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*Pomme*

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# Programs for Successful Apple Thinning

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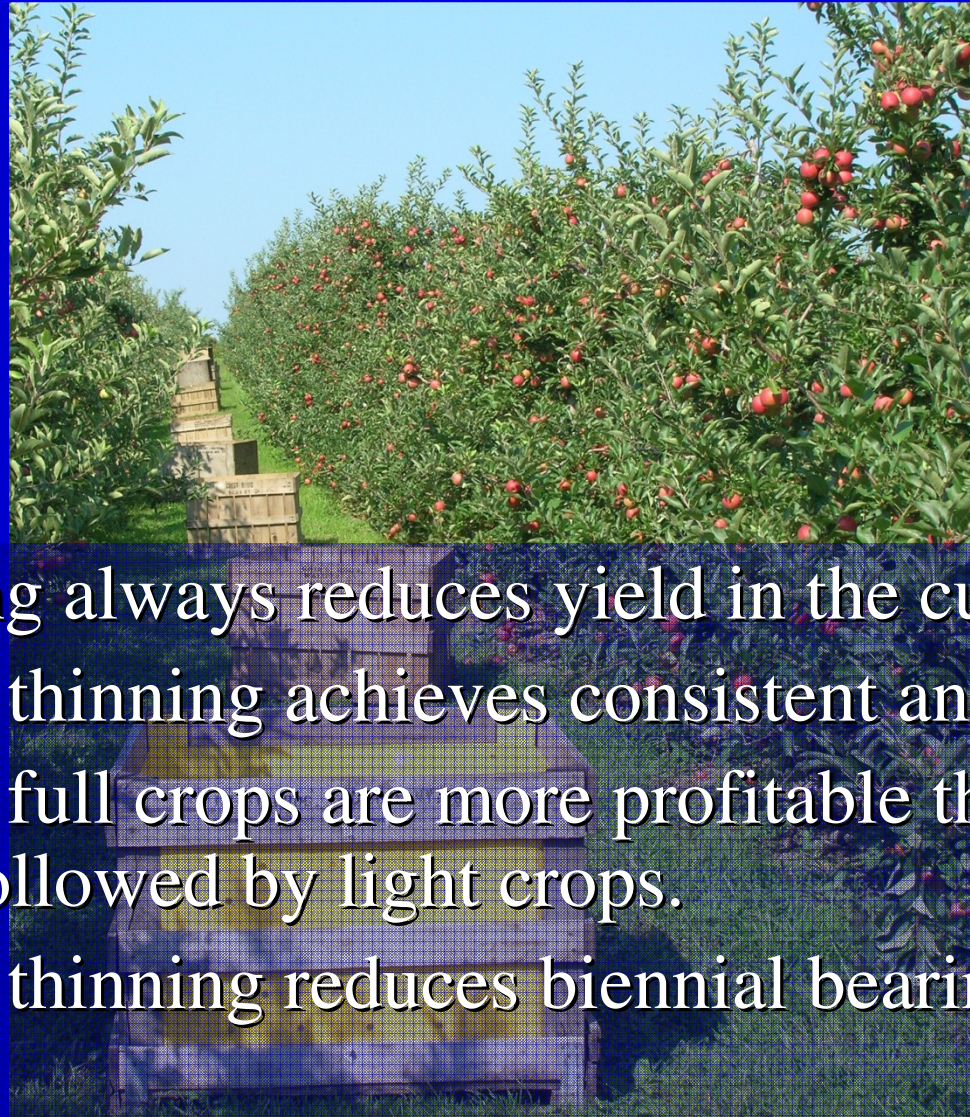


# Why Thin?

- Improve Fruit Quality – Size, Color, SS
- Ensure return bloom and annual cropping
- Ensure tree growth and prevent runting of trees
- Prevent limb breakage



