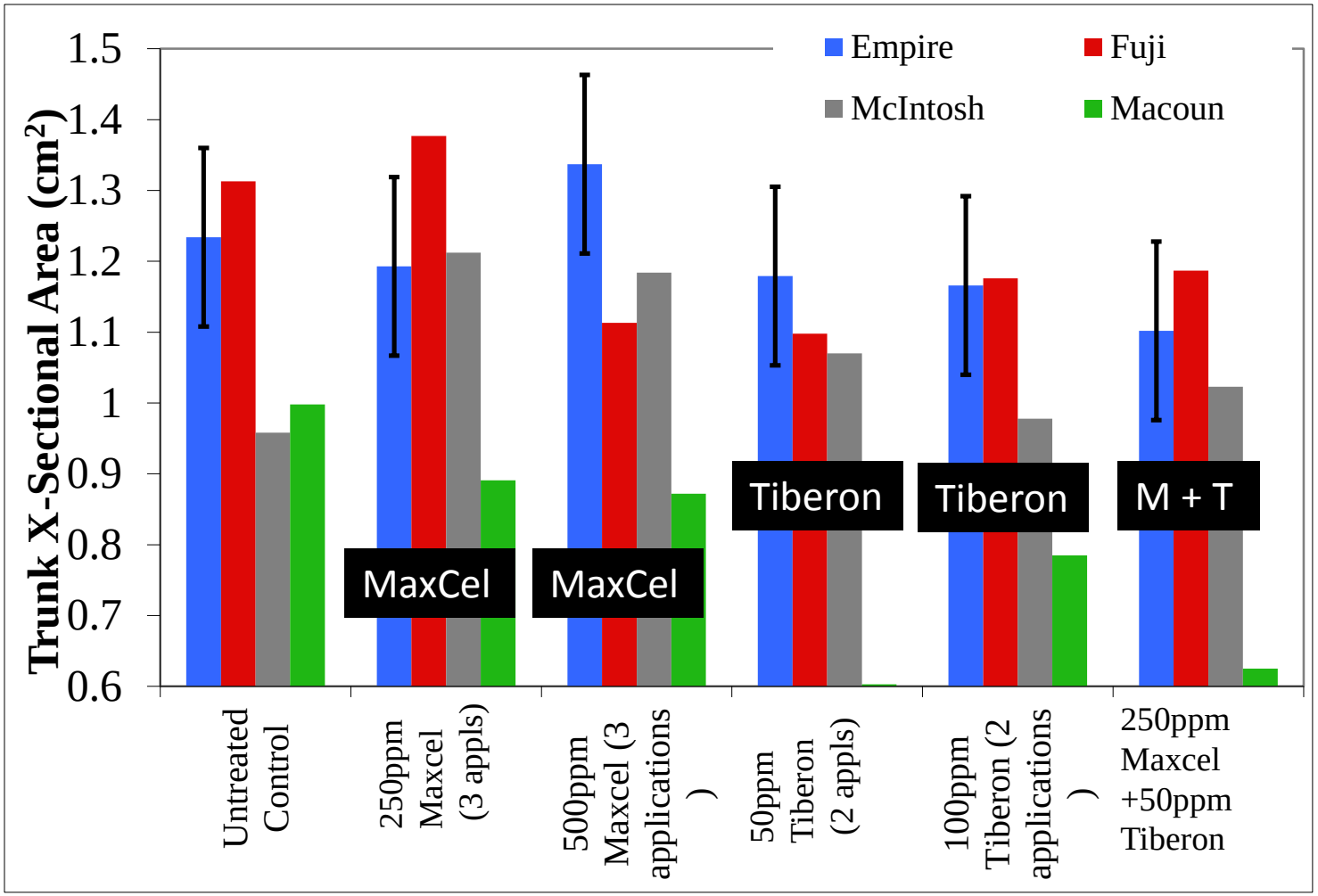



Height of 1st Feather on Trunk (cm)
80
75
70
65
60
55
50
29" Empire
31" Fuji
31" McIntosh
29" Macoun
MaxCel
MaxCel
Tiberon
Tiberon
M + T
Untreated Control
250ppm Maxcel (3 appls)
500ppm Maxcel (3 applications)
50ppm Tiberon (2appls)
100ppm Tiberon (2 applications)
50ppm Tiberon+ 250ppm Maxcel

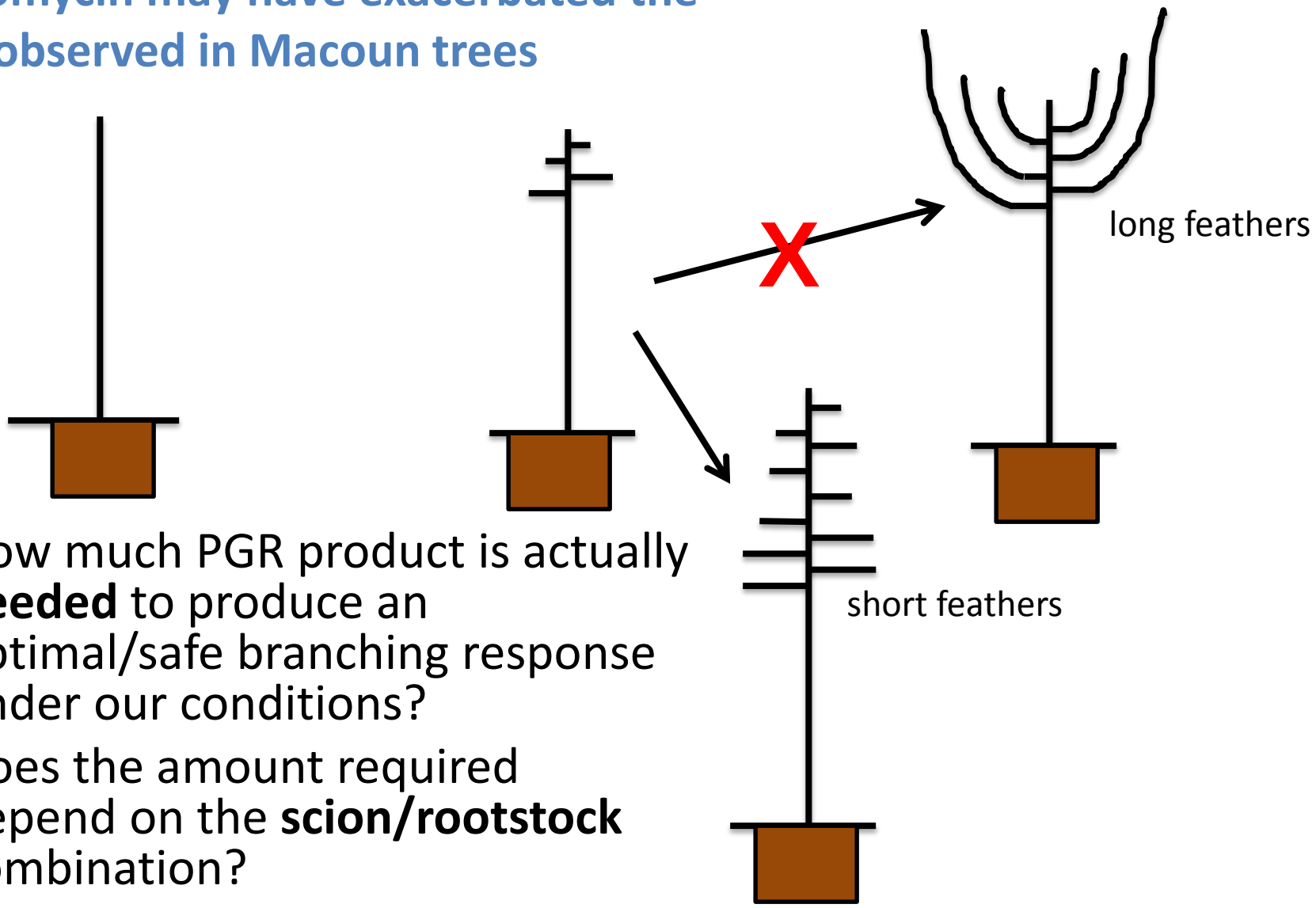
- Crotch angles were affected by the PGR treatments.
- CYC treatments positively affected feather crotch angle, especially for the Fuji cultivar with crotch angles of 60 or more degrees.



