

## What is Precision Thinning?

Precision Thinning is a strategy to manage the chemical thinning process better by:

1. Identifying the target number of fruit per tree in each block
2. Using the carbohydrate thinning model to predict thinning response on the date of a chemical thinning spray
3. Assessing the results of each thinning spray with the fruit growth rate model
4. Re-applying another chemical thinning spray if needed

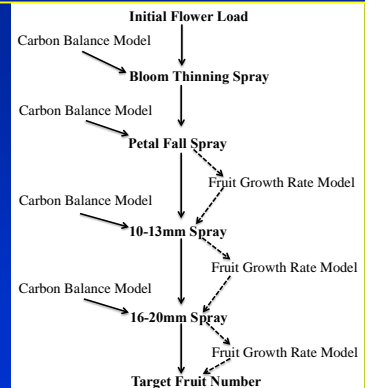


## Precision Crop Load Management

1. Prune to a specific flower bud number
2. Chemically thin to a specific fruit number
3. Hand thin to a specific fruit number



## Steps in Precision Thinning



## Step 1. Calculate the Target Fruit Number and Measure Initial Bud Load (Gala Tall Spindle Example 3'X12')

1. Determine desired yield/acre and desired fruit size  
 $1500 \text{ bu/acre} \times 100 \text{ apples/bu} = 150,000 \text{ fruits/acre}$   
 $150,000 \text{ fruits/acre} \div 1210 \text{ trees/acre} = 124 \text{ fruits/tree}$
2. Count flowering spurs on 5 representative trees at pink.  
 (In this example I counted 186 flowering spurs/tree X 5 flowers per spur = 930 potential fruits/tree)
3. Calculate the initial bud load  
 $\text{Flower buds/tree (186)} \div \text{target number of fruits (124)} = 1.5$
4. Calculate the percent of fruits needed (thinning task)  
 $124 \text{ fruits/tree} \div 930 \text{ potential fruits per tree} = 13.3\% \text{ fruit set}$



## Honeycrisp Tall Spindle Example 3'X12'

1. Determine desired yield/acre and desired fruit size  
 $1200 \text{ bu/acre} \times 88 \text{ apples/bu} = 105,800 \text{ fruits/acre}$   
 $105,800 \text{ fruits/acre} \div 1210 \text{ trees/acre} = 87 \text{ fruits/tree}$
2. Count flowering spurs on 5 representative trees at pink.  
 (In this example I counted 156 flowering spurs/tree X 5 flowers per spur = 783 potential fruits/tree)
3. Calculate the initial bud load  
 $\text{Flower buds/tree (156)} \div \text{target number of fruits (87)} = 1.8$
4. Calculate the percent of fruits needed (thinning task)  
 $87 \text{ fruits/tree} \div 783 \text{ potential fruits per tree} = 11.1\% \text{ fruit set}$



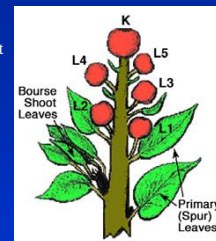
## Step 2. Apply sequential thinning sprays

- Bloom
  - Ammonium Thiosulfate (ATS) (2.5%)
  - Lime Sulfur (2.5%) and Fish Oil, Soybean oil or Damol (2%)
  - Promalin (2pt/acre)
  - NAA (8oz/acre)
  - Amid-Thin (16oz/acre)
- Petal Fall (fruits at 5-6mm)
  - Sevin (2pt/acre)
  - Amid-Thin (16oz/acre)
  - Maxcel (64-128oz/acre) + Sevin (2pt/acre)
  - NAA (4oz-8oz/acre) + Sevin (2pt/acre)
- Fruits at 10-14 mm
  - NAA (4oz-8oz/acre) + Sevin (2pt/acre)
  - Maxcel (64-128oz/acre)+ Sevin (2pt/acre)
  - Maxcel (64-128oz/acre) + NAA (3oz/acre)
- Fruits at 16-20 mm
  - Sevin (2pt/acre)+ (1pt/100gal)
  - Maxcel (64-128oz/acre)+ Sevin (2pt/acre) + Oil (1pt/100gal)
  - Ethrel (2-3pt/acre) + Oil (1qt/100gal)