# Improving Yield and Quality

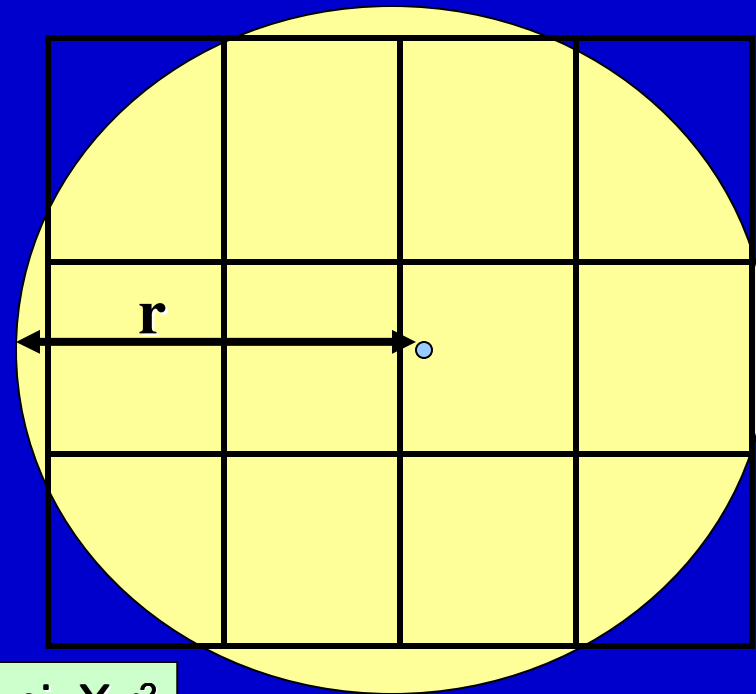
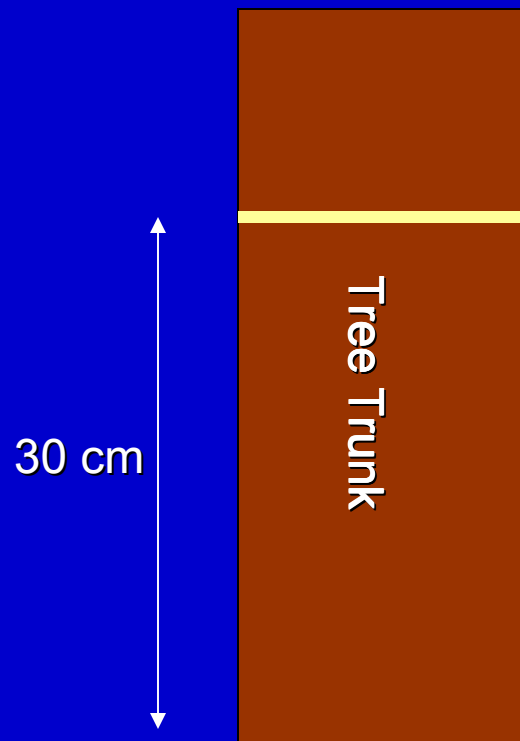
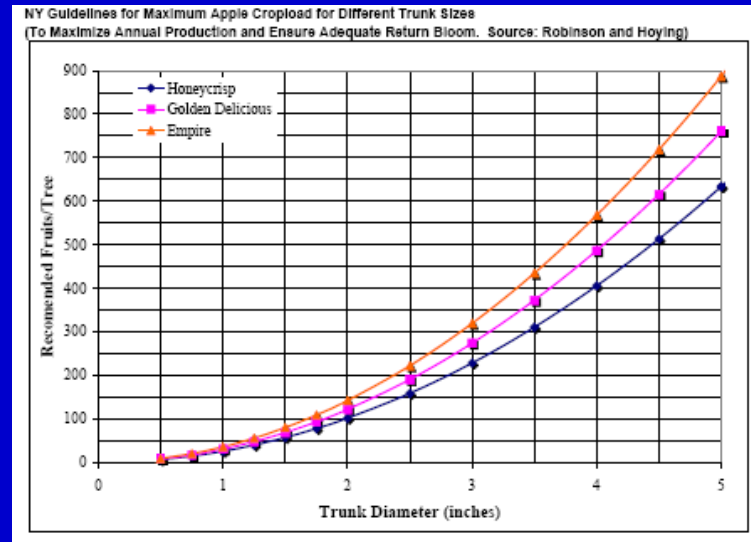


- Thinning always reduces yield in the current year.
- Annual thinning achieves consistent annual bearing.
- Annual full crops are more profitable than bumper crops followed by light crops.
- Annual thinning reduces biennial bearing.