- TCSA negatively influenced by Tiberon trts and its mean area decreased in direct proportion to the amount of Tiberon applied
- Tiberon reduced trunk caliper (Macoun more affected)



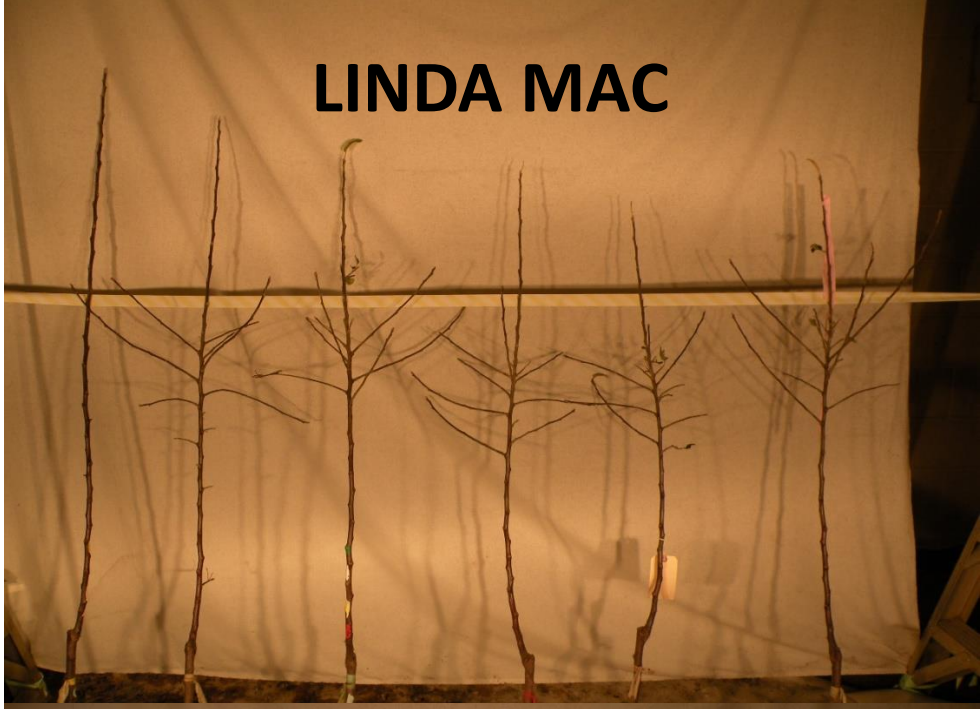
After the first year of nursery work, we were not sure if the combined effect of Tiberon, hot weather conditions, and the use of streptomycin may have exacerbated the injury observed in Macoun trees

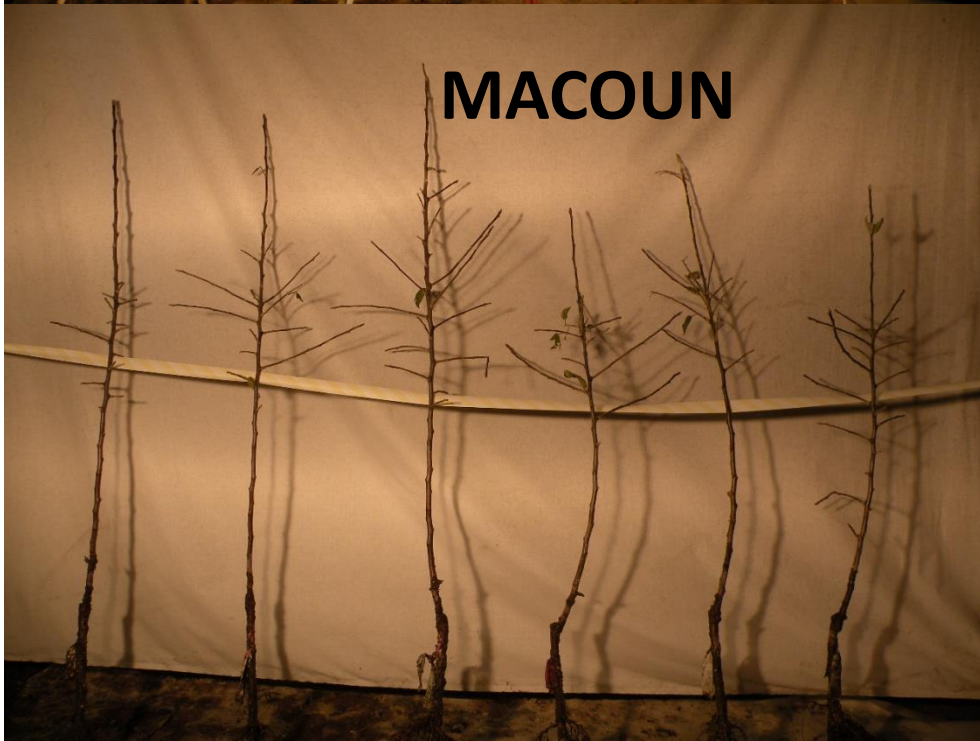


- How much PGR product is actually **needed** to produce an optimal/safe branching response under our conditions?
- Does the amount required depend on the **scion/rootstock** combination?

2011

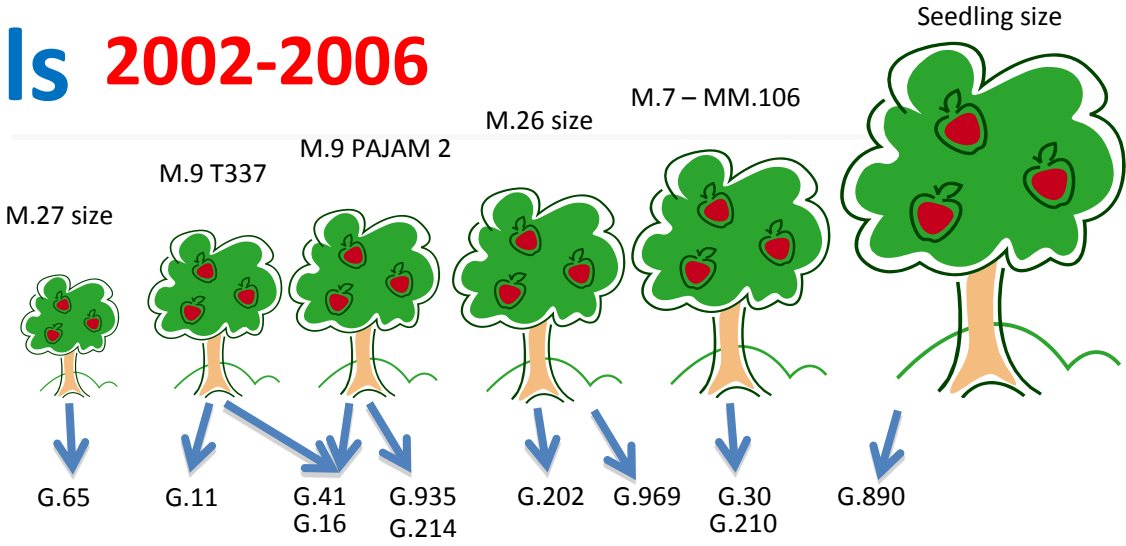
- What are the effects of **streptomycin** when applied before (or after) a CYC spray in the nursery?
- What happens with CYC-treated trees in **successive years** on canopy development and the onset of production?





WSU nursery trials 2002-2006

- Cameo,Gala/M.26, M.7
- TAC114 Fuji/M.26
- Scarletspur Delicious/B.118
- Scarletspur Delicious/M.7



Cornell nursery trials

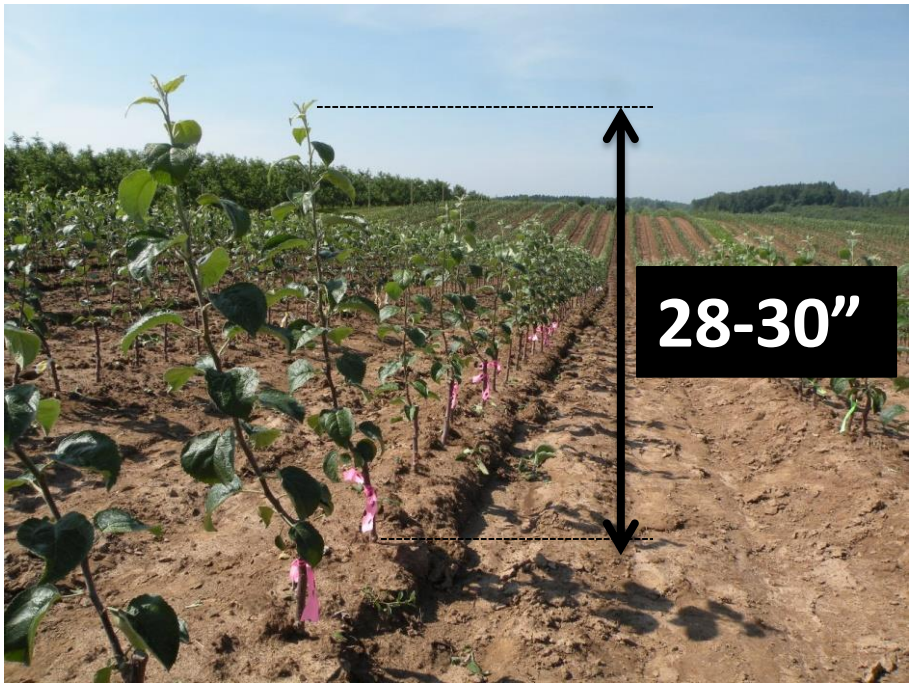
- Sun Fuji, Empire Royal, Linda Mac, and Macoun/B.9

2010

- Gala, Empire, and Aceymac/M.9T337

2011

- Macoun/G.11



Trt N°	PGR / rate	# Sprays
1	Untreated	None
2	Max 500ppm	1
3	Max 500ppm	2
4	Max 500ppm	3
5	Tib 10ppm	1
6	Tib 10ppm	2
7	Tib 10ppm	3
8	Tib 20ppm	1
9	Tib 20ppm	2
10	Tib 20ppm	3
11	Tib 30ppm	1
12	Tib 30ppm	2
13	Tib 30ppm	3
14	Tib 40ppm	1
15	Tib 40ppm	2
16	Tib 50ppm	1
17	Tib 50ppm	2
18	Tib 100ppm	1

