# Thinning Strategies for 2021

### Tools Available for a Precise, Data-Driven Approach to Thinning

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## 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. Today, with a more scientific approach to thinning we can achieve successful consistent annual croploads.

A firm understanding of the thinning materials, thinning stages, the natural background sensitivity to thinning sets the foundation for successful thinning. Thinning begins with pruning in the dormant season to reduce budload. Next, a precise, data-driven approach, including Nibble Thinning and Precision Thinning, can be used to guide thinning decisions. Models including the Fruitset Model and the Carbohydrate Model provide guidance based on block data and environmental conditions to achieve better thinning results. We review each of these concepts, approaches, and tools below.

### Pruning to Budload: Early Cropload Management

Cropload management should begin with pruning, well before the traditional thinning window (between petal fall and 30mm fruitlet size. Reducing the number of buds on the tree early in the season will result in stronger buds and better return bloom. With fewer buds on the tree, the nutrients and hormones (cytokinins) provided by the tree are divided among fewer buds. In addition, there are fewer floral buds, and therefore fewer fruits and seeds, producing gibberellins, which inhibit the production of floral buds in the following season.

Begin by determining a target cropload. This should be based on tree age, size, trunk cross sectional area. Large pruning cuts should be made during dormant pruning, typically between January and budbreak. A second, more detailed pruning effort should take place once floral buds are easy to identify (closer to budbreak as buds begin to swell and as late as bloom). Begin by counting the number of buds on a subset of trees. Prune to 1.5x the desired cropload for most varieties. For Honeycrisp, prune to 1.8x the desired crop load, to account for unreliable return bloom.

### Thinning Materials

The window for chemical thinning apples begins at bloom and continues 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 or have not been tested long enough to offer reliable recommendations. Thinning materials, windows, and timings are reviewed in **Reference Tables 1, 2, and 3**.

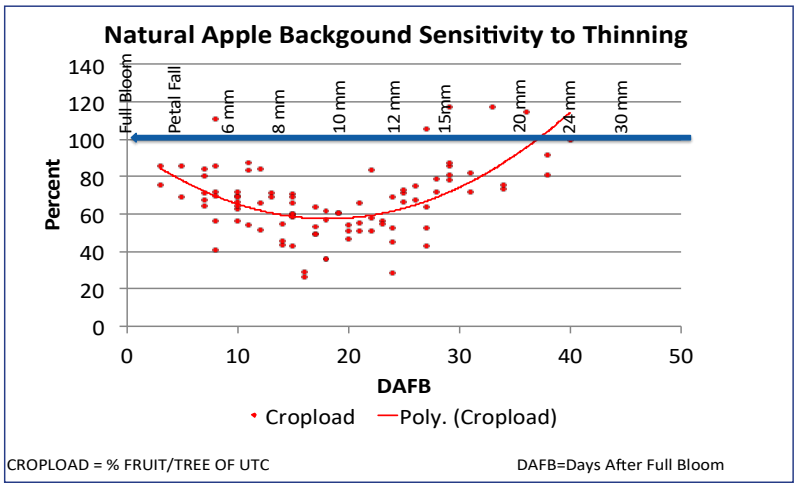
### Natural Apple Background Sensitivity to Thinning

Apples vary in their sensitivity to chemical thinners based on their stage of development (**Figure 1**). This natural background sensitivity to thinning was evaluated in a thinning timing trial in a mature Gala block at CRC (Clarksville Research Center) from 2004 to 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. There are four things that can be learned from the results:

1. At the 8 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 late timings, and not as much at 10 mm stage.
4. The thinning window closes rather quickly after 15 mm.

Overall, the natural background sensitivity to thinning predicts typical success in thinning. The sensitivity is low at PF, greatest at 10 mm, and then quickly becomes insensitive as 25 mm stage is approached. The thinning response is also 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.

**Figure 1. Natural Background Sensitivity of Gala 2004-2011.**



## Nibble Thinning

The concept of "Nibble Thinning" is to thin a little of the crop at every opportunity until the cropload has been reduced 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**). Proceed to 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. We would like to delay thinning until more time has passed and there is more information to judge fruitset and thinning needs, including frost injury, bee activity, pollination, and fertilization.

But apple trees are resilient; they will set crops almost every year even when conditions look bleak. In addition, you may be making it harder on yourself by delaying thinning. Fruitlets are much more resistant to thinning after the 10mm stage. At bloom through PF, thinning is also relatively safe because the flowers are less sensitive to thinning. 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!

Thinning early (at bloom) is especially important for hard to thin varieties, biennial varieties (Honeycrisp and Jonagold), small-fruited varieties (Gala), and in years with a heavy bloom or 'Snowball' bloom. 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.

Nibble and Precision thinning is to thin at every time there is an opportunity (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** indicates 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.