# Acceptable Crop Loads

Empire = 10 fruit/sq cm TCA

Honeycrisp = 5 fruit/sq cm TCA

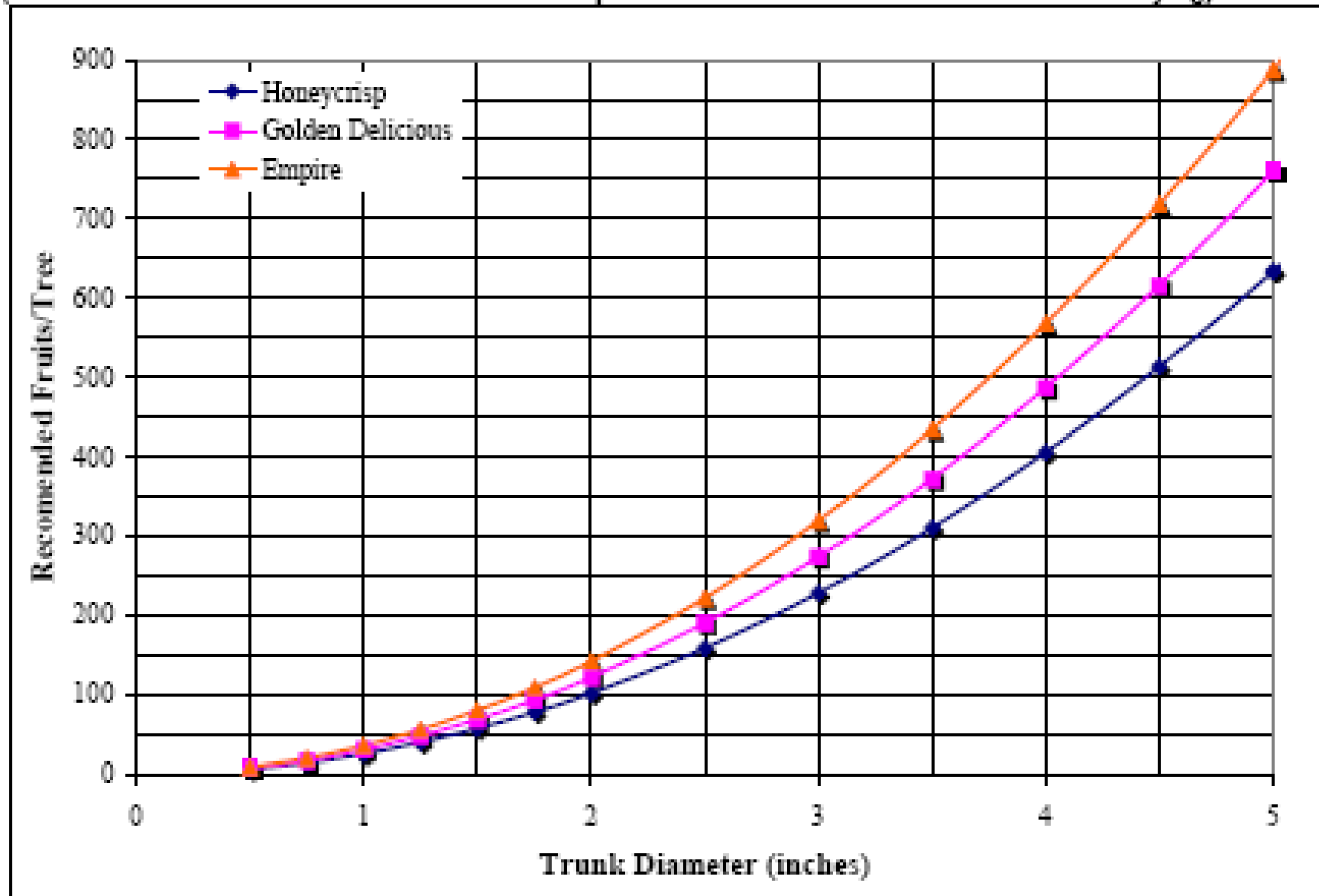


$$TCA = \pi \times r^2$$

# How much thinning?

NY Guidelines for Maximum Apple Cropload for Different Trunk Sizes

(To Maximize Annual Production and Ensure Adequate Return Bloom. Source: Robinson and Hoying)



# How and when to Thin?

- Pruning - Dormant
- Mechanical - Bloom
- Chemical - Bloom, PF, 8-16mm
- Hand - Before FB initiation

Typically two or more of these methods should be used in combination to achieve thinning success.

# When to Thin

- Dormant pruning – December to May
- Bloom – Mechanical thinning and caustic
- Petal fall – Hormone-type thinners
- Fruit set - Usually 7-14 days after bloom
  - 8-16 mm fruit diameter
- Fruit Growth – Use Hand thinning – promotes return bloom
  - June drop – 25 mm
- Fruit Growth – Use Hand Thinning – promotes improved fruit quality
  - July - harvest



# Fruit Development

- **Cell division**

- Early fruit thinning before the end of division stimulates remaining fruit to divide more freely creating more cells. Potential fruit size is limited by the number of cells available for expansion.

- **Cell expansion**

- Nutrients and water are transported to the fruit after cell division stage causing fruit to expand. There is a maximum size which cells can expand.



# Pruning

- Remove portion of fruit buds
  - Apple trees typically carry 100's of times the number of flowers needed to set a full crop.



- An inexact science, but annual pruning makes thinning easier since chemical thinning always removes a similar percentage of flowers or fruit despite the crop load.



# Mechanical Thinning



Mechanical Thinner  
"Darwin"  
N.M. Bartlett

# Mechanical Thinning

- Careful calibration of machine required
  - Tractor speed, drum rotation speed, string spacing
- Mode of action is physical damage to flowers.
- Non-selective
- Works best with narrow structured canopies
- Good Potential for fireblight

# Chemical Thinners

- **Naphthaline Acetic Acid (NAA)**
  - Hormone (auxin) type thinner
  - Can be applied from petalfall through 15 mm fruit diameter. Works by inhibiting photosynthesis and by slowing growth rate of fruit.
    - Should not be used at high rates on small fruited varieties or Red Delicious and Fuji
  - Rates recommended from 2.5 ppm to 15 ppm for thinning depending on whether used in combination with other thinners and the variety.
  - Best used with 378 L of water or better (up to 3X concentration).

# Chemical Thinners

- **Naphthalene Acetic Acid (NAA)**
  - Complete coverage necessary
  - Best used when temperatures are between 18 – 27 degrees C. Under-thinning at lower temperatures and over-thinning at higher temperatures.
  - Sunlight breaks down chemical so no residual activity.
  - Use on large fruited varieties or where depression of fruit size doesn't matter.

**Table 1. Thinners and Rates for Apple**

Stage FB-Full Bloom PF-Petal Fall mm-fruitlet size	Products	Rate	Product Required per		
			Litre of Water	Hectare	Acre
100% F B	ATS 0.6% v/v	Medium	10 mL	33.7 L	13.7 L
100% F B	ATS 0.75 % v/v	High	12.5 mL	42.1 L	17.1 L
P F	Amid-Thin	Low	0.24 g	809 g	327 g
P F	Amid-Thin	High	0.48 g	1,620 g	660 g
P F/7-14 mm	Seven XLR Plus	Low	0.87 mL	2.9 L	1.2 L
7-14 mm	Seven XLR Plus	High	1.25 mL	4.2 L	1.7 L
P F	Fruitone-N	Low-2.5 ppm	0.08 g	270 g	109 g
P F 7-12 mm	Fruitone-N	Medium-5 ppm	0.16 g	539 g	218 g
7-12 mm	Fruitone-N	High-7.5 ppm	0.24 g	809 g	327 g
7-12 mm	Fruitone-N	Very High-10 ppm	0.32 g	1,087 g	436 g
7-14 mm	Sevin XLR Plus & Fruitone-N	Low Low-Medium 2.5-5 ppm	0.87 mL 0.08-0.16 g	2.9 L 270-539 g	1.2 L 109-218 g
7-14	Sevin XLR Plus & Fruitone-N	High High 7.5 ppm	1.25 mL 0.24 g	4.2 L 809 g	1.7 L 327 g
PF-14 mm	MaxCell	Low-50 ppm	2.5 mL	8.4 L	3.4 L
7-14 mm	MaxCell	Medium Low 75 ppm	3.75 mL	12.6 L	5.1 L
7-14 mm	MaxCell	Medium High 100 ppm	5.0 mL	16.8 L	6.8 L
7-14 mm	MaxCell	High 125 ppm	6.25 mL	21.0 L	8.5 L
7-14 mm	MaxCell	Very High 150 ppm	7.5 mL	25.2 L	10.2 L
7-14 mm	Seven XLR Plus & MaxCel	High Medium High 100 ppm	1.25 mL 5.0 mL	4.2 L 16.8 L	1.7 L 6.8 L