2011 Treatments

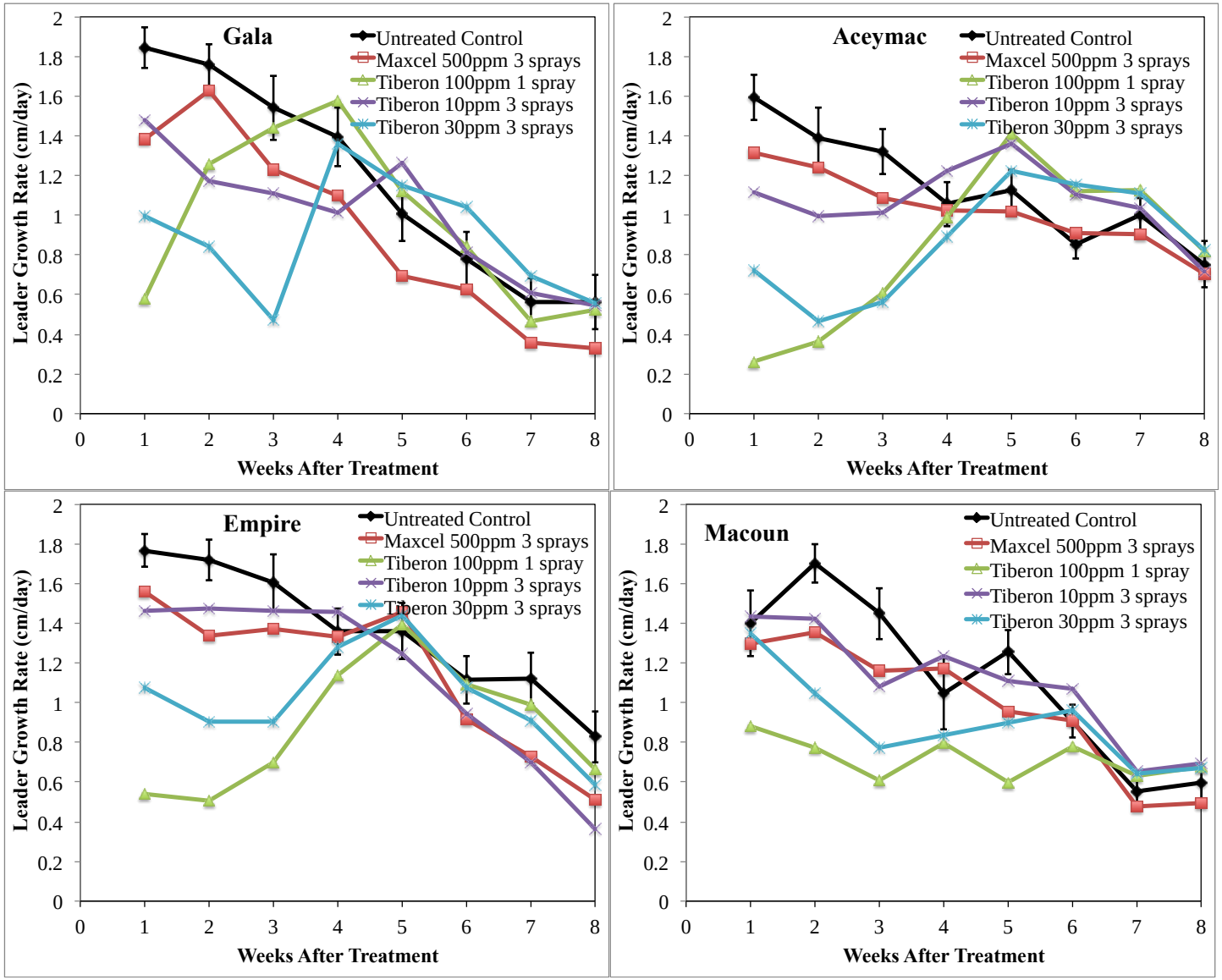
Cultivar/rootstock:
Gala, Empire, and
Aceymac/**M.9T337**

Macoun/**G.11**

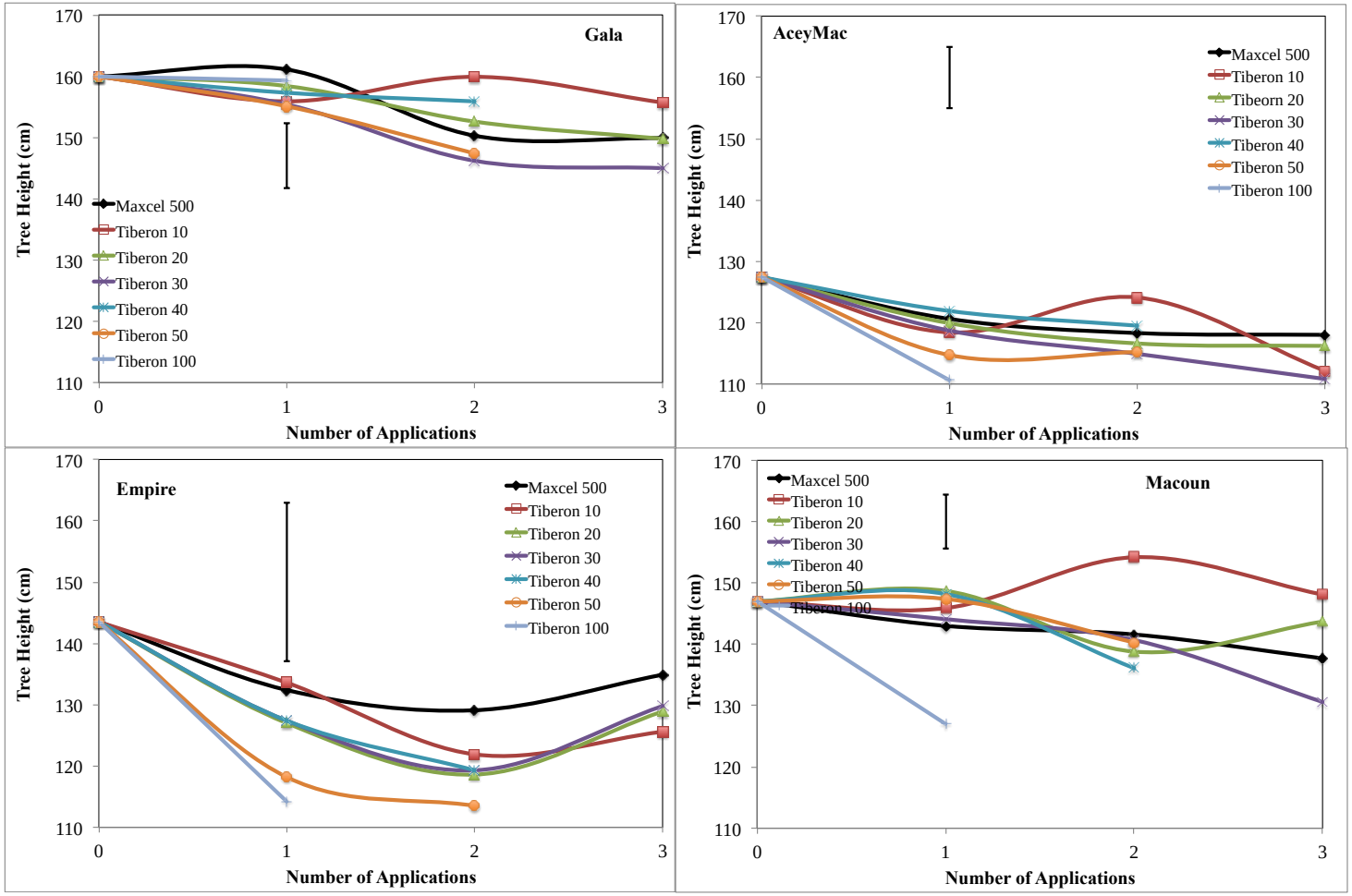
Weekly measurements (Gala, Empire, Aceymac, Macoun) started @ June 16-18, 2011

Data collected: Trunk caliper measured 5 inches above bud union (early June, end of August, late November), length of central leader above ground level to tip (early June and end of Nov.), total number of feathers (any lateral shoot > 4 inches), distance from the ground level to each of the induced feathers, length of each feather, and crotch angle of each feather.

