Cornell University Cooperative Extension

Eastern NY Commercial Horticulture Program

Tree Fruit News

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2014 Petalfall Pest and Crop Load Management Meetings

May 19, 2014

Rosenberger, Jentsch, Robinson, Cowgill, Hoying, & Donahue

10 AM – Porpiglia Home Farm, Porpiglia Lane, Marlboro, Ulster County, NY 12542 (41.619485, -73.996314) – we will meet at the Gala & Honeycrisp block by the wind machine on the drive to the packing house.

2 PM – Mead Orchards, 15 Scism Road, Tivoli, NY 12534. Meet at the Farm Shop, just east of Route 9 off W. Kerley Corners Road.

Insect Trap Catches (Number/Trap/Day) (Pheromone Traps)

Pest Species	Count	Observations
Psylla Eggs/Cluster	0.8	
Psylla Nymphs/Cluster	0.5	
Oriental Fruit Moth (OFM)	12.6	
Red Banded Leaf Roller (RBLR)	15.8	
Spotted Tentiform Leaf Miner (STLM)	30.0	
Lesser Apple Worm (LAW)	1.0	1st Capture
Codling Moth (CM)	0.0	
Brown Marmorated Stink Bug (BMSB)	1.0	1st Capture

Degree Day Accumulations (as of 05/11/2014, via NEWA)

Location	Base 43 F	Base 50 F
Peru	258.6	106.1
Watermill	295.4	75.5
Clifton Park	295.7	131.5
Marlboro	415.5	201.9
Hudson	433.3	223.1
Clintondale	439.9	199.2
Highland	460.8	234.3

Tree Phenology (as of 05/12/2014, HVL Ulster County)

Crop	Variety	Growth Stage
Apple	Ginger Gold	Full Bloom
Apple	McIntosh	Full Bloom
Apple	Golden Delicious	Full Bloom
Apple	Spur Red Delicious	Full Bloom
Pear	Bartlett	Full Bloom
Pear	Bosc	Full Bloom
Pear	Hosui (an early oriental)	Early Petal Fall
Plum	Stanley	Petal Fall
Apricot	(early varieties)	Fruit Set/Shuck Off
Apricot	(late varieties)	Fruit Set/Shuck On
Cherry	Danube (an early variety)	Petal Fall
Cherry	Regina (a late variety)	Petal Fall
Peach	n/a	Petal Fall
Peach	n/a	Early Petal Fall

Seasonal Rainfall at the Hudson Valley Lab, Highland, NY (inches)

Weekly	0.93
Total for May	1.32
Total from March 1st	9.89

PGR's and Thinning Strategies GLEXPO 2013

Philip Schwallier
District Horticulture Agent
Clarksville AgBioResearch Center

Introduction

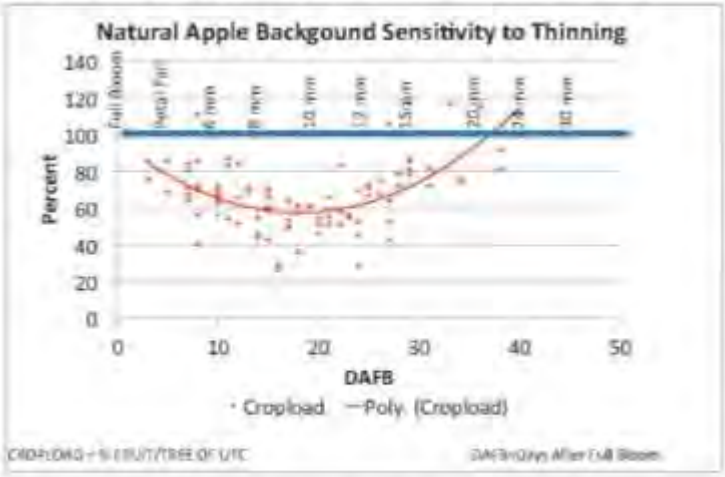
Thinning is the most difficult, most important, yet necessary practice a grower must perform each year. Making a mistake will compromise both this year's crop and next year's crop. Over-cropping and under-cropping will reduce income for a block for multiple years. But today with a more scientific approach to thinning we can achieve successful consistent annual croploads.

A review of the thinning materials, thinning stages, the natural background sensitivity to thinning, Nibble thinning, Precision thinning, the Fruitset Model, the MaluSim Carbohydrate Model and 2014 thinning strategies will help achieve better thinning results in 2014 and beyond. These new models and approaches to thinning will help achieve a closer level of thinning to the target crop.

Thinning Materials

Apples can be chemically thinned in all the thinning windows starting with bloom and continuing up to about 30 DAFB (days after full bloom). The major materials that could be considered include: Lime-Sulfur+Oil, ATS (ammonium thiosulfate), NAD (Naphthaleneaceatimide), NAA, 6-BA, Carbaryl, and Ethrel. Some experimental thinners look promising but are not labeled at this time.