Note: The product requirement is based on full tree-row canopy that would require water delivery of 3370 L/hectare, or 1363 L/acre or 300 imp gal/acre.

- Prepared by C. G. Embree AAFC and D. S. Nichols NSFGA

# Chemical Thinners

- **Carbaryl (Sevin)**

- Carbamate insecticide that can be used dual purpose for thinning and at higher rates for petal-fall pest control.
- Can be applied from petalfall through 20 mm fruit diameter. Best when applied early and in combination depending on variety.
- Rates recommended from 250 ml to 750 ml for liquid forms. Rate depends on potential for rewetting.
- Best used with 378 L of water or better (up to 3X concentration).
- A mild thinner that tends to single fruit within a cluster. Do not use on Cortland.



# Chemical Thinners

- **Benzyl Adenine (6 BA) (Maxcel, Riteway, Exilis Plus, Cilis plus)**
  - Hormone type (cytokinin) thinner
  - Stimulates cell division resulting in larger fruit
  - Can be applied from petal fall – 15 mm fruit diameter but is most effective between 10-12 mm.
  - Weather 3-5 days after application important and should expected to be 18° C.

# Chemical Thinners

- **Ethephon (Ethrel)**
  - Hormone type thinner used in NY as a rescue treatment only when weather conditions do not permit other materials at optimum fruit size.



# Other Chemicals That Thin

- **ATS (Ammonium thiosulphate)**
  - An inexpensive nitrogen-based fertilizer with caustic thinning mode of action. Should be applied immediately after pollination of King bloom and before pollination of side flowers
- **Vydate** – thinning properties similar to carbaryl at same timing. Very toxic to bees
- **Oil** – Fish oil, Spray oil
- **Lime Sulfer** – photosynthetic inhibitor combined with oil in organic programs. Very phytotoxic.

# FOLS

- Effective thinner.
- Broad application window.
  - Effective blossom thinner,
  - Effective post-bloom activity (photosynthesis depression).
- FOLS shows promise as a replacement for carbaryl & as an organic thinner.
- 3.8L Fish Oil : 7.6 L Lime Sulfer
- Must be able to tolerate phyto



# Caustic Bloom Thinners



# Hand Thinning

- Timing Important
- Break up clusters
  - Doubles or Singles depends on variety
  - light crop always leave multiple fruit per spur
- Reducing crop load
  - # fruit/TCA
- Remove whole clusters







# Fruit Bud Initiation and Return Bloom

Fruit buds initiate or form a flower primordia typically by the end of June in NY. This process determines whether there will be flowers on that spur the following year.

# of free spurs without fruit at initiation (end of June) determine the number of spurs available to set the following year.

Typically 50% or more of spurs on a tree should be free of fruit at initiation to insure the best chance of fruit set.

# Putting it all Together

- What are your objectives? Fruit quality, return bloom. How are you going to thin?
  - Pruning, Mechanical, Chemical, Hand or a combination.
  - Consider
    - Your history, have you been successful, unwanted side affects?
    - Varietal differences
    - Last Year
    - Current conditions
    - Chemicals available and cost



# Influence of Variety

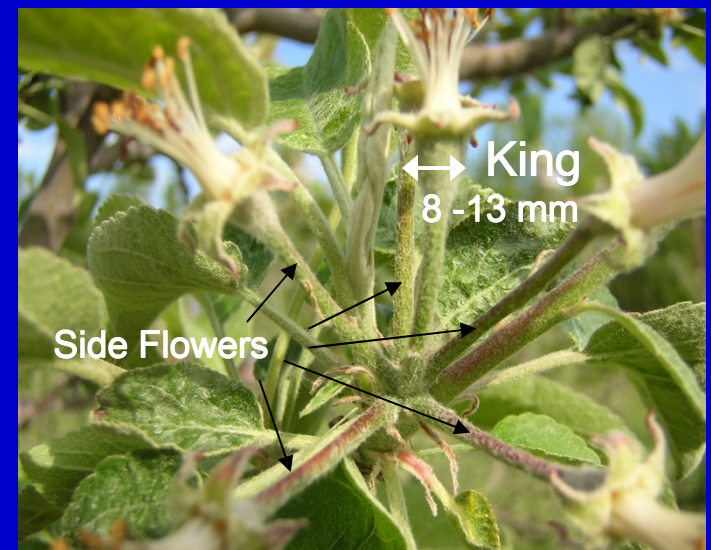
- Easy to Thin
  - IdaRed, McIntosh, Cortland, Ginger Gold
- Moderately Hard to Thin
  - Paula Red, Jonagold, Autumn Crisp, AceyMac
- Difficult to Thin
  - Liberty, Empire, Fuji, Gala, Honeycrisp, Macoun, Golden Delicious
- Determine whether light , heavy, or moderate thinning justified