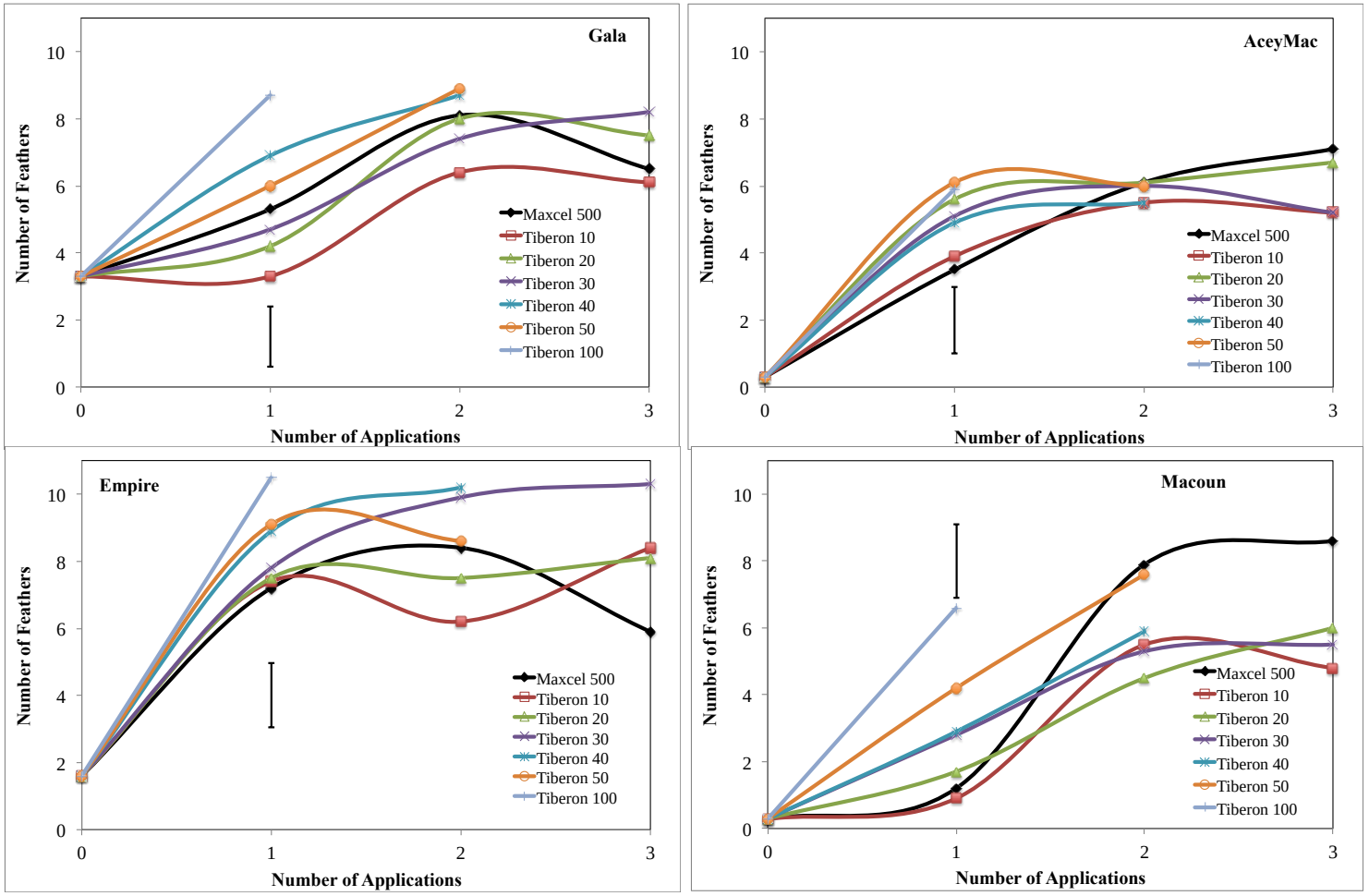
Effects of cyclanilide (Tiberon) or benzyl adenine (Maxcel) on leader growth rate of Gala, AceyMac, and Empire on M.9 rootstock and Macoun apple trees on G.11 rootstock in the nursery over 8 weeks after treatment during the 2011 growing season at Wolcott, NY.



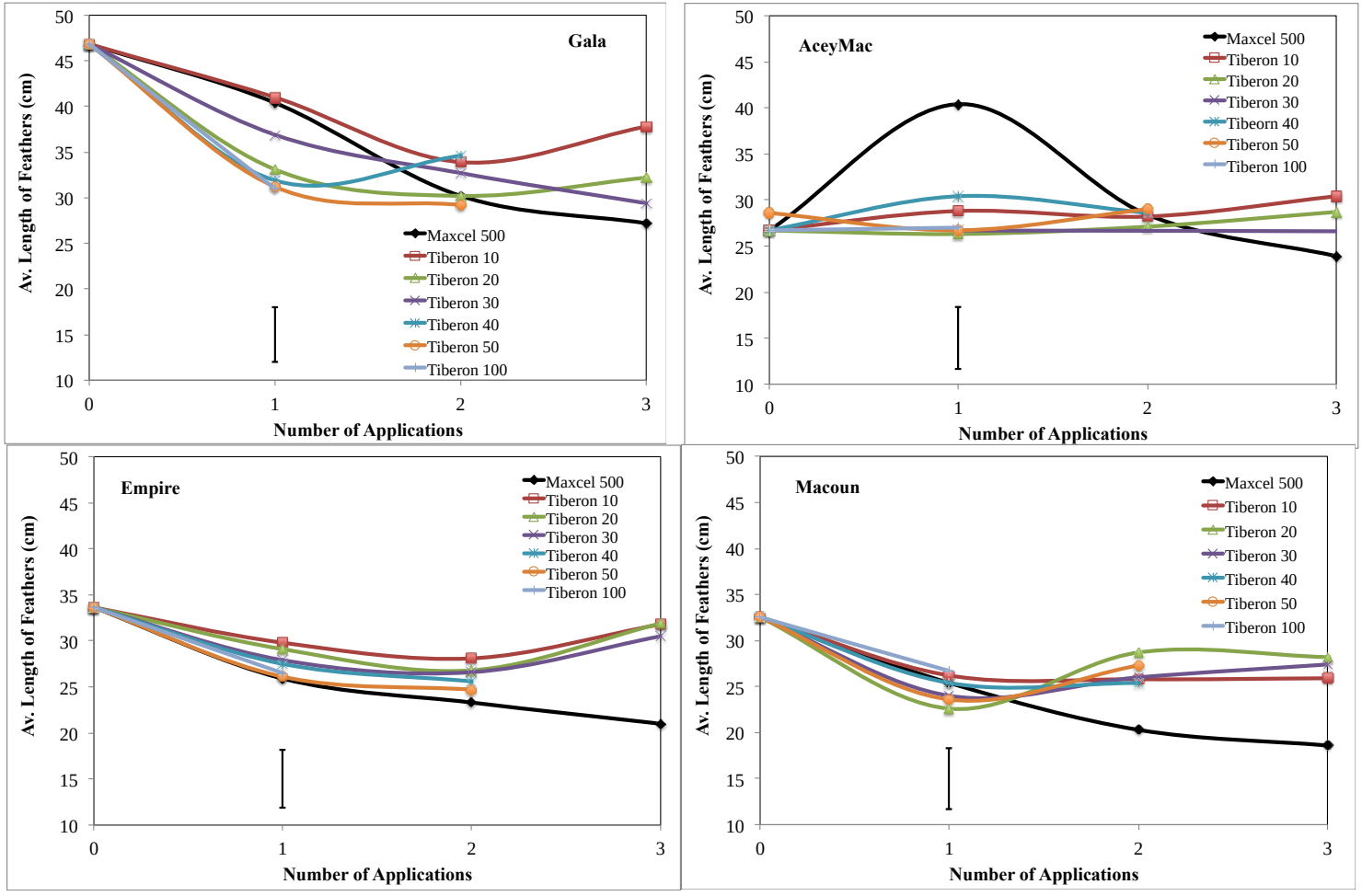
Effects of cyclanilide (Tiberon) or benzyl adenine (Maxcel) on tree height of Gala, AceyMac, and Empire on M.9 rootstock and Macoun apple trees on G.11 rootstock in the nursery during the 2011 growing season at Wolcott, NY.



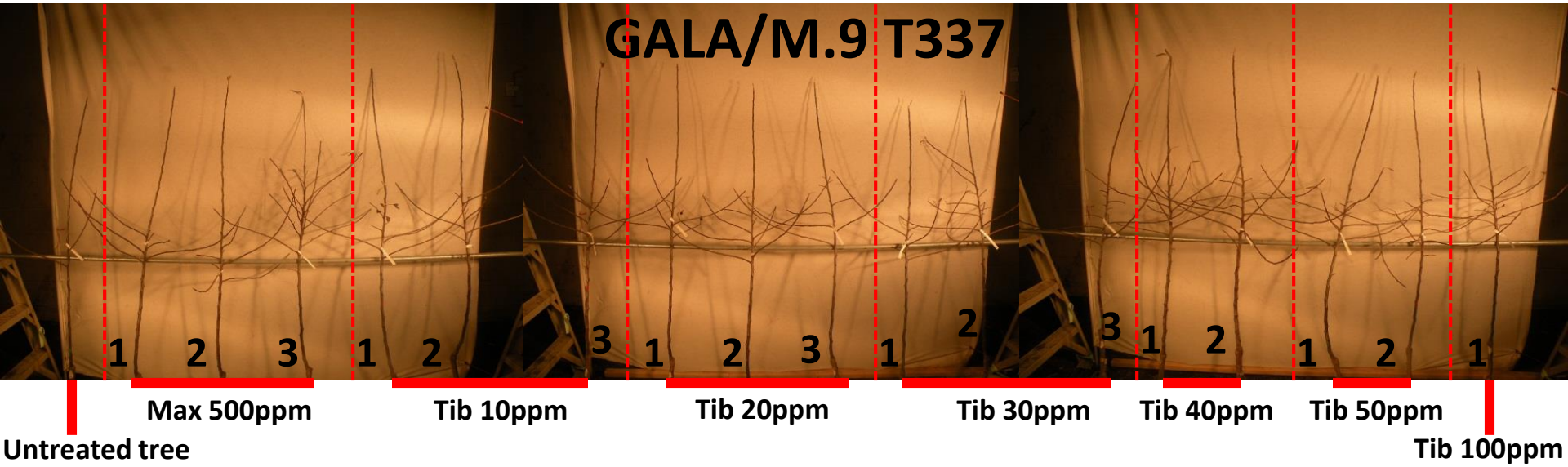
Effects of cyclanilide (Tiberon) or benzyl adenine (Maxcel) on number of feathers of Gala, AceyMac, and Empire on M.9 rootstock and Macoun apple trees on G.11 rootstock in the nursery during the 2011 growing season at Wolcott, NY.