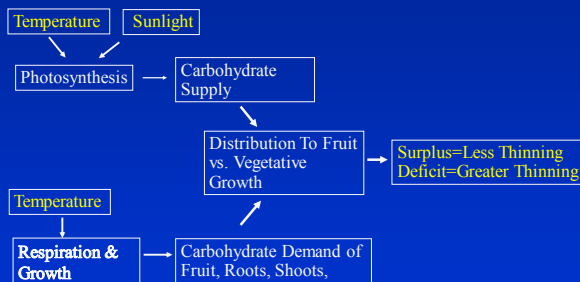
## Step 3. Use the Carbohydrate Model

### The Carbohydrate Theory of Thinning:

1. Fruitlets need carbohydrates to grow.
2. The tree allocates carbohydrates first to the shoot then to the fruits.
3. Weather conditions that result in low carbohydrate production often create a shortage of carbohydrates to support the growth of the fruits.
4. The weakest fruits do not receive enough carbohydrates and stop growing and begin to abscise.
5. Chemical thinners magnify the carbohydrate deficit and thus are more effective when applied during periods of natural shortage and are less effective when applied during periods of ample carbohydrate supply.



## The Carbohydrate Model



## New Web version of Carbohydrate Model

<http://newa.cornell.edu>

**Cornell Apple Carbohydrate Thinning Model**

Weather Station: [Select Station] | [Weather] | [Results] | [Print Info]

Apple Carbohydrate Thinning Model for Williams (Dennet)

Change grow up and/or bloom date and click "Calculate" to recalculate results.

Select Date: [4/1/2013] | [Continue]

Grow Up Date: [4/1/2013] | Bloom Date: [4/1/2013] | [Calculate]