Figure 1. Natural Background Sensitivity of Gala



Natural Apple Background Sensitivity to Thinning

Thinning can be done during every growing stage starting at Full Bloom up to about 30 mm. There is a natural background sensitivity to thinning (Figure 1). To measure timing sensitivity to thinning, a thinning timing trial in a mature Gala block at CRC (Clarksville Research Center) was conducted each year from 2004 thru 2011. Every 3.5 days, a treatment of either S+N (Sevin+NAA) or S+M (Sevin+MaxCel) at aggressive rates (NAA @ 15 ppm or MaxCel @ 150 ppm combined with Sevin @ 1 qt/100) was applied. All treatments data points are plotted in Figure 1. There are four things that can be learned from the results, 1) at the 8

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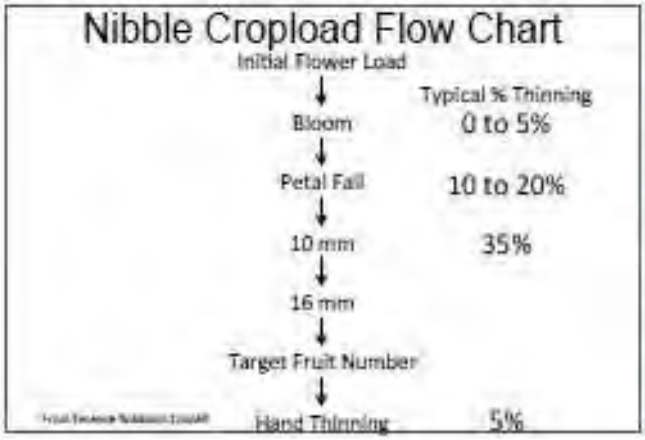
HV Info Blogs

To better serve the fruit industry in the Hudson Valley, both Dave Rosenberger and Peter Jentsch have recently established websites where they are posting information on diseases, pests, and pest management that is relevant to fruit growers in the Hudson Valley. Both the plant pathology and entomology websites for the Hudson Valley Lab contain blogs where they post time-sensitive observations and pest alerts. Fruit growers interested in receiving alerts via e-mail when they make new posts in these blogs can subscribe by entering their e-mail address in the "subscribe" box on the relevant website. The bottom of each e-mail alert from the blogs will contain an "unsubscribe" link so that alerts can be discontinued at any time.

The URL for the Hudson Valley Entomology website and blog is http://blogs.cornell.edu/jentsch/, and the URL for the Hudson Valley Plant Pathology website/blog is http://blogs.cornell.edu/plantpathhvl/. Both websites are still in the early stages of development, but then websites documenting the current state of knowledge are never really complete.

PGR's and Thinning Strategies, continued from previous page

Figure 2. Nibble or Precision Cropload Flow Chart.

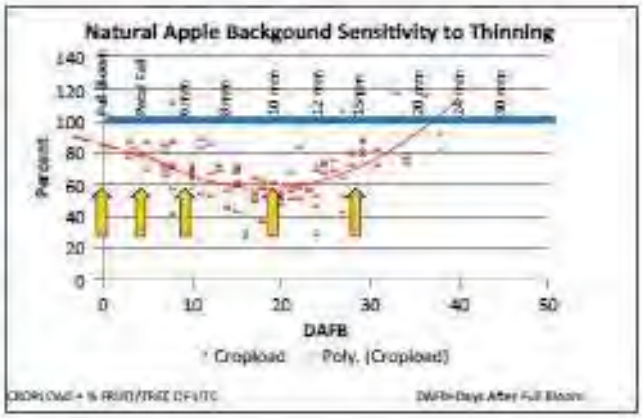


to 12 mm stage, fruitlets are at maximum sensitivity, 2) at PF (Petal Fall), the fruitlets are not very sensitive and over-thinning is a low risk, 3) there is a lot of variation in thinning at the early and at the late timings, and not as much at 10 mm stage and 4) the thinning window closes rather quickly after 15 mm. Of course, the thinning response is driven by the weather at the time of thinning. Hot cloudy conditions at any of these stages will promote thinning and cold sunny weather will decrease thinning.

Nibble Thinning

The concept of "Nibble Thinning" is to thin a little of the crop at every opportunity until the cropload has been reduce to the desired target level. This means to thin starting early and planning multiple applications. Start thinning early at FB, then at PF, then again at 6 mm and 10 mm and more if needed (Figure 2 & 3). Nibble the crop down to the perfect cropload. Often, we let the early thinning windows (FB, PF, and 6 mm) pass by because we are unsure of bud health or fruit set. A frost event or some other early trauma makes us want to wait and see what fruitset will be before thinning. But, apple trees are resilient; they will set crops almost every year even when conditions look bleak. As time goes on, more information of frost injury, bee activity, pollination, fertilization becomes known and this allows a better judgment of fruitset and thinning needs. However, delaying first thinning action until late in the thinning window may allow only one chance to thin and then results may be unsatisfactory. Start early when over-thinning risk is low.

