Precision Chemical Thinning-2015

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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

- Initial Flower Load
  - Carbon Balance Model
  - Bloom Thinning Spray
  - Carbon Balance Model
  - Petal Fall Spray
  - Carbon Balance Model
  - Fruit Growth Rate Model
  - 10-13mm Spray
  - Carbon Balance Model
  - Fruit Growth Rate Model
  - 16-20mm Spray
  - Carbon Balance Model
  - Fruit Growth Rate Model
  - Target Fruit Number

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 bu/acre X 100 apples/bu = 150,000 fruits/acre
   - 150,000 fruits/acre ÷ 1210 trees/acre = 124 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
   - Flower buds/tree (186) ÷ target number of fruits (124) = 1.5
4. Calculate the percent of fruits needed (thinning task)
   - 124 fruits/tree ÷ 930 potential fruits per tree = 13.3%

**Honeycrisp Tall Spindle Example 3’X12’**

1. Determine desired yield/acre and desired fruit size
   - 1200 bu/acre X 88 apples/bu = 105,800 fruits/acre
   - 105,800 fruits/acre ÷ 1210 trees/acre = 87 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
   - Flower buds/tree (156) ÷ target number of fruits (87) = 1.8
4. Calculate the percent of fruits needed (thinning task)
   - 87 fruits/tree ÷ 783 potential fruits per tree = 11.1%

fruit set
Step 2. Apply sequential thinning sprays

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

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

<table>
<thead>
<tr>
<th>4-Day Av. Carb Balance</th>
<th>Thinning Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>~20g/day to ~40g/day</td>
<td>Increase Chemical Thinning Rate by 30%</td>
</tr>
<tr>
<td>+20g/day to 0g/day</td>
<td>Increase Chemical Thinning Rate by 15%</td>
</tr>
<tr>
<td>0g/day to -20g/day</td>
<td>Apply Standard Chemical Thinning Rate</td>
</tr>
<tr>
<td>-20g/day to -40g/day</td>
<td>Decrease Chemical Thinning Rate by 10%</td>
</tr>
<tr>
<td>-40g/day to -60g/day</td>
<td>Decrease Chemical Thinning Rate by 20%</td>
</tr>
<tr>
<td>-60g/day to -80g/day</td>
<td>Decrease Chemical Thinning Rate by 30%</td>
</tr>
<tr>
<td>&lt; than ~80g/day</td>
<td>Do not thin (many fruits will fall off naturally)</td>
</tr>
</tbody>
</table>
Carbohydrate Balance of 3 Locations in NY State-2008

Carbohydrate Balance 2014

Step 4. Use The Fruit Growth Model

Tagging Spurs and Measuring Fruit Diameter

1. At pink, select and tag 15 representative spurs per tree
   - Location of spurs must represent where the fruit is (top, middle and bottom of tree)
   - Do not tag flowering clusters on 1 year wood
   - Use a strip of orange ribbon and label for easy identification later (spur 1-15)
2. At exactly 3 days after each spray, measure and record diameter of each fruitlet with a digital caliper on day 3 after application
3. Re-Measure diameter of each fruitlet 5 days later on day 8 after application

Enter Data in Fruit Growth Rate Model Spreadsheet
NY Participants in Precision Thinning Group Effort 2014

Abbott
Buhr
Cahoon
Coene
Dominguez
Farrow
Furber
Hance
Oaks
Reisinger
Russell
Smith
Vandewalle

Using the Pruning Shears to Thin (Reducing Bud Load)

Target 1.5 flower buds : 1 final fruit

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Precision Thinning Orchards in HV in 2014