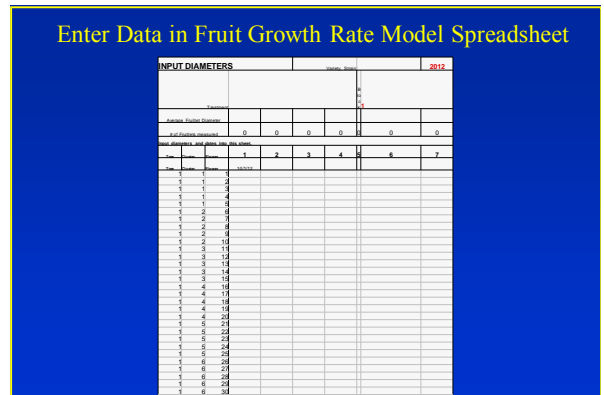
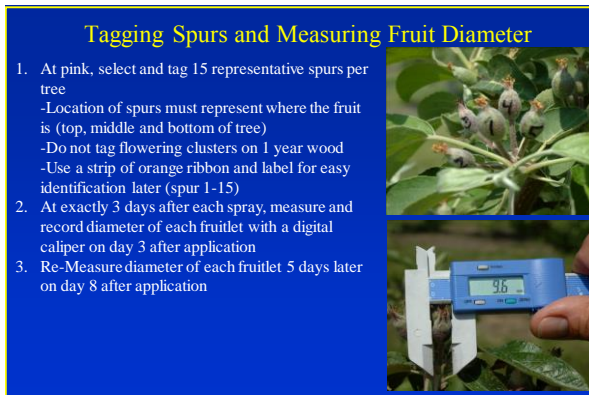
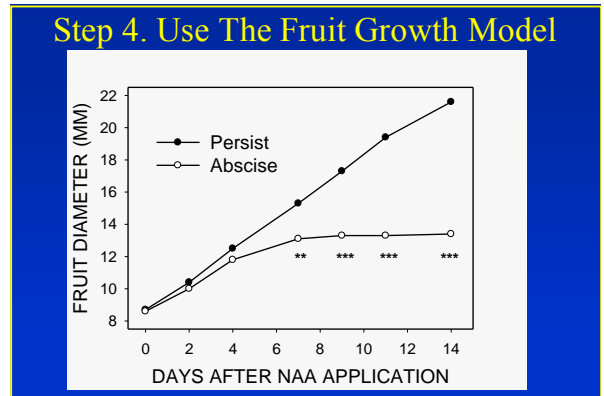
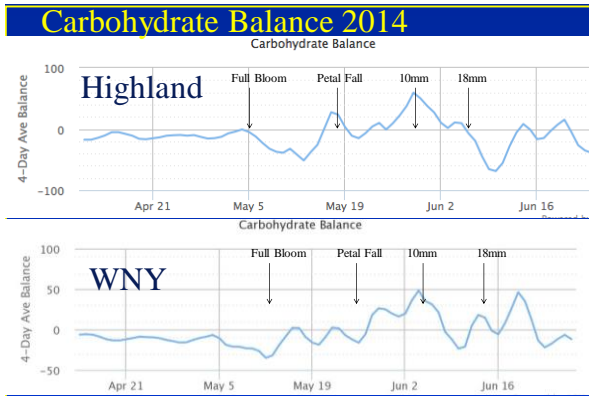
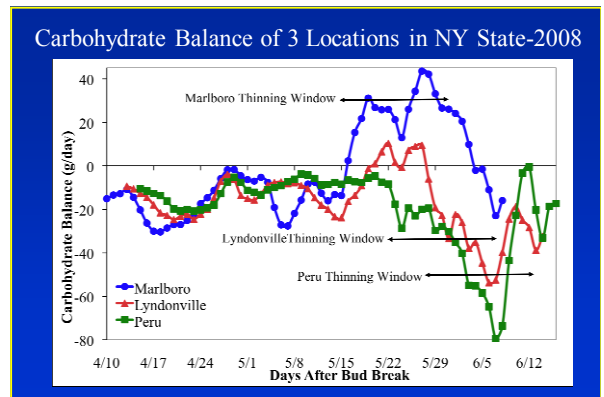
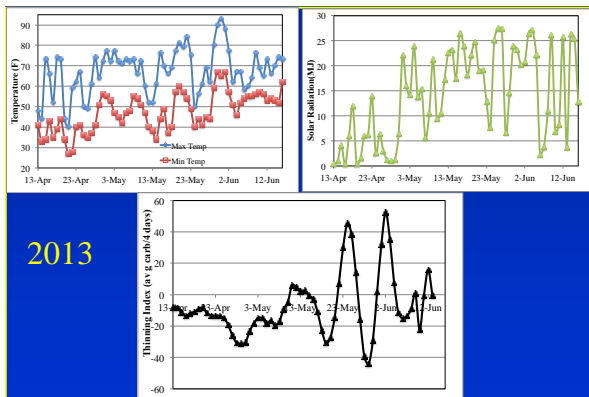
Apple Carbohydrate Thinning Model Results									
Date	Max Temp (°F)	Min Temp (°F)	Max Wind (mph)	Min Wind (mph)	Photosynth. Potential (g/m²/h)	Respiration (g/m²/h)	Net Carb. (g/m²/h)	Thinning Recommendation	Thinning Rate (%)
4/1	48	41	0.4	0.00	5.76	-1.76	4.00	-	-
4/2	44	35	1.0	0.00	5.30	-1.93	3.37	-	-
4/3	73	34	4.1	0.00	10.23	-10.23	-11.36	-	-
4/4	60	43	6.3	0.00	12.40	-12.40	-11.36	-	-
4/5	52	35	6.0	0.00	8.84	-8.84	-11.36	-	-
4/6	56	39	12.0	0.00	15.05	-15.05	-11	-	-
4/7	55	44	9.3	0.00	15.05	-15.05	-11	-	-
4/8	44	34	1.3	0.00	5.82	-1.82	4.00	-	-
4/9	40	27	6.0	0.00	3.29	-3.29	-11.82	-	-
4/10	39	28	6.2	0.00	6.75	-6.75	-13.17	-	-
4/11	42	40	13.9	0.39	15.41	-15.03	-13.43	-	-
4/14	47	41	2.6	0.00	20.18	-20.18	-13.54	-	-