Figure 3. Precision Multiple Thinning Timing.



Initial flower load is the best early indicator of cropload. The initial flower numbers on a tree follows with corresponding number of fruit on the tree following fruitset. Heavy bloom or "Snowball" bloom will set heavy crops. Get started with early thinning during "Snowball" years. The natural background sensitivity to thinning predicts typical success in thinning. The sensitivity is low at PF and greatest at 10 mm and then quickly becomes insensitive as 25 mm stage is approached.

Nibble and Precision thinning is to thin at every time there is an opportunity such as FB, PF, 6 mm, 10 mm, etc. until the target cropload is reached. This method achieves success yet reduces risk of over and under thinning. Figure 2 indicate the typical percent thinning expected if thinning is performed at the corresponding stage with moderate thinning rates. Aggressive rates will have a greater response. Typically about 50% thinning is the target level in the vast majority of years on most blocks.

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Table 1. Chemical Apple Thinning Materials and Comments.

Material	Description	Comment
Lime Sulfur & Oil	Depresses Photosynthesis. Burns Pistils. Reduces Fertilization. Good for Organic Growers.	Use LS @ 2.5 gal/100 + Oil @ 2 gal/100. Apply @ 100/acre. Target 80% FB (just after KB). Follow every 3 to 4 days as needed.
ATS (Ammonium Thiosulfate) Fertilizer	Burns Pistils. Nitrogen and Sulfur fertilizer.	Use ATS @ 2 to 3 gal/100. Apply @ 100/acre. Target 80% FB (just after KB). Follow 2 days later if needed.
NAD (Naphthaleneacetamide) Amid-Thin	Mild to little thinning. Use only at Petal Fall. NAD treated trees should be more difficult to thin at the 10 mm stage.	Use @ 50 ppm. Mostly on early summer varieties (Spy, Mac, Empire).
NAA (Naphthaleneacetic Acid) Fruitone N Fruitone L PoMaxa	Workhorse thinner. Moderate harsh thinner. Dose dependent. Use throughout thinning window. Can be damaging (defoliation). Promotes return bloom. Stunts fruit growth temporarily, but fewer fruits then grow larger. Aggressive with Sevin.	Use @ 5 to 20 ppm. Red Delicious and Fuji are sensitive to NAA. Stunted leaves and pygmy fruits can result if applied with or close to Promalin or 6-BA applications.
6-BA (6 Benzyadenine) MaxCel Exilis	Mild to moderate, gentle, thinning. Dose dependent. Improves fruit size, increases cell division. Not compatible with NAA. (needs more research) Aggressive with Sevin.	Use @ 50 to 150 ppm. Standard rate = 100 ppm (64 oz/100 or /acre). Labeled up to 200 ppm.
Carbaryl Sevin	Workhorse thinner. Mild to moderate thinning. Relatively safe gentle thinner. Tends to promote large fruit size. Not dose dependent. Use throughout window, but generally used late. Can be damaging (russet). Selective, thins weak laterals, leaving one fruit/cluster (singulates fruit). Will also thin out whole clusters. Can be used from PF to 30 mm. Harsh on beneficials and bees.	Use at 1# to 2#/acre (1 pt to 1 qt/100 or /acre). Combinations with NAA or 6-BA are aggressive thinners.
Ethrel	Mild to excessive thinning. Dose dependent. Will thin very late (20mm +). Generally used late for emergency thinning. Somewhat unpredictable. Can over-thin.	
Other Thinners	ACC ABA Metamitron	

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Table 2. Apple Thinning Windows Considerations.

Stage	Description	Choices and Comments
Bloom	Set unknown. Early timing, start of "Nibble" or "Precision" thinning. Generally, too early for growers to feel comfortable. Helps difficult to thin varieties. Helps small fruited varieties. Fruits drop early. Maximizes fruit size & return bloom. Allows additional steps in reducing a heavy crop. Generally, weather is not best.	Lime Sulfur & Oil (not preferred). ATS (possible with experience). MaxCel (preferred choice). NAA (good choice).
Petal Fall	Generally early time to thin. Best 1st thinning for return bloom. 1st thinning which allows 2nd and 3rd chance. Fruitset is unknown, generally under-thins. Bloom climate and bee activity is known.	NAD on early summer varieties. Sevin alone on all varieties across the board. NAA alone. Sevin+NAA or Sevin+MaxCel for more aggressive thinning.
6 mm	Get started early. Can get some thinning, but generally under-thins. Moderate risk thinning. Excellent return bloom. Still will have more chances to thin. Good for "Nibble" or "Precision" thinning.	Dose/rate dependent for thinners, choose rates to get target thinning: 6-BA or NAA or combinations of: Sevin+NAA or Sevin+6-BA.
10 mm	8 mm to 12 mm diameter fruit. **Traditional best timing and results for one-time application thinning.** Choose thinning level. Fruitset somewhat unknown, but fruitlets showing strength. Good return bloom. Still will have a last chance in 7 days.	Dose/rate dependent for thinners, choose rates to get target thinning: 6-BA or NAA or combinations of: Sevin+NAA or Sevin+6-BA.
15 mm	12 mm to 18 mm diameter fruit. Still receptive to thinning. Should use full or higher rates. Combinations best. **Last chance** thinning. Thinning window closing fast.	Dose/rate dependent for thinners, choose rates to get target thinning: Probably need combinations of: Sevin+NAA or Sevin+6-BA.
25+	Very late, probably no or low response. Use aggressive combinations. Perhaps **Ethrel** is only good choice. Dangerous and unpredictable. Ethrel at 300 to 600 ppm (1 pt-1 qt). Can use **Ethrel + other thinners and oil.**	Use: Ethrel +Sevin +Oil All @ 1 qt/100 or /acre.