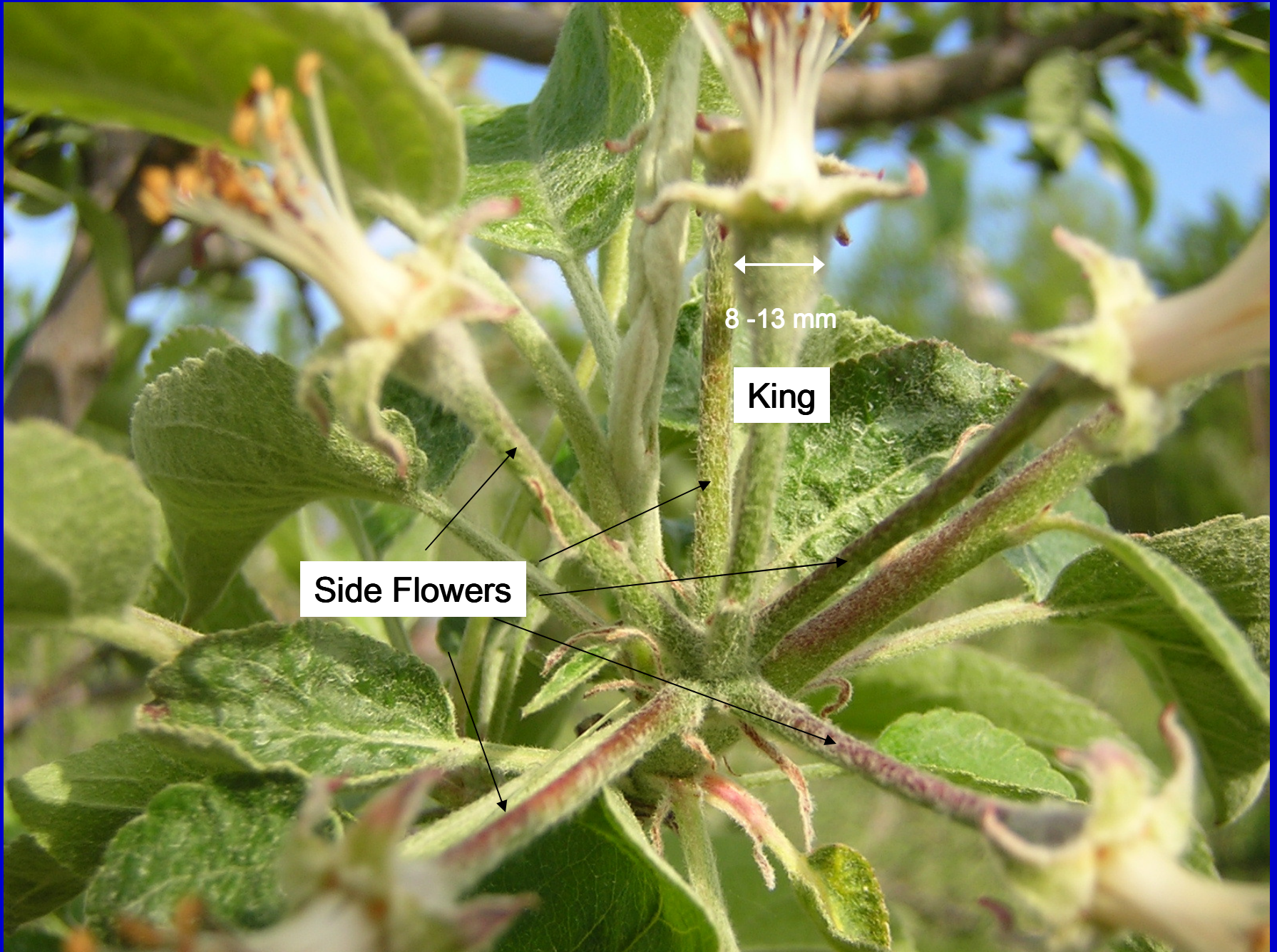
# Previous Season

- Analyze tree and crop data from previous season
  - Expected crop size - bienniality
  - Last year's growing conditions and tree health (carbohydrate accumulation based on crop (small vs large), leaf and tree health (mites, winter injury?))
- Determine whether light , heavy, or moderate thinning justified

# Current Season

- Analyze current tree and crop conditions
  - Bloom density
  - Pollination
  - Pre-thinning weather conditions
  - Fruit size
  - Presence of and separation between king and side fruitlets
  - Seed viability
  - Frost or other damage
- Determine whether light , heavy, or moderate thinning justified