<table>
<thead>
<tr>
<th>Block</th>
<th>Variety</th>
<th>Initial Number of Fruits</th>
<th>Target</th>
<th>Target Bud Load</th>
<th>Estimated Bud Load</th>
<th>Bud Load Ratio</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>HC</td>
<td>775</td>
<td>176</td>
<td>9</td>
<td>2.07</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>HC</td>
<td>1075</td>
<td>82</td>
<td>2.6</td>
<td>1.085</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>HC</td>
<td>1190</td>
<td>44</td>
<td>5.6</td>
<td>1.195</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
<td>Gala</td>
<td>1880</td>
<td>125</td>
<td>3.0</td>
<td>1.895</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>Gala</td>
<td>1825</td>
<td>102</td>
<td>1.9</td>
<td>1.985</td>
<td>1.0</td>
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<tr>
<td>6</td>
<td>Gala</td>
<td>2080</td>
<td>132</td>
<td>3.2</td>
<td>2.085</td>
<td>1.0</td>
</tr>
<tr>
<td>7</td>
<td>Gala</td>
<td>1895</td>
<td>349</td>
<td>1.1</td>
<td>1.895</td>
<td>0.87</td>
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<tr>
<td>8</td>
<td>Gala</td>
<td>2725</td>
<td>450</td>
<td>1.2</td>
<td>2.725</td>
<td>1.0</td>
</tr>
<tr>
<td>9</td>
<td>Gala</td>
<td>3090</td>
<td>248</td>
<td>1.2</td>
<td>3.090</td>
<td>1.0</td>
</tr>
<tr>
<td>10</td>
<td>Gala</td>
<td>1985</td>
<td>100</td>
<td>4.0</td>
<td>1.985</td>
<td>0.98</td>
</tr>
<tr>
<td>11</td>
<td>Gala</td>
<td>1080</td>
<td>72</td>
<td>1.0</td>
<td>1.080</td>
<td>1.0</td>
</tr>
<tr>
<td>12</td>
<td>Fuji</td>
<td>1060</td>
<td>170</td>
<td>1.2</td>
<td>1.060</td>
<td>1.0</td>
</tr>
<tr>
<td>13</td>
<td>Fuji</td>
<td>1260</td>
<td>110</td>
<td>2.3</td>
<td>1.260</td>
<td>1.0</td>
</tr>
<tr>
<td>14</td>
<td>Fuji</td>
<td>2440</td>
<td>454</td>
<td>1.1</td>
<td>2.440</td>
<td>1.0</td>
</tr>
<tr>
<td>15</td>
<td>Fuji</td>
<td>1880</td>
<td>182</td>
<td>2.1</td>
<td>1.880</td>
<td>1.0</td>
</tr>
<tr>
<td>16</td>
<td>Fuji</td>
<td>1640</td>
<td>76</td>
<td>4.3</td>
<td>1.640</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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Gala and Honeycrisp Bud Load Study

- Leaving more than 2 buds: final fruit resulted in a large job of hand thinning
- Was my target right?

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Initial Results of the Precision Thinning Protocol in 2014

<table>
<thead>
<tr>
<th>Block</th>
<th>Variety</th>
<th>Target Number of Fruits on Tree on May 28, 2014</th>
<th>Extra Fruits</th>
<th>Still on Tree</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HC</td>
<td>76</td>
<td>172</td>
<td>-4</td>
<td>Thinning in done</td>
</tr>
<tr>
<td>2</td>
<td>HC</td>
<td>125</td>
<td>175</td>
<td>93</td>
<td>Need another 3/4 dose spray of NAA+Sevin</td>
</tr>
<tr>
<td>3</td>
<td>HC</td>
<td>72</td>
<td>196</td>
<td>96</td>
<td>Need another 3/4 dose spray of NAA+Sevin</td>
</tr>
<tr>
<td>4</td>
<td>HC</td>
<td>44</td>
<td>657</td>
<td>613</td>
<td>Need another full spray of NAA+Sevin</td>
</tr>
<tr>
<td>5</td>
<td>Gala</td>
<td>125</td>
<td>430</td>
<td>328</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>6</td>
<td>Gala</td>
<td>123</td>
<td>498</td>
<td>362</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>7</td>
<td>Gala</td>
<td>349</td>
<td>394</td>
<td>45</td>
<td>Hand Thin only</td>
</tr>
<tr>
<td>8</td>
<td>Gala</td>
<td>450</td>
<td>1017</td>
<td>567</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>9</td>
<td>Gala</td>
<td>248</td>
<td>717</td>
<td>469</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>10</td>
<td>Gala</td>
<td>100</td>
<td>408</td>
<td>308</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>11</td>
<td>Gala</td>
<td>72</td>
<td>253</td>
<td>181</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>12</td>
<td>Gala</td>
<td>40</td>
<td>10</td>
<td></td>
<td>Hand Thin only</td>
</tr>
<tr>
<td>13</td>
<td>Fuji</td>
<td>170</td>
<td>296</td>
<td>124</td>
<td>Need another 3/4 dose spray of Mescal+Sevin</td>
</tr>
<tr>
<td>14</td>
<td>Fuji</td>
<td>110</td>
<td>158</td>
<td>48</td>
<td>Hand Thin only</td>
</tr>
<tr>
<td>15</td>
<td>Fuji</td>
<td>454</td>
<td>442</td>
<td>-12</td>
<td>Thinning done</td>
</tr>
<tr>
<td>16</td>
<td>Fuji</td>
<td>182</td>
<td>496</td>
<td>314</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
<tr>
<td>17</td>
<td>Fuji</td>
<td>76</td>
<td>324</td>
<td>248</td>
<td>Need another full spray of Mescal+Sevin</td>
</tr>
</tbody>
</table>
Gala fruit set at HVL after 3 sprays with an initial bud load of 3 (1080 flowers)

Honeycrisp fruit set at HVL after 3 sprays with an initial bud load of 5.4 (1190 flowers)