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Table 3. Precision Thinning, Timing, Materials and Predicted Percent Thinning Most Years.

Stage	Material Choices (red = preferred choice)	Predicted % Thinning (red = expected result)			
Bloom	Lime & Sulfur Oil	0 to 20%			
	ATS (2 to 3 gal/100)	0 to 20%			
	MaxCel (100 ppm, 64 oz/100)	5 to 10%			
	NAA (10 to 15 ppm, 8 to 16 oz/acre)	5 to 10%			
Petal Fall	Sevin (1 qt/100 or /acre)	10 to 20%			
	NAA (10-15 ppm, 8-16 oz/acre)	10 to 20%			
6 to 20 mm		6 mm	10 mm	15 mm	20 mm
	Sevin (1# to 2#, 1 pt to 1 qt /acre) NAA (10-20 ppm, 8-20 oz/acre)	10 to 25% 15%	15 to 30% 20%	15 to 30% 20%	10 to 25% 15%
	Sevin+NAA (standard rates) Sevin+MaxCel (standard rates)	15 to 35% 30%	25 to 50% 40%	25 to 50% 40%	15 to 35% 25%

Theory of Fruitset

Fruitlets are living respiring organs; they need energy (carbohydrates) to grow and set. When fruitlets demand for energy is greater than supply, fruitlets will be shorted energy, and the weakest ones will drop. When energy is abundant, fruitlets set and resist thinning. Fruitlet stress, both environmental and chemical stress, has a big impact on sensitivity and response to thinning actions. Temperature and sunlight affect the supply and demand of energy (carbon) available for the fruit and leaves. Energy is supplied to fruitlets from two sources, 1) last years overwintering reserves in the wood and 2) this years photosynthesis. It is thought that photosynthesis is the most important fruitlet energy source. A supply/demand crisis occurs after bloom when reserves are depleted and photosynthesis is picking up. This energy crisis on average occurs at the 10 mm stage, which is why fruit are so responsive to thinning at that time.

MaluSim Carbohydrate Model

Dr. Alan Lakso and Dr. Terence Robinson of Cornell University have developed a MaluSim Carbohydrate Model to predict in current real time the energy levels of a fully bearing mature moderately cropped Empire tree. This model is useful to assist thinning decisions. That is, it predicts the daily stress small young setting fruitlets might be experiencing and therefore, help growers adjust their chemical thinning applications. MaluSim predicts the daily carbohydrate balance of a tree. This assists growers in the prediction of fruitlets sensitivity to drop, set and thinning. A surplus of energy at thinning time will set fruitlets and growers will need to thin more aggressively. A serious energy deficit will drop fruitlets and growers may want to delay thinning or reduce rates. The model starts at green tip and will predict the tree daily supply and demand of carbon (energy) based on three daily inputs, 1) daily max, 2) min temperature and 3) daily solar radiation. It also adjusts predictions for the earth latitude of the weather station to estimate day length. Sparta is at latitude 43°, Benton Harbor 42°, and Suttons Bay 45°. The four days following a thinning application is the most important carb model stress prediction to estimate thinning results. A four-day average carb balance of the predicted carb levels is used to help make a thinning decision. In real time this four-day average is using the results of the weather forecast to predict the future. This is risky, in that rarely are the forecast predictions correct, but it is the best information in real time during the thinning time. A decision guide has been developed by Cornell (Figure 3) and adjusted for Michigan conditions (Figure 4 & 5), which include a suggested rate at various stress levels for difficult to thin varieties (Table 4 and 5).

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Figure 3. Cornell Carb Balance Predicted Thinning.

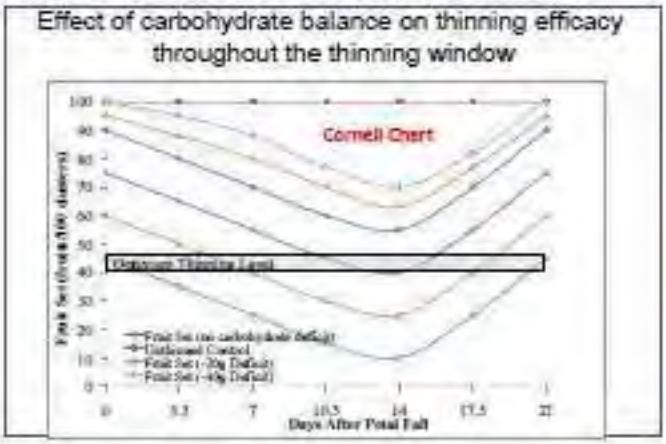

Figure 4. Michigan Carb Balance Predicted Thinning.