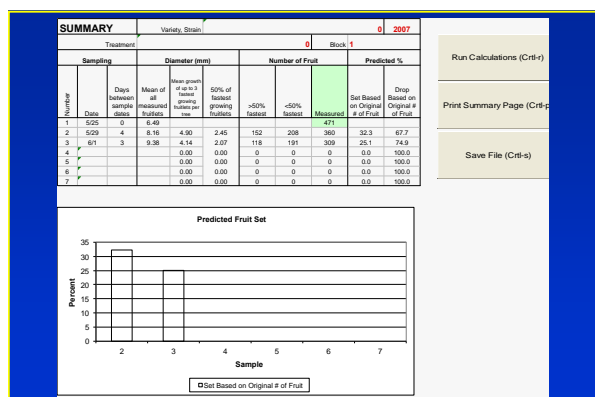
5/22	84	54	19.2	61.49	93.99	-32.50	4.37	Increase chemical thinner rate by 30%
5/23	75	49	12.9	54.73	70.94	-16.21	27.3	Increase chemical thinner rate by 30%
5/24	50	40	7.7	39.36	27.10	12.26	42.15	Increase chemical thinner rate by 30%
5/25	56	44	25.1	93.50	39.57	53.93	34.88	Increase chemical thinner rate by 30%
5/26	61	41	27.5	102.02	42.80	59.22	10.59	Increase chemical thinner rate by 30%
5/27	69	45	27.4	103.73	60.54	43.20	-19.91	Apply standard chemical thinner rate
5/28	62	44	6.6	33.54	50.37	-16.83	-45.19	Decrease chemical thinner rate by 30%
5/29	80	59	14.5	58.79	102.04	-43.25	-51.49	Decrease chemical thinner rate by 30%
5/30	90	67	23.9	71.26	134.04	-62.78	-36.33	Decrease chemical thinner rate by 15%
5/31	93	65	23.2	68.42	126.34	-57.92	-4	Apply standard chemical thinner rate
6/1	88	67	20.2	65.97	108.00	-42.02	28.36	Increase chemical thinner rate by 30%
6/2	77	57	20.7	89.22	71.82	17.41	50.57	Increase chemical thinner rate by 30%
6/3	62	51	26.5	114.18	47.65	66.53	34.17	Increase chemical thinner rate by 30%
6/4	67	46	27.2	119.36	47.84	71.52	6.75	Increase chemical thinner rate by 30%
6/5	67	52	22.1	102.98	56.18	46.80		
6/6	58	54	2.3	0.59	48.77	-48.18		
6/7	60	55	3.8	12.10	55.24	-43.15		

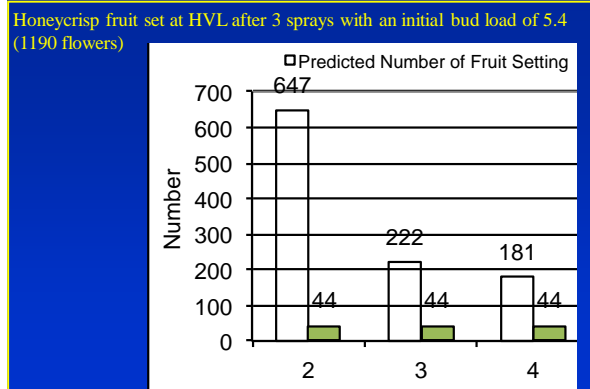
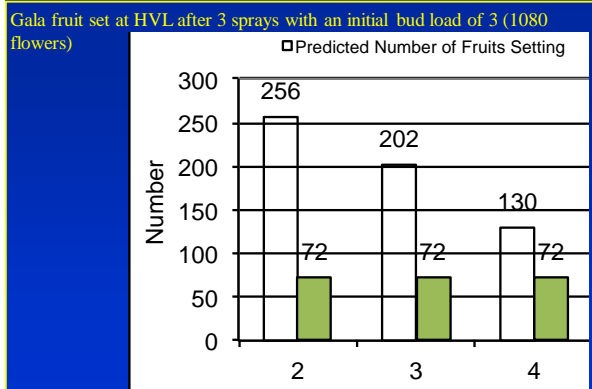
## Decision Rules We Use to Make Recommendations with the Carbohydrate Model

### 4-Day Av. Carb. Balance Thinning Recommendation

- +20g/day to +40g/day: Increase Chemical Thinning Rate by 30%
- +20g/day to 0g/day: Increase Chemical Thinning Rate by 15%
- 0g/day to -20g/day: Apply Standard Chemical Thinning Rate
- 20g/day to -40g/day: Decrease Chemical Thinning Rate by 10%
- 40g/day to -60 g/day: Decrease Chemical Thinning Rate by 20%
- 60g/day to -80 g/day: Decrease Chemical Thinning Rate by 30%
- < than -80g/day: Do not thin (many fruits will fall off naturally)