Gala fruit set at Geneva after 4 sprays with an initial bud load of 2 (1300 flowers)

Gala fruit set at Lyndonville after 3 sprays with an initial bud load of 1.38 (690 flowers)
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 Sullivans at Peru after 3 sprays with an initial bud load of 1.7 (1250 flowers)
This required significant hand thinning
Select a mature orchard of either Gala or blocks thinned enough and a few
(48oz/100=96oz/acre) +
Count all flowering clusters on 5 representative trees at pink.
(1pt/100=2pt/acre) +
Measure fruit diameters on 75 spurs 6 times (3 and 8 days after petal
(48oz/100=96oz/acre) +
Tag 15 spurs per tree on each of 5 representative trees
(1pt/100=2pt/acre)
Use the carbohydrate model to adjust rates up or down based on model
a 12 mm Spray
Send the data within 24 hours after each 8 day measurement to Terence
Apply one of two spray protocols of thinning sprays
Maxcel
Protocol for group effort of willing participants in 2015
1. Apply a Bloom Spray
NAA (4oz/100=8oz/acre on Tall Spindle)
2. Apply a Petal Fall Spray (5mm)
NAA (3oz/100=6oz/acre) +
Sevin (1pt/100=2pt/acre)
3. Apply a 12 mm Spray
Maxcel (48oz/100=96oz/acre) +
Sevin (1pt/100=2pt/acre)
4. 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)

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

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

Precise Thinning Group Effort in 2015
Protocol for group effort of willing participants in 2015
1. Select a mature orchard of either Gala or Honeycrisp.
2. Count all flowering clusters on 5 representative trees at pink.
3. Calculate target fruit number for a high yield.
4. Tag 15 spurs per tree on each of 5 representative trees (75 total spurs) at pink.
5. Apply one of two spray protocols of thinning sprays
6. Use the carbohydrate model to adjust rates up or down based on model recommendations.
7. Measure fruit diameters on 75 spurs 6 times (3 and 8 days after petal fall spray, and 3 and 8 days after 12mm spray and 3 and 8 days after 18 mm spray)
8. Send the data within 24 hours after each 8 day measurement to Terence Robinson
9. Get back an assessment within 24 hours of thinning progress before next spray

Two Options in 2015 for Precision Thinning of Gala

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Option 2 (No Bloom spray)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Apply a Bloom Spray NAA (4oz/100=8oz/acre on Tall Spindle)</td>
<td>1. Apply a Petal Fall Spray (5mm) NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
</tr>
<tr>
<td>2. Apply a Petal Fall Spray (5mm) NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
<td>2. Apply a 12 mm Spray Maxcel (48oz/100=96oz/acre) + Sevin (1pt/100=2pt/acre)</td>
</tr>
<tr>
<td>3. Apply a 12 mm Spray NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
<td>3. 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)</td>
</tr>
<tr>
<td>4. 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)</td>
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Two Options in 2015 for Precision Thinning of Honeycrisp

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<tr>
<th>Option 1</th>
<th>Option 2 (No Bloom spray)</th>
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<tbody>
<tr>
<td>1. Apply a Bloom Spray NAA (4oz/100=8oz/acre on Tall Spindle)</td>
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</tr>
<tr>
<td>2. Apply a Petal Fall Spray (5mm) NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
<td>2. Apply a 12 mm Spray Maxcel (48oz/100=96oz/acre) + Sevin (1pt/100=2pt/acre)</td>
</tr>
<tr>
<td>3. Apply a 12 mm Spray NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
<td>3. 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)</td>
</tr>
<tr>
<td>4. 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)</td>
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</tr>
</tbody>
</table>

Two Options in 2015 for Precision Thinning of Honeycrisp

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<td>1. Apply a Petal Fall Spray (5mm) NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
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<td>2. Apply a Petal Fall Spray (5mm) NAA (3oz/100=6oz/acre) + Sevin (1pt/100=2pt/acre)</td>
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<tr>
<td>4. 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)</td>
<td></td>
</tr>
</tbody>
</table>

Spray Mixing Protocol

1. Calculate Tree Row Volume (Tree height X Tree width X 43,560 X 0.73) / (Between row spacing X 1000)
For many mature Tall Spindle Orchards this is ~170-210 gallons/acre
Example (11’ X 7’ X 43560 X 0.73) / (12’ X 1000) = 196 gallons/acre

2. Set sprayer up to spray ~5 of Tree Row Volume (~85-100 gallons/acre)
This is a 2X application

3. 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/FF000 gallons X 2 = 96 oz Maxcel/FF000 gallons X 5 = 480 oz/sprayer
1pt Sevin/100 gallons X 2 = 2 pt Sevin/100 gallons X 5 = 10 pt/sprayer

4. 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. Count fruit number of the 5 trees before hand thinning in June or July

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.

Questions?