Figure 5. Michigan Predicted Percent Thinning.

Michigan Predicted % Thinning

	4 Day Ave Carb. Balance					
	0	-20	-40	-60	-80	-100
Full Bloom	0	0	2	3	4	5
Petal Fall	0	5	10	20	30	40
6 mm	5	20	30	40	50	60
10 mm	15	30	40	50	60	80
15 mm	15	30	40	50	60	80
20 mm	10	20	30	40	45	60
25 mm	3	10	15	20	30	35
30 mm	0	0	2	5	10	15

Table 4. Carb Model Thinning Decision Guide.

Stress Level	4 Day Ave Carb Balance	Thinning Rate Recommendation
No	>0	Increase Rate by 30%
Slight	-20 to 0	Use Standard Rate
Mild	-40 to -20	Reduce Rate by 15%
Moderate	-60 to -40	Reduce Rate by 30%
Severe	-80 to -60	Reduce Rate by 50%
Extreme	<-80	Do not thin, many fruits will fall off

Table 5. Thinning Combination Rates Levels, 100 gal/acre for difficult to thin varieties.

Level	Sevin + MaxCel (1 qt + ppm)	Sevin + NAA (1 qt + ppm)
30% Increase	1 + 150 + 1 qt Oil	1 + 15 + 1 qt Oil
Aggressive	1 + 150	1 + 15
Standard	1 + 100	1 + 10
10% Reduction	1 + 75	1 + 7
20% Reduction	1 + 50	1 + 5
30% Reduction	1 qt Sevin	1 qt Sevin
Sevin rate = 1 qt/100 = 1 qt/acre.		

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Cornell Pest Management Guidelines

Please note that the 2014 Cornell Pest Management Guidelines for Commercial Tree Fruit Production is available only as a hard copy this year. A visit to the PMEP website (http://ipmguidelines.org/treefruits/) gives the following explanation:

"Due to budgetary constraints, the 2014 Cornell Pest Management Guidelines for Commercial Tree Fruit Production will not be available online. We are currently exploring options that will allow us to recover the costs of posting this publication online. We hope to have the Guidelines back online in 2015."

Distribution has been taken over by the Cornell Store. Guidelines can be purchased with enrollment in the ENYCHP – a free copy of the pest management guidelines comes with enrollment (contact Marcie at 518-272 -4210) – or through the Cornell Store, online at http://store.cornell.edu/c-875-guidelines.aspx.

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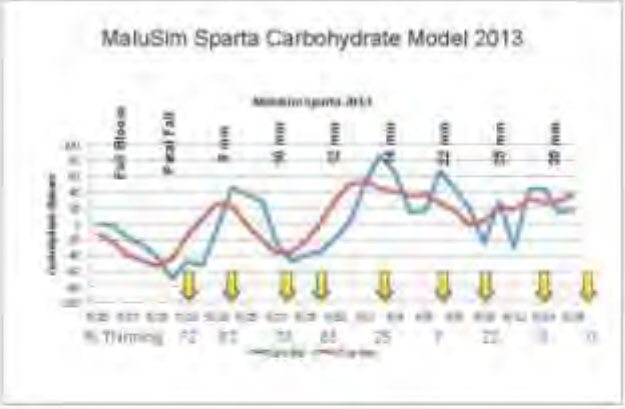
Figure 6. Nibble or Precision Cropload Flow Chart.

Figure 7. MaluSim Sparta Model 2013.



Honeycrisp Timing Thinning 2013

A thinning trial was conducted in 2013 on Honeycrisp with S+N (1 qt/100+10 ppm) and S+M (1 qt/100+150 ppm) as the thinning materials combinations. The applications were made every 3.5 days throughout the thinning window starting at PF and continuing to about 28 DAFB (Figure 6). The results are expressed as fruit/tree and AFW and should be compared to the prediction output of the MaluSim Model (Figure 7). Significant stress occurred on three occasions, 1) Petal Fall, 2) 10 mm and 3) the 25 mm stage. The amount of thinning is indicated in Figure 7. The down arrows indicate average percent thinning for each timing. More aggressive thinning than expected occurred in the early stages but the significant thinning at 25 mm was not expected. Good thinning occurred at the 25 mm stage with S+M. The resultant thinning followed the MaluSim Model predictions quite well. The model is good, but not precise.