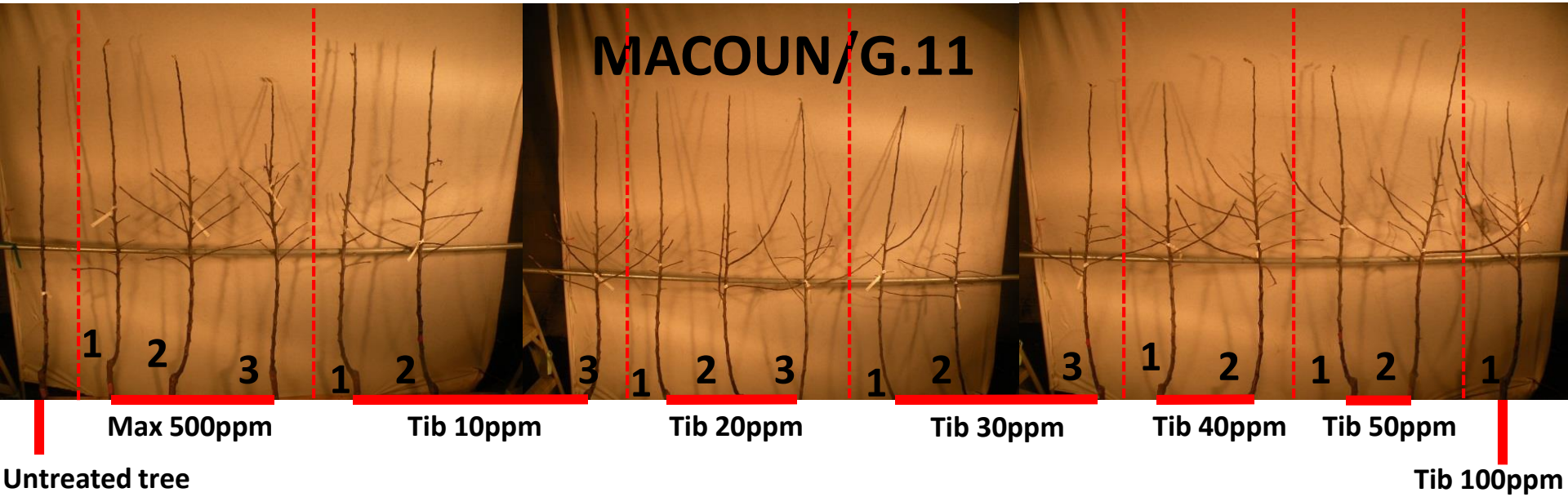


Effects of cyclanilide (Tiberon) or benzyl adenine (Maxcel) on number of feathers of Gala, AceyMac, and Empire on M.9 rootstock and Macoun apple trees on G.11 rootstock in the nursery during the 2011 growing season at Wolcott, NY.



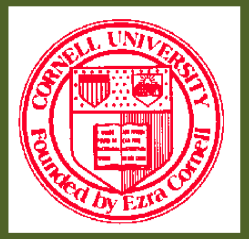
Feathering response of 2 apple cultivars to 18 chemical branching treatments during the 2011 growing season (Wolcott, NY)





2012 Nursery Research

"Tools to Secure Successful Chemical Branching of Apple Trees in the Nursery at Various Geographic Locations in the U.S."



WSU's Tree Fruit Research and Extension Center, Wenatchee, WA. Tuesday April 24th, 2012

2012/13 nursery research funded by NNII and IFTA

Year	Cultivar/Rootstock	Nursery	Location	Researcher(s), cooperators
2012	Gala/M.9	Van Well	WA	Miranda Sazo and Robinson
2012	Fuji/M.9	C & O	WA	Miranda Sazo and Robinson
2012	Ambrosia/B.9	Mori	Ontario, CA	Huffman and Grigg-McGuffin
2012	Macoun/G.11	Wafler	NY	Miranda Sazo and Robinson
2012	Golden Delicious and Macoun on M.9	ACN	Virginia	Cowgill
2013	Granny Smith, Fuji, and Gala on M.9	UniViveros	Chile	Miranda Sazo and Robinson

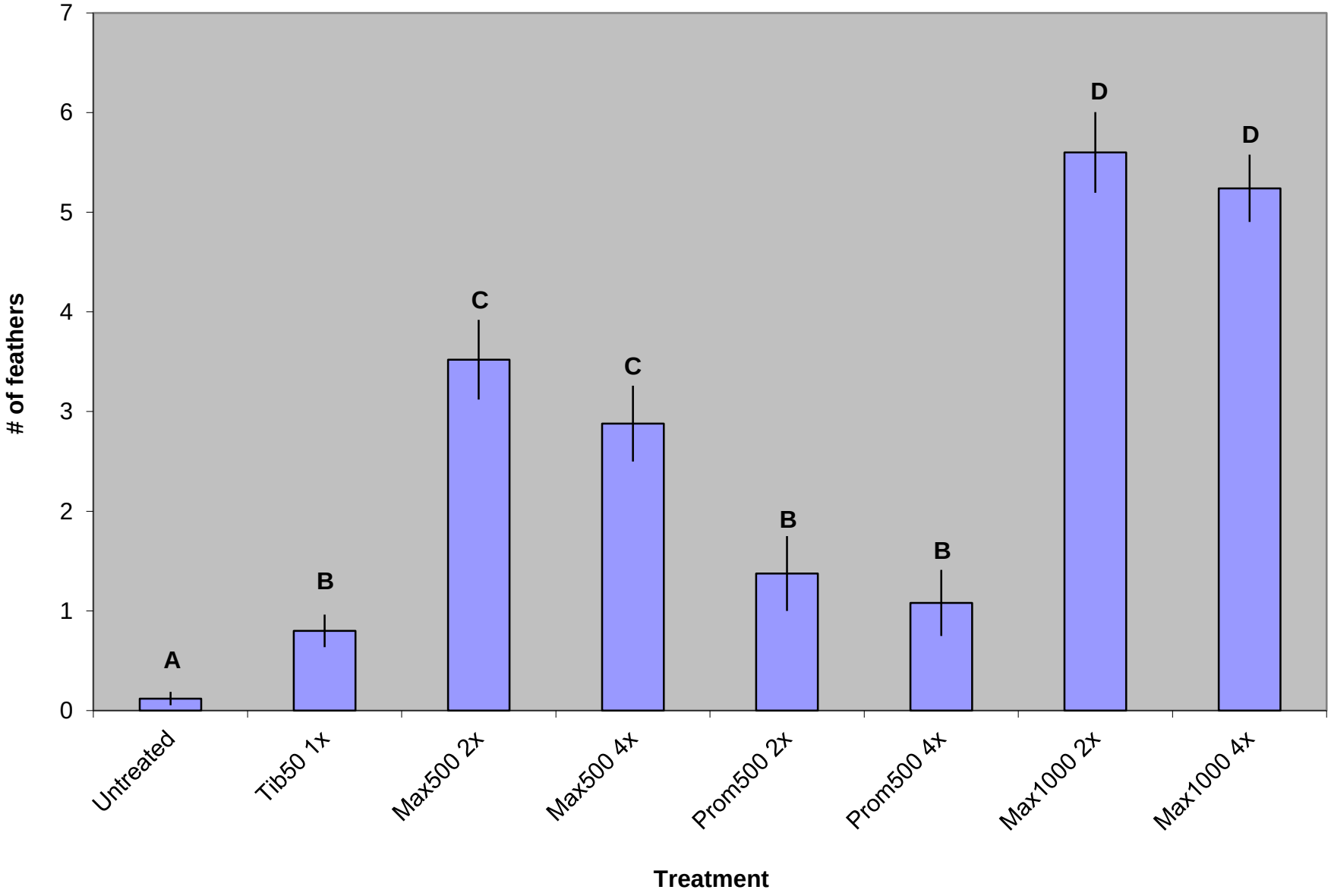
2012 Mori nursery trial

- Ambrosia/B.9
- Sprays applied on July 3, 13, 20, and 27
- Trt 1 (Untreated)
- Trt 2 (Tib 50ppm, 1 Spray)
- Trt 3 (Max 500ppm, 2 Sprays)
- Trt 4 (Max 500ppm, 4 Sprays)
- Trt 5 (Prom 500ppm, 2 Sprays)
- Trt 6 (Prom 500ppm, 4 Sprays)
- Trt 7 (Max 1000ppm, 2 Sprays)
- Trt 8 (Max 1000ppm, 4 Sprays)