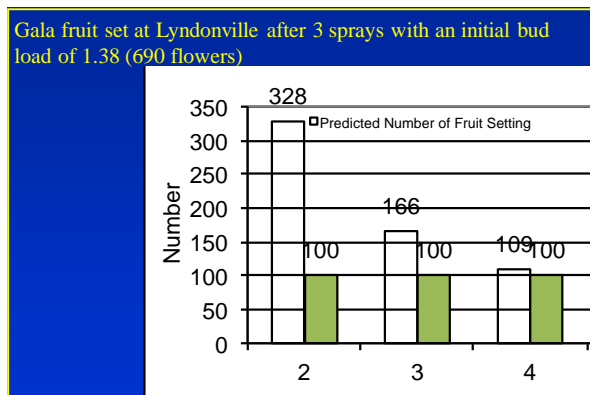
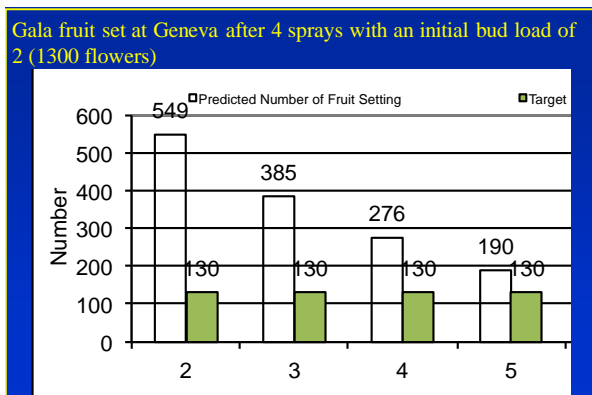


Final Results of the Precision Thinning Protocol in 2014

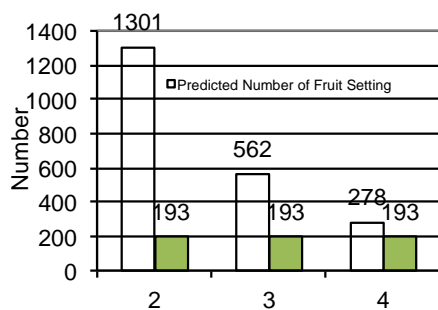
Block	Variety	Target Number of Fruitlets	Extra Fruits Still on Tree May 28	Recommendation May 28	Final Fruit/ tree in July	Extra fruits on tree in July
1	HC	176	-4	Thinning is done	157	-19
2	HC	82	93	Need another 3/4 dose spray of NAA+Sevin	134	52
3	HC	72	96	Need another 3/4 dose spray of NAA+Sevin	71	-1
4	HC	44	613	Need another full spray of NAA+Sevin		
5	Gala	125	291	Need another full spray of Maxcel+Sevin	134	9
6	Gala	102	328	Need another full spray of Maxcel+Sevin	76	-26
7	Gala	132	362	Need another full spray of Maxcel+Sevin	108	-24
8	Gala	349	45	Hand Thin only	255	-94
9	Gala	450	567	Need another full spray of Maxcel+Sevin		
10	Gala	248	469	Need another full spray of Maxcel+Sevin	192	-56
11	Gala	100	308	Need another full spray of Maxcel+Sevin	85	-15
12	Gala	72	181	Need another full spray of Maxcel+Sevin		-72
13	Fuji	170	124	Need another 3/4 dose spray of Maxcel+Sevin	109	-61
14	Fuji	110	48	Hand Thin only	74	-36
15	Fuji	454	-12	Thinning is done		
16	Fuji	182	314	Need another full spray of Maxcel+Sevin	159	-23
17	Fuji	76	248	Need another full spray of Maxcel+Sevin	84	-8