Precision Thinning

The Precision Thinning concept uses all information available to achieve a target cropload. The concept of Precision Thinning takes the nibble thinning concept and adds the use of the Fruitset Model to help verify or indicate how the thinning process is proceeding. Duane Green of UMASS developed the Fruitset Model. Precision Thinning uses the MaluSim Model to help guide thinning choices or predictions at each stage and measure ongoing fruitset with the Fruitset Model during fruitlet growth (Figure 8 & 9). It starts with an evaluation of initial flower load on a typical tree. It is suggested to dormant prune trees to a level of two to three times the bud load of the desired cropload. For example, if 100 fruits/tree is the target cropload, then reduce the flower clusters/tree to a level of 200 to 300 with dormant pruning. The initial flower load is a good indicated of final cropload most years. Start at FB with the MaluSim Model indicating stress. Then step right through the stages, adding the Fruitset Model at 6 mm to get a prediction of crop set.

Fruitset Model

This model is available as an Excel Spreadsheet downloadable at:

Apples.msu.edu
http://www.glexpo.com/summaries
http://extension.umass.edu/fruitadvisor/resources/clements-corner

This model keeps track of measurements of fruitlet growth and predicts set. We suggested that between 20 to 100 (40 is probably adequate) representative flower clusters should be marked (Figure 10) and

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diameter measured every three to four days. The diameter growth will be used to predict fruitlet abscission (Table 6). All fruit that slow to a growth rate of 50% or less of the growth rate of the fastest growing fruit, will ultimately stop growth and abscise.

Table 6. Fruitset Model Growth Prediction.

Fruitlet Fate	Prediction
Persist	A fruit is predicted to persist if the growth rate over the measurement period was at least 50% or greater of the fastest growing fruit.
Abscise	A fruit is predicted to abscise if the growth rate of the fruit slowed to 50% or less of the growth rate of the fastest growing fruit.

Figure 8. Cornell Precision Flow Chart.

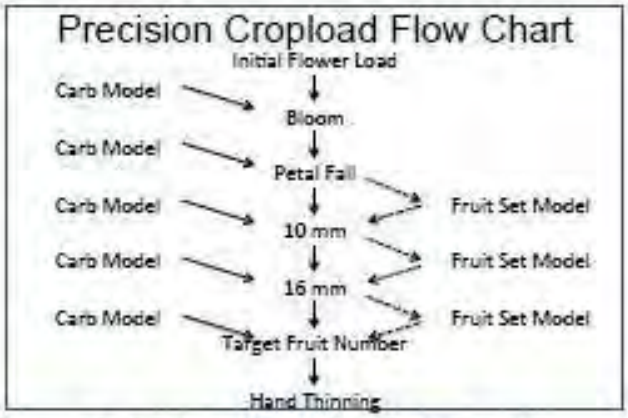

Figure 9. Persisting and Abscising Fruitlet Growth.

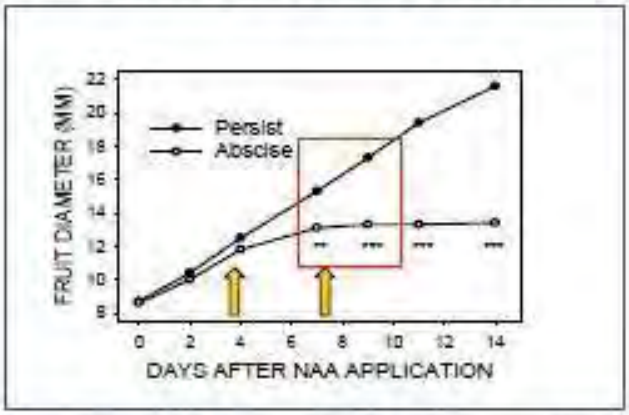

Figure 10. Fruitset Model Numbering Fruits.

Figure 11. Record Fruitlet Diameters 2013.

A summary of the data collected is shown in Figure 11 collected by Bridget and Nicole Engelsma. The first step is to determine the target cropload. In this block, the target crop load was 15% (20 apples) of the 130 original fruit measured. On June 1st, three days after the first measurement, the model predicts only 30 (23.1%) apples are growing fast and thus very close to the predict target of 20 apples. On June 11th, 13 days after the first measurement, the model predicts 28 (21.5%) are setting and thus the cropload will be about 6% heavy. The model predicted early (after 3 days) that the setting crops was close to the target cropload.

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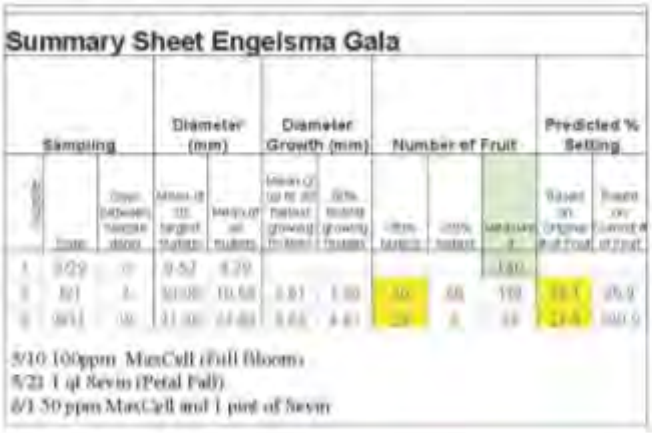
Figure 12. Fruitset Model Summary Sheet.