MORI NURSERIES

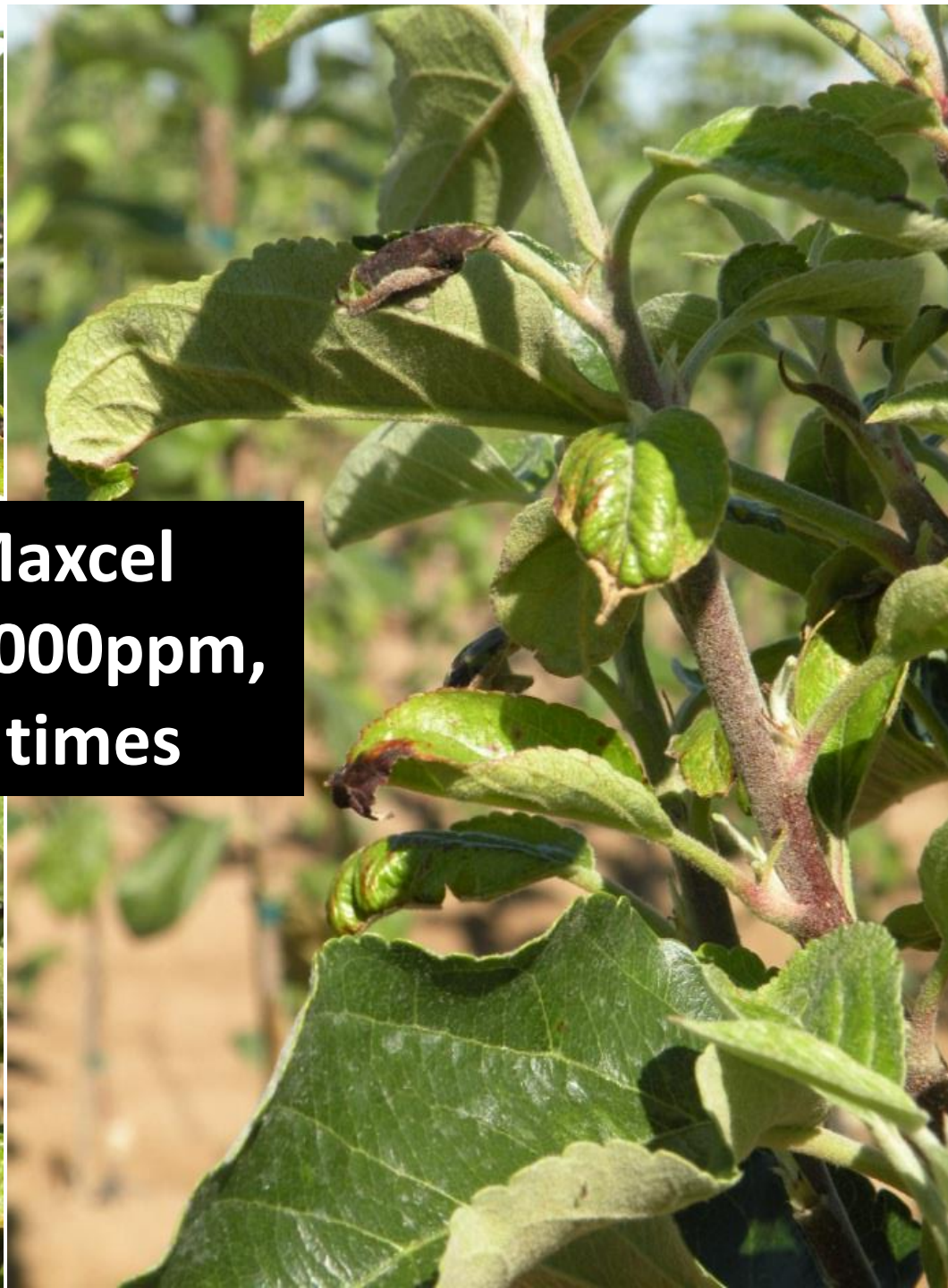
Ontario

Effects of Tiberon, Promalin, and Maxcel on number of feathers of Ambrosia on B.9 rootstock in the nursery during the 2012 growing season in Ontario, Canada.



12 days after 4th Maxcel spray (Mori nursery, Aug. 8th, 2012

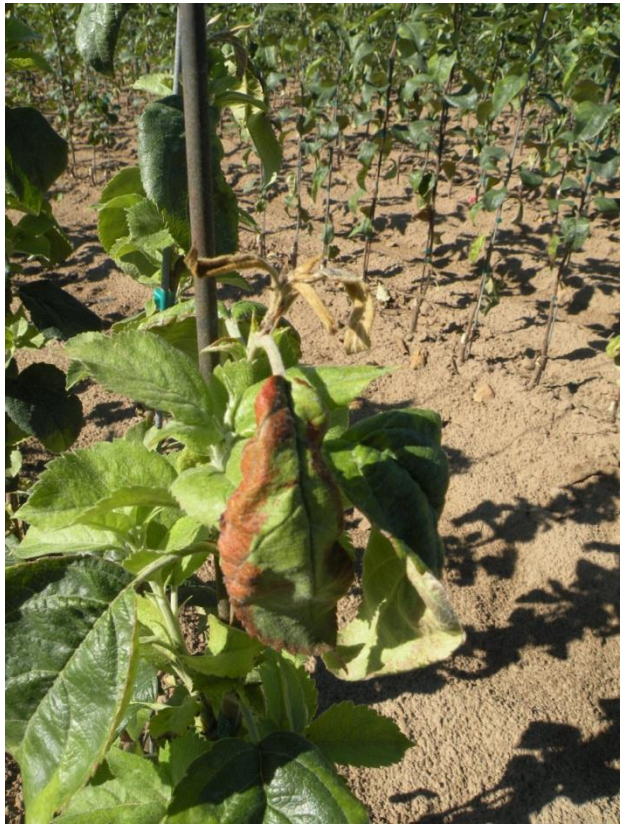
Maxcel 1000ppm, 4 times



Maxcel 1000ppm, 4 times

Commercial Maxcel sprays (Mori nursery, Aug. 8th, 2012)

Phyto with Maxcel sprays (Mori nursery, Aug. 8th, 2012)