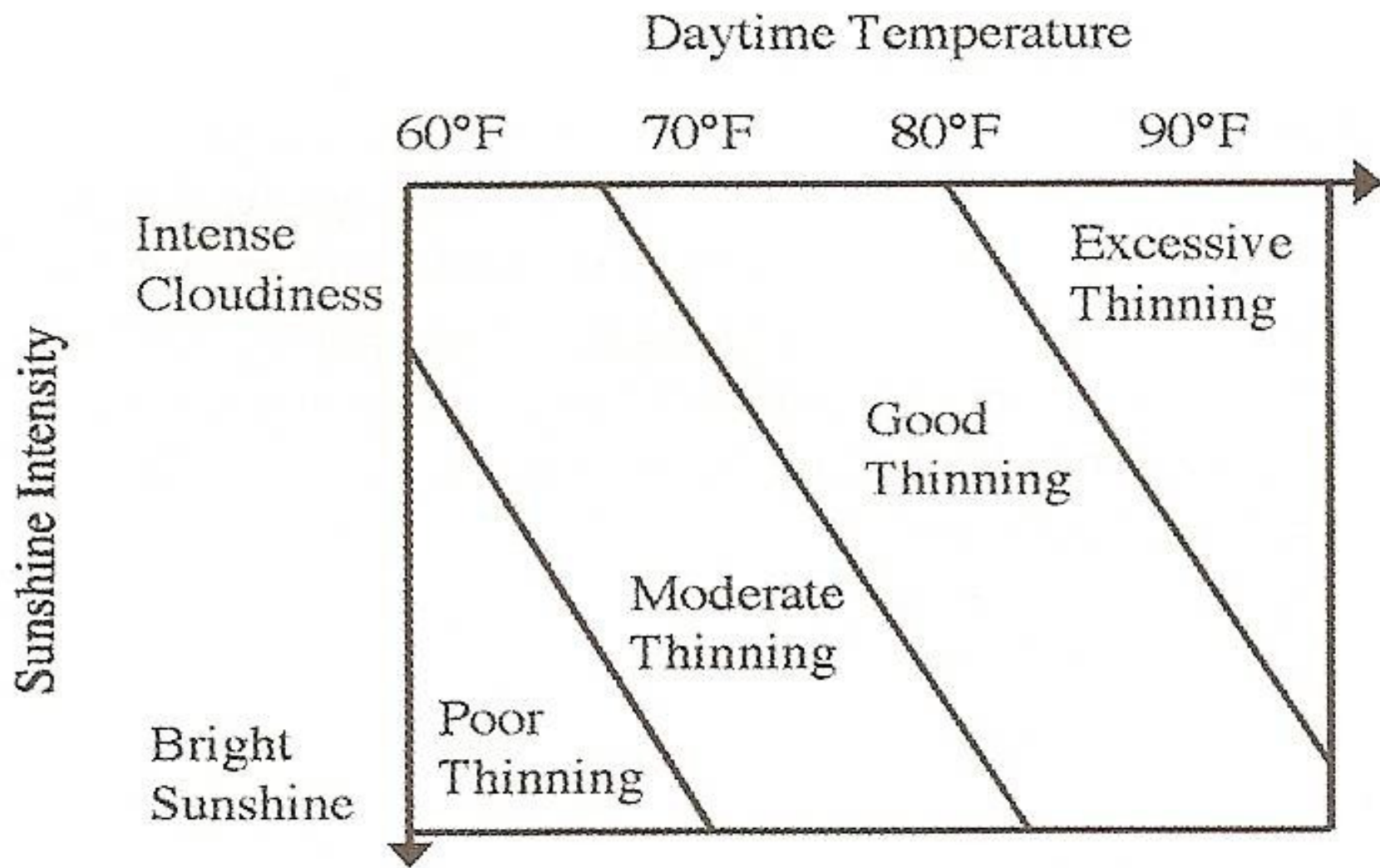
8 - 13 mm

King

Side Flowers

# Forecast

- **Analyze expected weather and application conditions**
  - Day and night temperatures
  - Sunlight vs cloudy conditions
  - Wind
  - Rainfall
- Determine how well your chemical thinners will work and whether to use low, medium or high rates based on amount of thinning needed.



**Figure 15. The interaction of temperature and sunlight intensity on thinner action.**



# Conditions that Warrant No Chemical Thinning

- very low flower density
- severe frost
- cool temperatures resulting in poor pollination and seed set.
- Hand thinning is **Often** required for these situations.



# Thinning Problem Varieties

- Use multiple spray approach.
- Use bloom spray on particularly difficult varieties such as Spur Delicious, Gala, Fuji, Golden Delicious, Macoun
- Follow up with petal fall sprays of carbaryl and a hormone type if warranted.
- Finish with a repeat of petal fall thinning sprays when fruit are 8-12 mm diameter if needed.

# Lakso Model

Simply stated:

“fruit that grows at less than 50% the rate of the fastest growing fruit during the thinning window will abscise”.

# The Greene Method



- Assess potential fruit on tree (or limbs) at pink by counting representative clusters and deciding the final # of fruit needed.
- Tag and keep track of individual fruitlets (7 representative trees and 15 representative spurs per tree per variety.)
- Measure and record each of these fruits at specific °DD intervals (50 °DD and 135 °DD base 50.)
- Enter these counts into the Schwallier spreadsheet.



<b>INPUT DIAMETERS</b>			Variety, Strain:		<b>Gala, Brookfield</b>		<b>2009</b>	
Treatment:		<b>Carbaryl plus Maxcel</b>			Block:		<b>1</b>	
Average Fruitlet Diameter		9.6	14.5	15.5				
# of Fruitlets measured		391	285	268	0	0	0	0

**Input diameters and dates into this sheet.**

Tree	Cluster	Flower	1	2	3	4	5	6	7
Tree	Cluster	Flower	5/21/09	5/27/09	5/30/09				
1	1	1	12.8	18.9	22.4				
1	1	2	11.1	12	11				
1	1	3	10	10.3	9.5				
1	1	4	9.8	11.4	10.8				
1	1	5	6.2						
1	1	6	5						