Carbohydrate Balance Hudson Valley Lab 2014

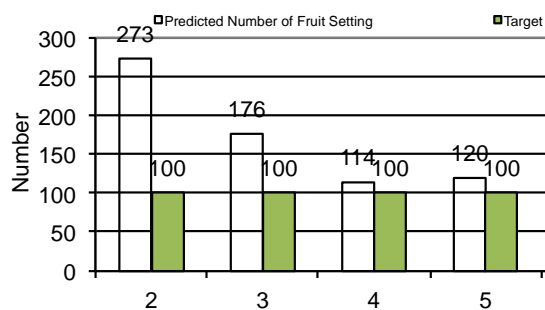
6/2	82	54	28.0	110.16	71.63	38.53	10.19	Increase chemical thinner rate by 30%
6/3	86	63	23.7	86.14	91.36	-5.22	1.66	Increase chemical thinner rate by 30%
6/4	78	61	23.9	98.09	80.53	17.56	10.68	Increase chemical thinner rate by 30%
6/5	71	59	12.8	62.48	72.60	-10.11	9.51	Increase chemical thinner rate by 30%
6/6	74	53	15.2	76.86	72.45	4.41	-6.85	Apply standard chemical thinner rate
6/7	80	53	26.5	112.24	81.38	30.86	-19.45	Apply standard chemical thinner rate
6/8	83	56	25.9	105.72	92.85	12.87	-44.85	Decrease chemical thinner rate by 30%
6/9	68	62	4.0	6.77	82.31	-75.54	-65.7	Decrease chemical thinner rate by 50%
6/10	79	62	12.4	55.25	101.24	-45.99	-68.84	-
6/11	71	60	5.3	16.96	87.69	-70.73	-55.53	-
6/12	65	58	3.5	6.52	77.07	-70.55	-28.22	-
6/13	74	65	5.0	10.83	98.92	-88.09	-5.87	-
6/14	70	55	16.7	87.77	80.52	7.25	8.18	-
6/15	74	52	25.8	119.84	81.33	38.51	-0.96	-
6/16	82	55	26.5	115.27	96.42	18.85	-16.62	-
6/17	87	64	20.9	85.32	117.23	-31.91	-14.8	-
6/18	84	67	21.8	88.71	118.01	-29.30	-3.02	-
6/19	80	61	16.1	78.78	102.91	-24.13	7.02	-
6/20	75	53	22.2	110.98	84.85	26.12	15.28	-
6/21	77	52	19.4	101.10	85.88	15.23	-4.68	-
6/22	80	54	31.3	104.64	95.78	10.86	-26.48	-



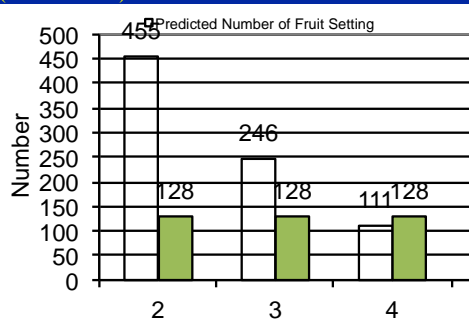
Gala fruit set in CNY after 3 sprays with an initial bud load of 2.2 (2130 flowers)



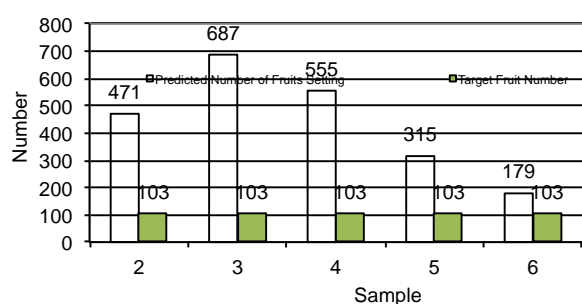
HC fruit set at Geneva after 4 sprays with an initial bud load of 2.6 (1300 flowers)



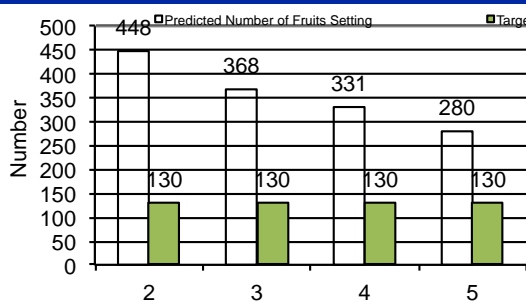
Honeycrisp fruit set in CNY after 3 sprays with an initial bud load of 1.8 (1185 flowers)