Empire, Max 500(2s) - July 8, 2011

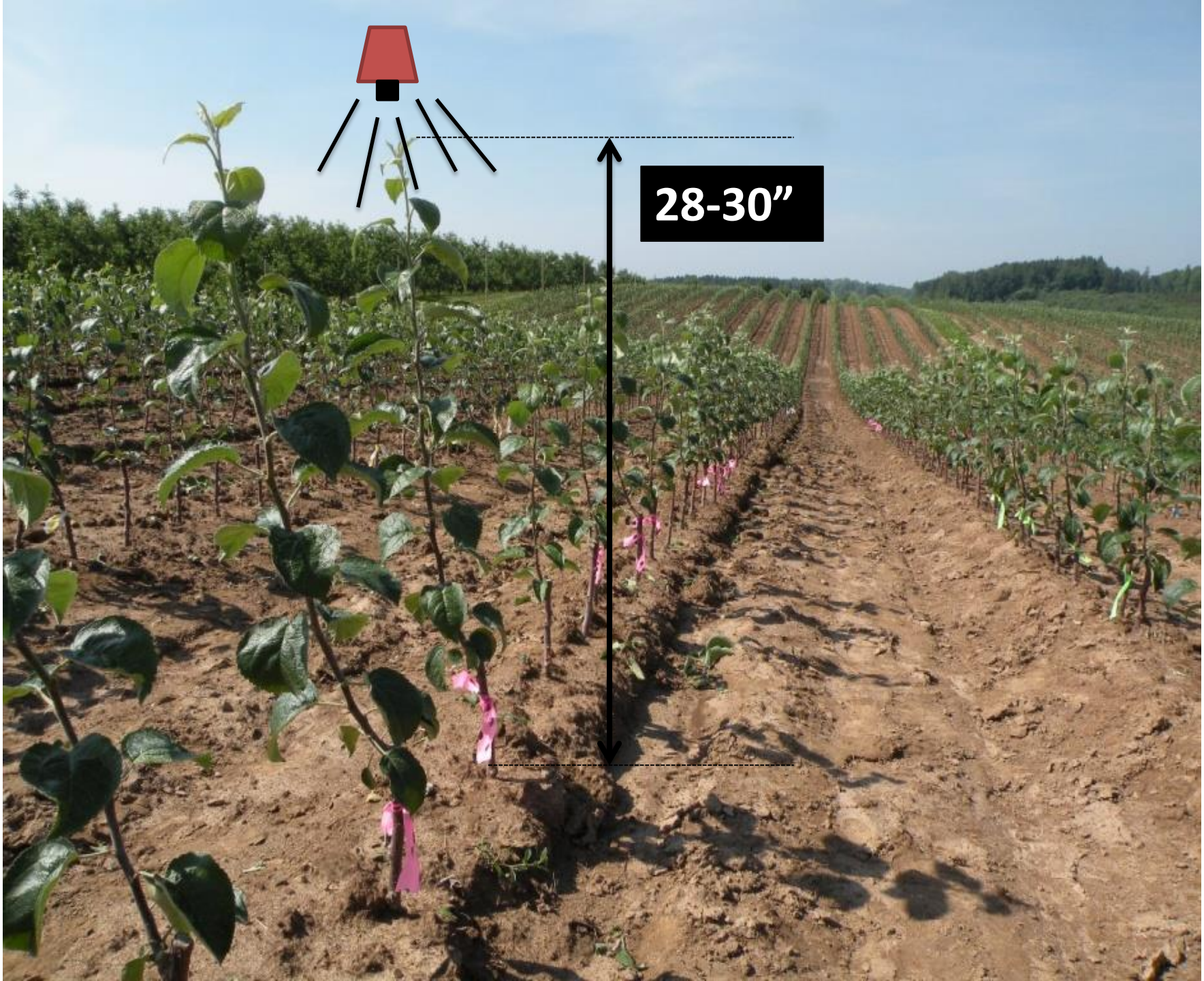
More Typical and Normal Maxcel Symptoms

Empire, Tib 40(2s) - July 8, 2011

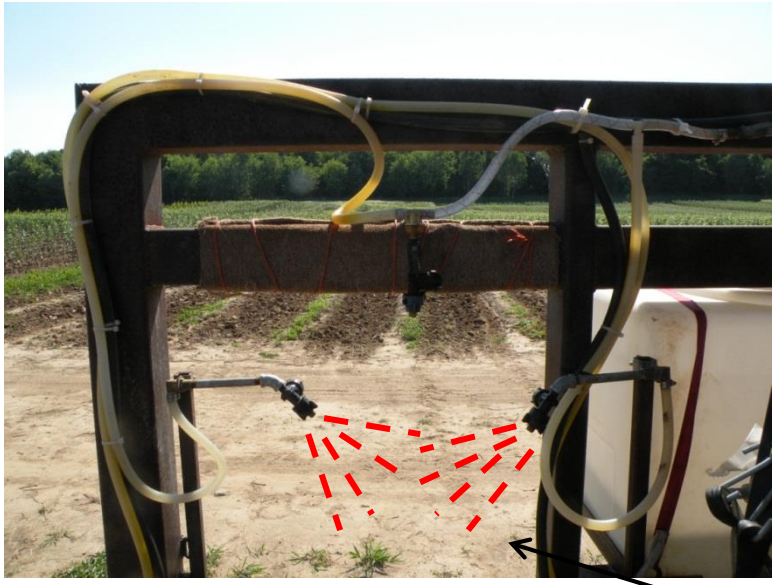
Empire, Tib 50 (1s) - July 8, 2011

Feathering started around Jul. 15-16, 2011

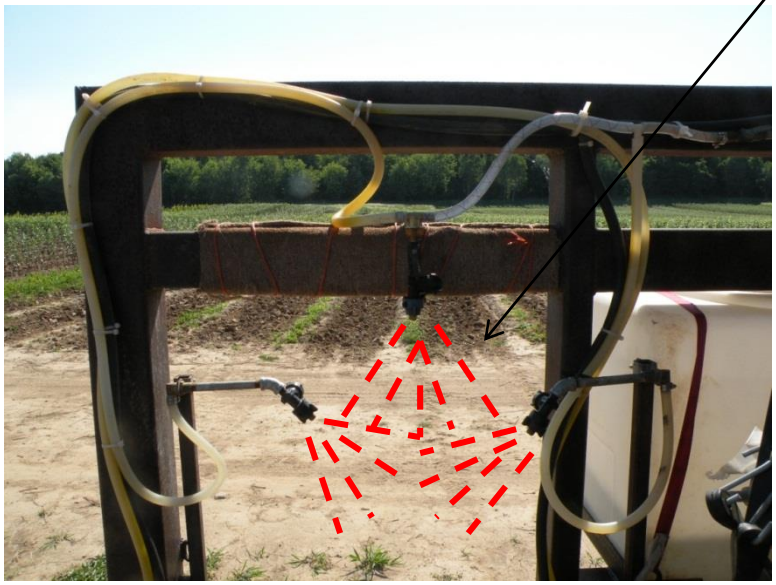
Feathering started around Jul. 15-16, 2011


28-30”



Nozzle configuration (2010/11/12)



2011 Maxcel applied at 500ppm – Wafler Nursery, NY

Machine designed/built by grower Paul Wafler

Nozzle 11003 – Water 40 GPA - Pressure @ 20 PSI

Nozzle 11003 – Water 50 GPA – Pressure @ 25 PSI

2012 Maxcel applied at 500ppm – Wafler Nursery, NY

Boom designed/built by grower Paul Wafler

Machine designed/built by grower Paul Wafler

Nozzle 11003 – Water 40 GPA - Pressure @ 20 PSI

Nozzle 11003 – Water 50 GPA – Pressure @ 25 PSI

2011 Manual Spray – Wafler Nursery, NY, USA

PGR applied to the actively growing shoot tips and nearby leaves on apple nursery trees is usually sufficient to stimulate adequate feathering. Spraying the remainder of the tree does not improve branching. Leaf removal is not necessary when Maxcel or Tiberon are used.

2012 Manual Sprays – Van Well and C & O Nurseries, WA

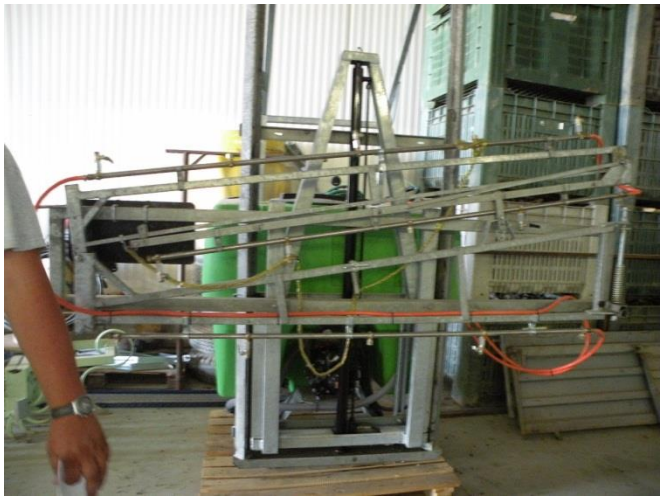
Two-nozzle boom designed/built by Van Well and Don Elfving. Boom utilized for Tiberon work in Washington.

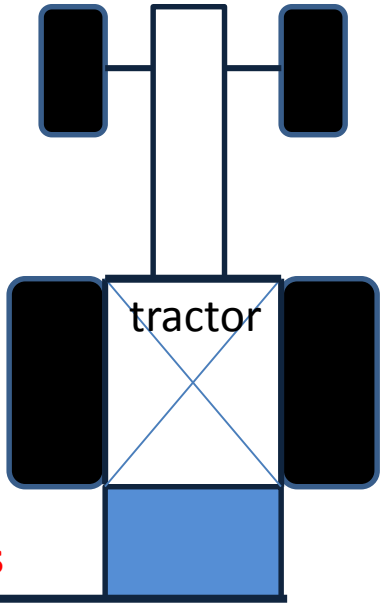
PGR applied to the actively growing shoot tips and nearby leaves on apple nursery trees is usually sufficient to stimulate adequate feathering. Spraying the remainder of the tree does not improve branching. Leaf removal is not necessary when Maxcel or Tiberon are used.

Two Chilean nurseries are branching with PGRs (IFTA Tour, January 2012)