Thinning Factors

Thinners work best when temperatures are warm especially for four days following the thinning application. Slow drying conditions when the thinners are applied will increase uptake and response. Cloudy, hot conditions will increase stress and thus, increase thinning. Young trees (under 4 or 5) will thin easier. Nighttime temperatures are important, warm nights increase respiration thus stress.

Table 7. Summary of Thinner Effectiveness and Climate Conditions (adapted from Cornell information).

Climate Condition	Prediction
Warm Conditions >65°F.	All thinners work best.
Dark Cloudy Weather.	Greater stress, greater thinning response, greater drop.
High night temperatures (>65°F).	Greater stress, high demand and use of energy for night respiration, greater drop.
Very High day-time temperatures (>85°F).	Greater stress, high energy demand, greater drop.
Very cool temperatures (<65°F), greater set.	Reduced stress, reduced energy demand, greater set.
High light.	Increased supply: harder to thin.
Low light.	Reduced supply: easier to thin.
Low temps.	Low demand: harder to thin.
High temps.	High demand: easy to thin.
Worst.	Low light and warm temps.

Thinning Timing

For best thinning response, pick climate conditions that favor a response. Apply thinners early in a forecasted warming trend when maximum temperature reaches 80 to 85°F (>65°F). If temperatures are cool, either increase the rate or delay treatment until warm conditions return. Avoid applying thinners during a cooling trend where maximum temperatures will drop <65°F. Cloudy warm conditions will increase drop and may cause mild thinning. Cut back on rates.

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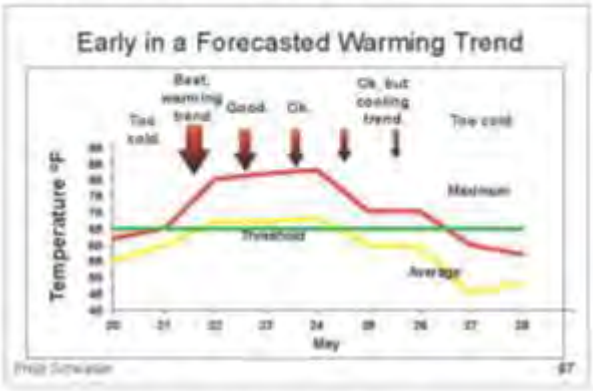
Figure 13. Best Timing for thinning.



2014 Thinning Considerations

- Consider last years cropload.
- Heavy crop 2013, easier thinning 2014, use normal rates.
- Light crop 2013, more difficult to thin 2014, be more aggressive.
- Winter weather, any extreme temperature drops that might damage buds.
- Evaluate 2014 bloom quality and density; higher numbers of bloom= greater fruitset.
- Evaluate bee activity, pollination, and fertilization conditions; most years these are not a factor.

Thinning Without Carbaryl in 2014

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In the Northeastern US, almost all apple orchards are chemically thinned early in the season each year using a combination of either Naphtaleneacetic Acid (NAA, a synthetic auxin plant growth regulator) plus Carbaryl or Benzyl Adenine (BA, a synthetic cytokinin plant growth regulator) plus Carbaryl. Carbaryl, which is a carbamate insecticide, causes some thinning by itself but also enhances the thinning efficacy of either NAA or BA. Carbaryl has been an essential component of chemical thinning programs for more than 40 years. However, there is concern that Carbaryl will be removed from the market by regulatory action either in the US or in Europe. If Carbaryl were removed from the market, apple growers in the Northeastern US would not achieve adequate thinning with NAA or BA alone. In 2014, one US based supermarket chain has prohibited the use of Carbaryl on apples they purchase even though it is still a legal product. This will require growers who supply apples to this supermarket chain to do their chemical thinning this year without Carbaryl. We have been researching alternatives to Carbaryl for several years to repond to this possible scenario. This article details our proposed solutions to the problem.

There are 5 strategies we recommend for thinning without carbaryl:

1. Multiple thinning sprays
2. Higher rates of NAA
3. Mixtures of BA and NAA
4. Additions of oil to BA
5. Additions of regulaid to NAA

1. Multiple thinning sprays Probably the best approach to thinning without Carbaryl in 2014 is to use multiple thinning sprays beginning at bloom and then use the precision thinning protocol to measure progress toward the target fruit number after each spray. Thus, a spray program for a hard to thin variety like Gala could begin at bloom with a 2% spray of Ammonium Thiosulfate (ATS) or a 10 ppm spray of NAA followed by a petal fall spray of NAA+Maxcel, followed by a 10-12mm spray of NAA+Maxcel. A spray program for an easy to thin variety like McIntosh could begin at petal fall with a NAA+BA spray followed by a second spray of NAA+Maxcel at 10-12 mm. With good assessments after each spray using the fruit growth rate model growers could adjust rates to achieve the target fruit number.