<b>SUMMARY</b>			Variety, Strain <b>Gala, Brookfield</b>				2009			
Treatment <b>Carbaryl plus Maxcel</b>							Block <b>1</b>			
<b>Sampling</b>			<b>Diameter (mm)</b>			<b>Number of Fruit</b>			<b>Predicted %</b>	
Number	Date	Days between sample dates	Mean of all measured fruitlets	Mean growth of up to 3 fastest growing fruitlets per tree	50% of fastest growing fruitlets	>50% fastest	<50% fastest	Measured	Set Based on Original # of Fruit	Drop Based on Original # of Fruit
1	5/21	0	9.64					391		
2	5/27	6	14.53	6.88	3.44	181	93	274	<b>46.3</b>	<b>53.7</b>
3	5/30	3	15.52	3.53	1.76	82	60	142	<b>21.0</b>	<b>79.0</b>
4				0.00	0.00	0	0	0	0.0	100.0
5				0.00	0.00	0	0	0	0.0	100.0
6				0.00	0.00	0	0	0	0.0	100.0
7				0.00	0.00	0	0	0	0.0	100.0

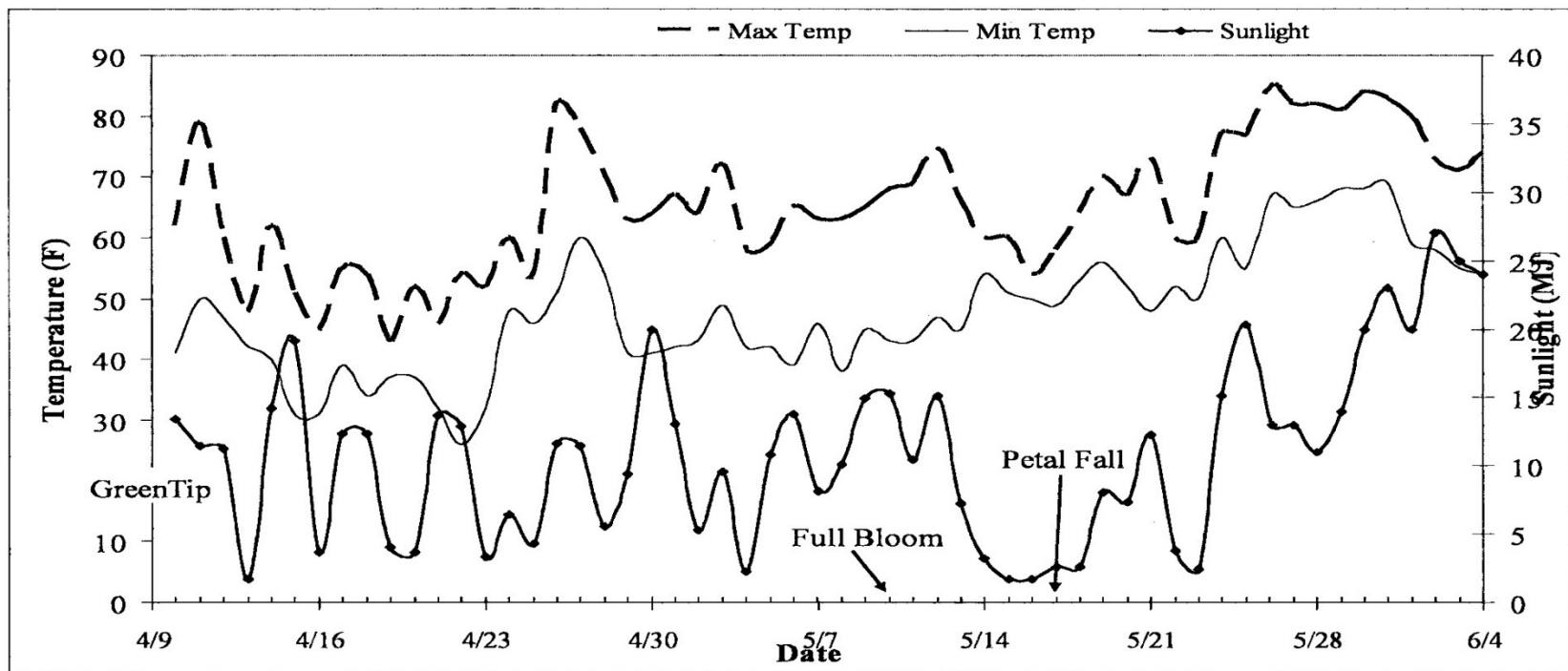
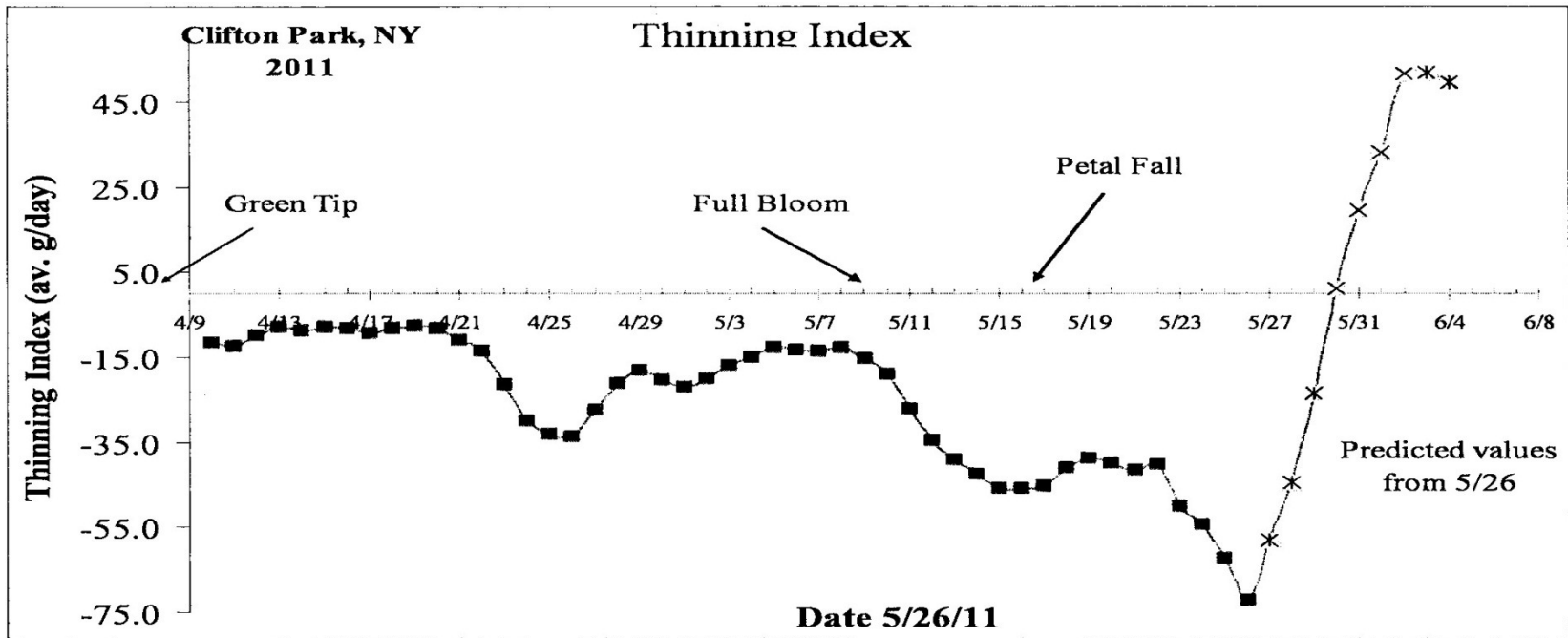
# The Problem