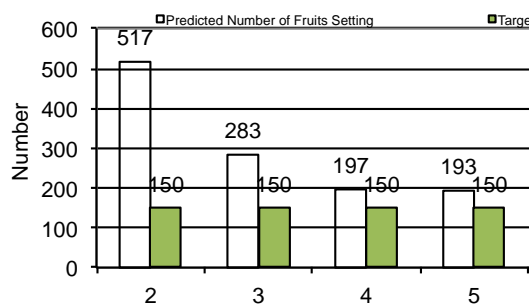
Honeycrisp fruit set at Chazy after 4 sprays with an initial bud load of 3.4 (1765 flowers)



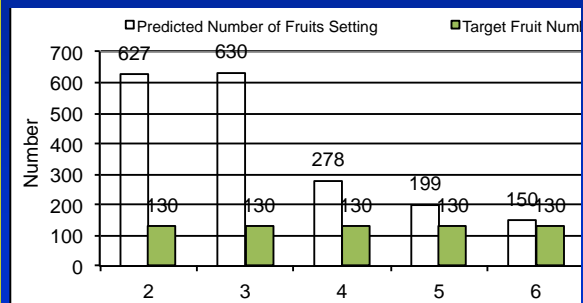
Honeycrisp fruit set at Peru after 3 sprays with an initial bud load of 1.5 (1000 flowers)



Honeycrisp fruit set at Sullivins at Peru after 3 sprays with an initial bud load of 1.7 (1250 flowers)



### Gala fruit set at Albany after 4 sprays with an initial bud load of 1.9 (1225 flowers)



### Conclusions from the Group Precision Thinning in 2014

- Both Gala and Honeycrisp needed more pruning to reduce bud load to 1:1.5 for Gala and 1:1.8 for Honeycrisp
- Most Gala blocks did not thin enough and had significantly more fruit than the target fruit number
  - This required significant hand thinning
- Most Honeycrisp blocks thinned enough and a few overthinned slightly
- Bloom and Petal Fall thinning sprays were quite effective
  - Bloom sprays of Amid-thin did a nice job
- The 10mm spray worked well in 2014.
- The 18mm spray of Maxcel/Sevin/Oil worked well and was more effective than Ethrel/oil.
- The sequential sprays gave excellent crop load control.

### Precision Thinning Group Effort in 2015

#### Protocol for group effort of willing participants in 2015

- Select a mature orchard of either Gala or Honeycrisp.
- Count all flowering clusters on 5 representative trees at pink.
- Calculate target fruit number for a high yield.
- Tag 15 spurs per tree on each of 5 representative trees (75 total spurs) at pink.
- Apply one of two spray protocols of thinning sprays
- Use the carbohydrate model to adjust rates up or down based on model recommendations
- Measure fruit diameters on 75 spurs 6 times (3 and 8 days after petal fall spray, 3 and 8 days after 12mm spray and 3 and 8 days after 18 mm spray)
- Send the data within 24 hours after each 8 day measurement to Terence Robinson
- Get back an assessment within 24 hours of thinning progress before next spray

### Two Options in 2015 for Precision Thinning of Gala

#### Option 1

- Apply a Bloom Spray  
NAA (4oz/100=8oz/acre on Tall Spindle)
- Apply a Petal Fall Spray (5mm)  
NAA (3oz/100=6oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply a 12 mm Spray  
Maxcel (48oz/100=96oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply an 18 mm spray (if needed)  
Maxcel (48oz/100=96oz/acre) +  
Sevin (1pt/100=2pt/acre) +  
Oil (1pt/100gal water) don't concentrate oil  
(directed to the upper part of the tree)

#### Option 2 (No bloom spray)

- Apply a Petal Fall Spray (5mm)  
NAA (3oz/100=6oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply a 12 mm Spray  
Maxcel (48oz/100=96oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply an 18 mm spray (if needed)  
Maxcel (48oz/100=96oz/acre) +  
Sevin (1pt/100=2pt/acre) +  
Oil (1pt/100gal water don't concentrate oil)  
(directed to the upper part of the tree)

### Two Options in 2015 for Precision Thinning of Honeycrisp

#### Option 1

- Apply a Bloom Spray  
NAA (4oz/100=8oz/acre on Tall Spindle)
- Apply a Petal Fall Spray (5mm)  
NAA (4oz/100=8oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply a 12 mm Spray  
NAA (3oz/100=6oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply an 18 mm spray (if needed)  
Sevin (1pt/100=2pt/acre) +  
Oil (1pt/100gal water) don't concentrate oil  
(directed to the upper part of the tree)