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2. Higher rates of NAA Thinning with NAA alone requires higher rates than when thinning with combination sprays of NAA+Carbaryl. A good rule of thumb is to increase the rate of NAA by 50% over the rate you have used when combined with Carbaryl. For example if you used 5ppm NAA+ Carbaryl last year on McIntosh, this year you should use 7.5ppm NAA alone. Likewise if you used 7.5ppm NAA+Carbaryl on Empire this year you should use 10ppm NAA alone. However very high rates of NAA can cause a temporary stunting of fruit growth and a negative effect on final fruit size. Thus, we recommend to not exceed 10ppm even though up to 20ppm will give more thinning.

3. Mixtures of BA and NAA BA alone is a weak thinner and requires very high rates for effective thinning. However, high rates (above 150ppm) can cause lateral bud break which we don't want. Thus a high rate of BA alone is not a good solution. Carbaryl gives a synergistic effect with BA which is the reason the mixture of BA and Carbaryl is so useful. We have had very good success mixing BA and NAA for several varieties. In one study (see reference below) we evaluated the mixture of BA and NAA on 12 varieties (Braeburn, Cortland, Delicious, Empire, Fuji, Gala, Gingergold, Jonagold, Jonamac, Liberty, McIntosh and Sansa). We had very successful thinning on 10 of the 12 but with Delicious and Fuji we ended up with numerous pygmy fruits from this mixture. For small fruited varieties like Gala, Empire, Jonamac etc., we recommend the combination of BA+NAA. Our studies indicated that 7.5ppm of NAA could substitute for the carbaryl. Thus if last year you thinned Gala with 75ppm BA+1pt Sevin this year you would spray 75ppm BA+7.5ppm NAA.

4. Additions of oil to BA Small amounts of spray oil (1pt/100 gallons) added to a spray of BA can increase thinning efficacy since the oil acts as a penetrant. With most BA sprays only a small fraction of the spray deposited on the leaf or fruit is absorbed into the plant where it can act as a thinner. Commercial BA formulations come with a surfactant already added to improve uptake; however more uptake can be achieved with oil. However, the use of oil carries its own risks of inducing russetting if Captan is applied shortly before or shortly after the BA+oil spray. This is especailly true if the BA+oil spray is applied when fruits are small (petal fall to 15mm) or following a frost. Thus, **we give this urgent caution: do not use oil as a surfactant with BA if you are using a Captan program from petal fall to 15mm.** The situation where BA+oil is most useful is with Delicious and Fuji where NAA causes pygmies. For these two varieties we suggest a thinning program that does not use NAA but rather BA. However, to get enough thinning response from the BA you must use some oil to get greater uptake. If last year on your Red Delicioius or Fuji you used 100ppm BA+ 1pt of Carbaryl this year you should use 100ppm BA+ 1pt of oil.

5. Additions of regulaid to NAA The use of regulaid (1pt/100) with NAA can significantly increase the thinning efficacy of NAA. The regulaid increases uptake of NAA in a similar manner to oil's effect on BA uptake. The use of Regulaid is very common in WA State but not so common in NY State because of the risk of overthinning in some years and the risk of russetting due to increased Captan uptake when Captan is used shortly before or after a NAA spray that contains regulaid. Thus, we give the same caution as with BA+oil **do not use Regulaid as a surfactant with NAA if you are using a Captan program from petal fall to 15mm.** If Regulaid is used, it can essentially substitute for the carbaryl. For example if last year you used 5ppm NAA+Carbaryl on McIntosh, this year you could use 5ppm NAA+1pt/100 of Regulaid. Likewise if last year you used 7.5ppm NAA+Carbaryl on Empire, this year you could use 7.5ppm NAA+1pt/100 of Regulaid.

Final Thoughts: For those who can still use Carbaryl, we continue to recommend sequential sprays with either BA+Carbaryl or NAA+Carbaryl. Mixtures with Carbaryl give the most consistent and effective thinning. I hope other supermarket chains will not prohibit the use of carbaryl since it is still a legal product and is such an essential component of effective thinning programs in the Eastern US. For those NY growers who must thin this year without Carbaryl, the options listed above should result in successful thinning this year if we are "lucky".

Reference: Robinson, T.L. 2006. Interaction of Benzyladenine and Naphtaleneacetic Acid on fruit set, fruit size and crop value of twelve apple varieties. *Acta Hort.* 727:283-290.

Every effort has been made to provide correct, complete and up-to-date pesticide recommendations. Nevertheless, changes in pesticide regulations occur constantly, and human errors are possible. These recommendations are not a substitute for pesticide labelling. Please read the label before applying any pesticide. This material is based upon work supported by Smith Lever funds from the Cooperative State Research, Education, and Extension.

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