- Tag procedure is time consuming!
- Each counts take 4 hours per block per variety.
- Great for researchers but practically impossible for growers and consultants.
- Can the results be affected by other factors such as weather extremes and fruit stress or insect damage?



# Carbohydrate Model

- AN Lakso used Stella software to model apple tree growth and development.
- Based on Empire's on M9.
- Uses temperatures and solar radiation values to predict carbohydrate accumulation within the apple tree (it's not that simple!!!!)
- The theory is that carbohydrate balance within the tree at thinning time determines sensitivity of fruit to abscission. Low carbohydrate more abscission, high levels less abscission.



Clifton Park	Date	Thinning Index	Bloom	Bloom				Recommendations
NY	5/10/2011	-18.9	Bloom	Bloom				
	5/11/2011	-27.1						
	5/16/2011	-45.8						
	5/17/2011	-45.4	PF	PF				Thinners applied at PF worked better than expected - Reduce rate at normal timing
	5/18/2011	-41.0	Red	Empire				
	5/19/2011	-38.7	Delicious	McIntosh				
	5/20/2011	-40.0	Projected	Projected				
	5/21/2011	-41.7	Fruit Size	Fruit Size				
	5/22/2011	-40.1						
Monday	5/23/2011	-50.1						
Tuesday	5/24/2011	-54.4		8	Forecast	Forecast	Forecast	Caution Thinners applied this day worked better than expected
Wednesday	5/25/2011	-62.4	8	9	Temp	Winds	Solar Rad	Caution Thinners applied this day worked better than expected
Thursday	5/26/2011	-72.3	9	10	85	2	Partly Sunny	Caution Thinners will work better than expected - Reduce rate
Friday	5/27/2011	-57.9	10	11	82	2	Partly Sunny	Caution Thinners will work better than expected - Reduce rate
Saturday	5/28/2011	-44.5	11	11	82	10	Partly Sunny	Caution Thinners will work better than expected - Reduce rate
Sunday	5/29/2011	-23.5	11	12	81	5	Partly Sunny	Reduce Rates slightly, Thinners will work better than expected
Monday	5/30/2011	1.1	12	12	84	3	Mostly Sunny	Use normal thinning rates
Tuesday	5/31/2011	19.6	12	13	83	3	Sunny	Use normal thinning rates
Wednesday	6/1/2011	33.0	13	13	80	0	Mostly Sunny	Increase normal rates slightly
Thursday	6/2/2011	51.5	13	14	73	2	Sunny	Increase Normal Rates
Friday	6/3/2011	51.9	14	14	71	0	Sunny	Increase Normal Rates
Saturday	6/4/2011	49.6	14	15	74	1	Sunny	Increase Normal Rates
Sunday	6/5/2011	47.7	15	16	78	0	Mostly Sunny	Run model after May 26 for recommendations
			16	17				Empire, McIntosh window closed
			17	17				Red Delicious Window closed Thinning Window Closed
			17	18				Thinning Window Closed
			18					

# Model limitations

- This model still is not perfect! More work needed among varieties.
- It is only as good as the weather predictions!
- Interpreting solar radiation is difficult based on information available and many weather stations do not have a solar radiation capability
- Temperature and solar radiation differences among orchard blocks can differ significantly causing different results among orchards
- We do not know exactly how to interpret small differences in the Index in terms of sensitivity of fruitlets to thinning.

# Plans for the Future

- Simplify model eliminating unnecessary parts
- Put grower friendly model on the WEB for use and testing (grant from NYS 2012).
- Continue research among varieties
- Refine Thinning index and what it means
- Determine the influence of pre-thinning carbohydrate levels including overwintering and green-tip to petalfall levels.



**Thanks for having me!**

Questions?