Two PONY machines for 4 and 8 rows

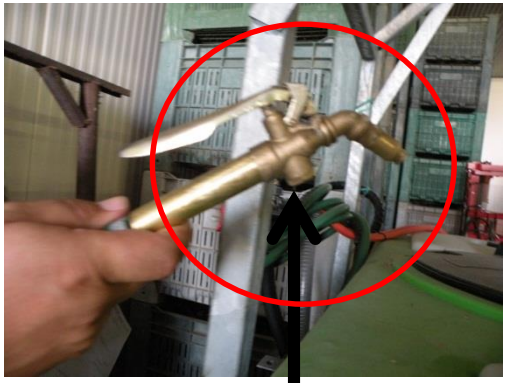
Italian Method of Application





Offset boom equipped with **9 spray hoses**

Maxcel tank

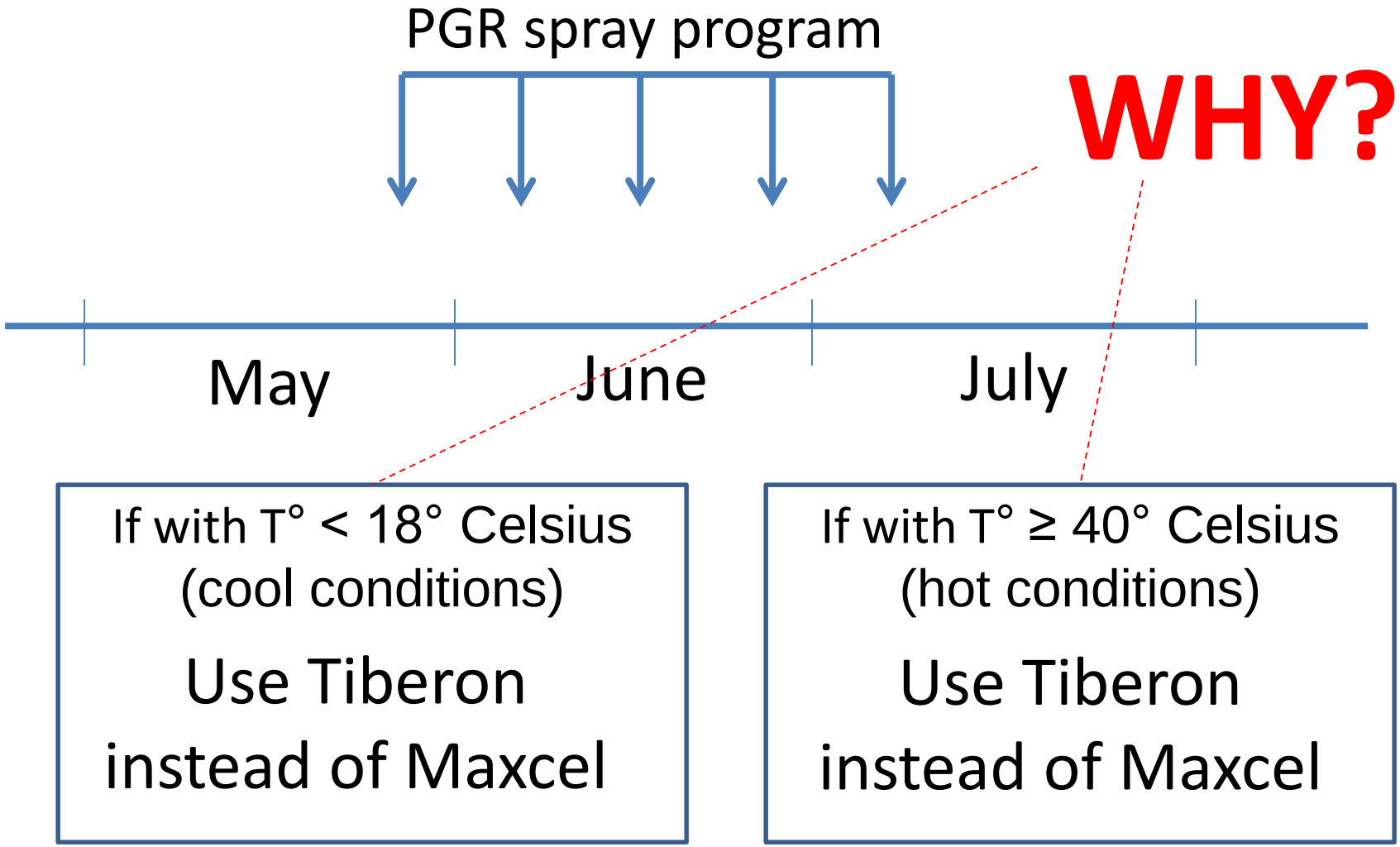


One brass spray header at the end of each spray hose

The Use of Maxcel in Italy

- Italian (and other European) nurserymen apply from 3 to 4 Maxcel treatments with sprays intervals of 5-7 days ("knip-boom" trees)
- A Maxcel spray **"works better"** for Italians when it is followed by a 3 hour period of at least 18°C (65°F).
- Italians prefer the use of Promalin to Maxcel only for branching of Red Delicious types for safety reasons so final tree height is not reduced
- A Maxcel solution of **+/- 4 ml** is applied to the actively growing shoot tip of each tree by hand. A crew of 9 people (more the tractor driver) can apply 250,000-300,000 trees/day working 10-11 hours/day

The Ideal PGR Program (Maxcel and Tiberon) for the Italian nurserymen (untested)



Maxcel Drift

Fuji tree treated with Maxcel 1000ppm (5 times), C & O Nursery, WA.

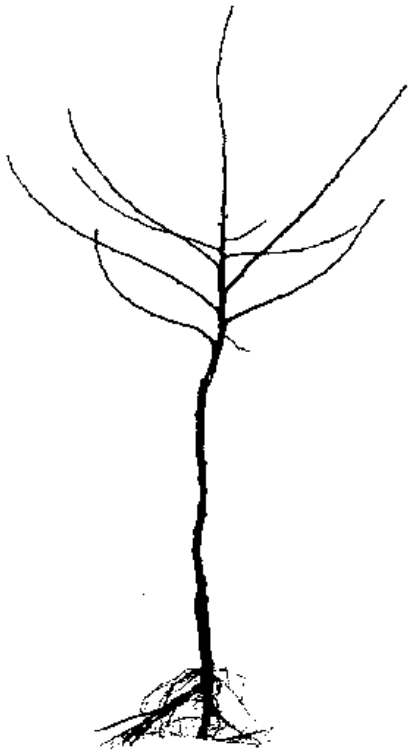
Avoiding Maxcel drift in Macoun trees, Wafler Nursery, NY

Maxcel 500ppm on Fuji, C & O Nursery, WA

Maxcel 1000ppm on Fuji, C & O Nursery, WA

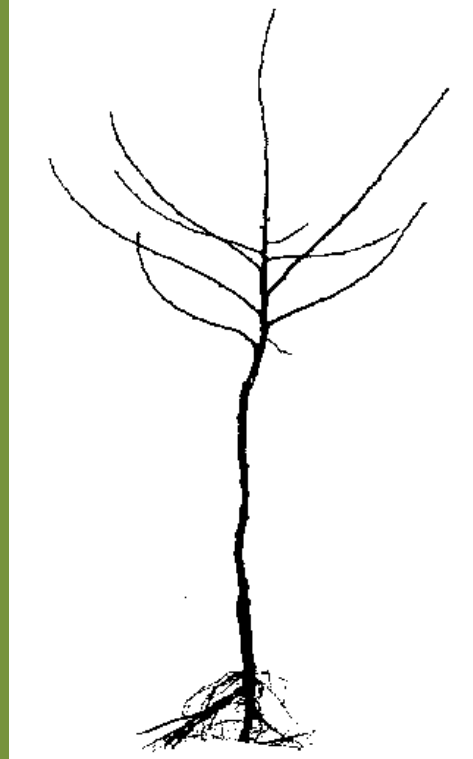
The Use of CG Rootstocks for Branching

- Two new traits were identified beyond dwarfing and precocity that are controlled by rootstocks: flat branching and number of feathers
- The rootstocks G.935, G.11, G.30, CG. 4210, CG. 4213, and CG. 4214 produce much wider (flatter branches) and 3.5 more branches per tree than the Malling or Budagovsky standars
- The new traits come from the *Malus robusta* parent used in the Geneva rootstock breeding program
- US nurserymen might produce flatter branches when growing upright growth-scion cultivars grafted on the new Geneva rootstocks by including the use of Maxcel
- Tree quality may potentially be improved by using Maxcel not just by producing good caliper trees with several short feathers, but also by inducing well feathered trees with wider crotch angles



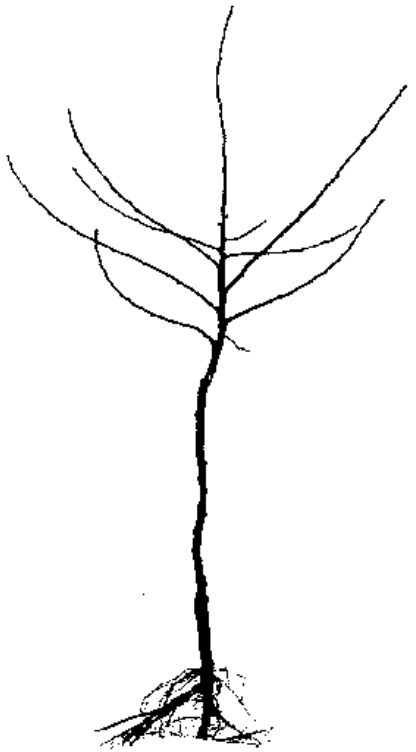
Conclusions

- The effect of Tiberon sprays in 2011 on shoot growth rate after treatment was negative for all 4 cultivars we tested and was rate dependent.
- Maxcel sprayed at 500ppm either 1, 2 or 3 times had only a small negative effect on leader growth rate.
- The labeled rate of Tiberon (100ppm) appears too high for NY State and quickly produced tree stunting.
- We conclude that Tiberon itself (not the humid weather conditions or the combined use of streptomycin as we previously speculated) is the major factor for the growth stunting we saw in Macoun trees.
- This negative effect is dose dependent and can be reduced if lower rates of 10-30ppm are used 1-3 times.



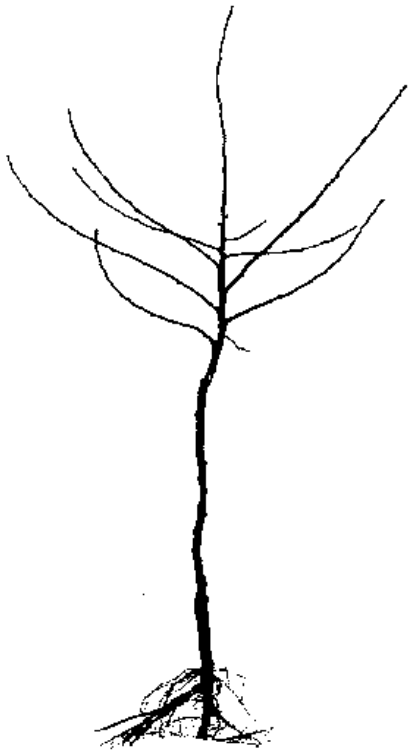
Conclusions

- Our results with multiple applications of Maxcel in 2010 and 2011 have been very promising.
- For the coming years, it appears that the potential use of Maxcel if applied multiple times (3-4 sprays of 500ppm) will help US nurserymen to continue producing highly feathered apple trees similar to the ones produced in the last 3 years with Tiberon
- The importance of having highly branched trees with good height and caliper is of such critical importance to the success of newly planted high density orchards that continued research of Maxcel rates and timings under different growing conditions (in the west and east in the United States) is very important.
- It will result in improved techniques for chemical branching of nursery apple trees. If Tiberon will not be available in the future, there is an opportunity for Maxcel to become a good alternative for chemical branching in the US.



A Maxcel program for a nurseryman

- Consider the use of Maxcel 500ppm (320 oz of formulated product/100 gallons of water) for chemical branching of nursery apple trees.
- First spray should be applied when tree height is about 28-30 inches above ground level.
- Use a backpack sprayer with a single nozzle directed to the shoot tip of each tree.
- We recommend 3 or 4 sprays per season.
- The timing of the 2nd-4th sprays should be when the leader adds 5 inches of new growth after the last spray (about 7-10 days).
- Use regulaid (1pt /100gal=0.16oz/1gal) for better feathering results.
- If possible apply in the morning when temperatures are 65-70 degrees.
- Avoid spraying the nursery in the afternoon if temperatures are 90 degrees or more.
- Do not tank mix with streptomycin or apply strep on the same day.



Thanks for Your Attention!

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