#### Option 2 (No Bloom Spray)

- Apply a Petal Fall Spray (5mm)  
NAA (4oz/100=8oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply a 12 mm Spray  
NAA (3oz/100=6oz/acre) +  
Sevin (1pt/100=2pt/acre)
- Apply an 18 mm spray (if needed)  
Sevin (1pt/100=2pt/acre) +  
Oil (1pt/100gal water) don't concentrate oil  
(directed to the upper part of the tree)

### Spray Mixing Protocol

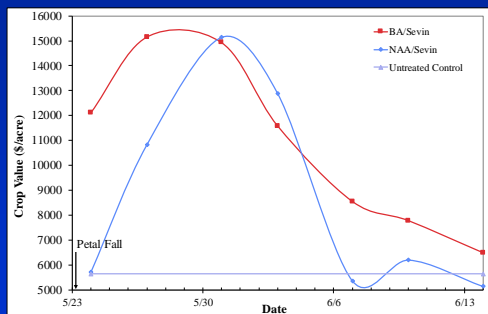
- Calculate Tree Row Volume  
(Tree height X Tree width X 43,560 X 0.7) / (Between row spacing X 1000)  
For many mature Tall Spindle Orchards this is ~170-210 gallons/acre  
Example (11' X 7' X 43560 X 0.7) / (12' X 1000) = 196 gallons/acre
- Set sprayer up to spray ½ of Tree Row Volume (~85-100 gallons/acre)  
This is a 2X application
- Concentrate the chemicals in the tank 2X  
Add the rate/100 gallons X 2 of each chemical (except oil or surfactants)  
Example 4oz Fruitone L/100 gallons X 2 = 8oz Fruitone L/100 gallons of finished spray mix X 5 = 40 oz/sprayer  
48 oz Maxcel/100 gallons X 2 = 96 oz Maxcel/100 gallons X 5 = 480oz /sprayer  
1pt Sevin/100 gallons X 2 = 2 pt Sevin/100 gallons X 5 = 10 pt/sprayer
- Spray 100 gallons / acre or ½ of the TRV of water  
A 500 gallon sprayer should cover 5 acres



## Next Steps

1. Send me an email today (tlr1@cornell.edu)
2. I will send you a copy of the fruit growth rate model spreadsheet (MS Excel)
3. Decide which varieties you will work with.
4. Calculate target fruit number for a high yield.
5. Count flowering clusters on 5 representative trees at pink.
6. Send target fruit number and flower cluster counts to TLR by petal fall.
7. Tag 15 spurs per tree on each of 5 representative trees (75 total spurs) at pink.
8. Apply one of two spray protocols
9. Use the carbohydrate model to adjust rates up or down based on model recommendations
10. Measure fruit diameters on 75 spurs 6 times (3 and 8 days after petal fall spray, 3 and 8 days after 12mm spray, 3 and 8 days after 18 mm spray)
11. Send the data within 24 hours after each measurement to Terence Robinson
12. Get back an assessment within 24 hours of thinning progress before next spray
13. Count fruit number of the 5 trees before hand thinning in June or July

## Gala Crop Value in 2011 at Geneva



## Plan to Manage Crop Load in 2015:

1. **Precision Prune**
  1. Count flower buds on 5 representative trees per variety.
  2. Prune to 1.5 buds per desired fruit number with Gala and 1.8 for Honeycrisp by removing 1-3 of the larger limbs
  3. Columnarize (simplify) all remaining branches
2. **Chemically thin using the "Precision Thinning Program"**
  1. Begin with a full bloom spray
  2. Apply a petal fall thinning spray
  3. Assess response
  4. If necessary, apply a thinning spray at 10-13mm
  5. Re-assess response
  6. If necessary apply a thinning spray at 18-20mm
3. **Hand thin with Precision Hand Thinning**
  - Count number of fruits per tree on 5 representative trees before hand thinning
  - Calculate extra fruits per tree
  - Use zone thinning using multi-level platform with each person removing his assigned number of fruits focusing on small and imperfect fruits.