**Figure 2. Nibble or Precision Cropload Flow Chart.**

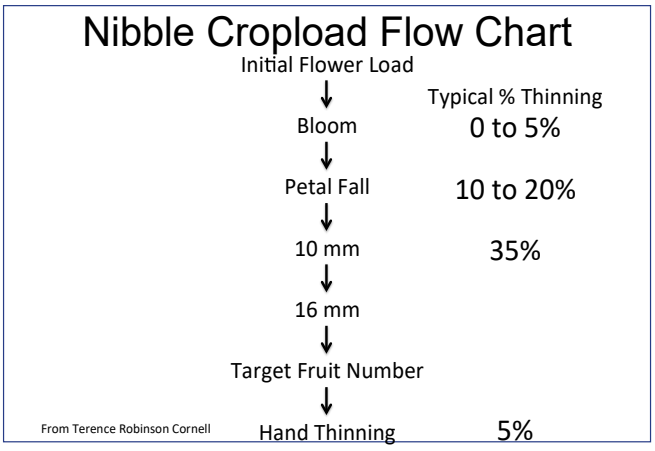
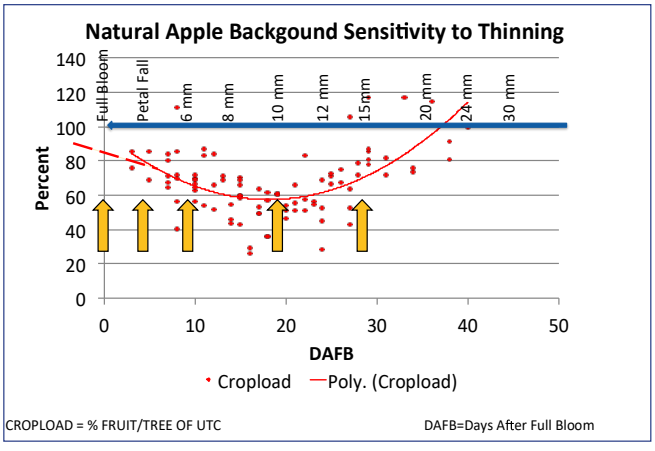



**Figure 3. Precision Multiple Thinning Timing.**



## Precision Thinning

To make accomplish more successful thinning, we can use data to make informed thinning decisions. Over the past 50 years, researchers from Cornell University, Michigan State University, and North Carolina State University have developed models based on data, to inform data-driven 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 Carbohydrate Model and the Fruitset Model to help verify or indicate how the thinning process is proceeding. The Carbohydrate Model predicts the stress on the fruitlets, while the Fruitset Model predicts their potential to abscise. Together these are powerful tools for making more informed data-driven thinning decisions.

### 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 year's overwintering reserves in the wood and 2) this year's 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. By quantifying the balance of energy and stress, we can make more informed decisions, leading to more successful thinning.

### Carbohydrate Model and MaluSim App

Dr. Alan Lakso and Dr. Terence Robinson of Cornell University developed the Apple Carbohydrate Model in 2019 to predict in current real time the energy levels. The original model was based on a fully bearing mature moderately cropped Empire tree, and decision rules were determined based on subsequent experiments on field and controlled greenhouse conditions. This model is useful to assist thinning decisions. In 2019, the Malusim app was developed as a more user-friendly interface to access this and other models for apple orchard management.

The Carbohydrate Model can be accessed several ways. In Michigan, we typically use the MSU Enviroweather website, which houses our Michigan-specific weather data and models. Clicking on the model in the Enviroweather website takes you to the Network for Environmental and Weather Applications (NEWA) Website to run the model. In 2019, researchers at Cornell also created an app called MaluSim, which houses the Carbohydrate Model along with others in a visually pleasing, easy-to-use format designed for smartphones.

- The MSU Enviroweather https://alpha.enviroweather.msu.edu/
- The Network for Environmental and Weather Applications (NEWA) http://newa.cornell.edu/
- The Malusim application https://malusim.org/

Simply, the model predicts the daily carbohydrate balance of a tree (photosynthesis producing energy vs. tree use of energy), and the resulting daily stress small, young, setting fruitlets might be experiencing. This information helps growers adjust their chemical thinning applications.

The carbohydrate balance predicts 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 are 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 and adjusted for Michigan conditions (**Figure 4 & 5**), which include a suggested rate at various stress levels for difficult to thin varieties (**Table 4 & 5**).

**Figure 4. Michigan Carb Balance Predicted Thinning.**

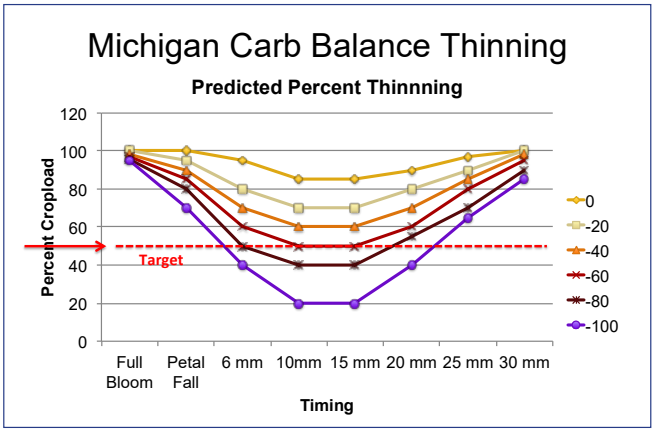



**Figure 5. Michigan Predicted Percent Thinning.**

Michigan Predicted % Thinning

Target

| 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 Avg 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**

| 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. | | |

***100 gal/acre for difficult to thin varieties.**

**Updates to the Carbohydrate Model for 2019**

(adapted from an email from Terence Robinson, May 1, 2019)

In 2019, several updates were made to the carbohydrate model's look and information, as follows:

- The NEWA apple carbohydrate thinning model will has an updated look.
- The input page requires users to input the % of spurs that are flowering in one of 4 ranges (0-25, 26-50, 51-75 and 76-100%.).
- The output data table has a column of DD base 4°C and will have colors highlighting when we are in the sweet spot for thinning (200-250DD from bloom).
- The new version gives a Thinning Index composed of the average carb balance of 2 days before, the day of thinning and the next 4 days= 7 day running average.
- The thinning recommendations are based on a 3-dimensional lookup table taking into account, DD from bloom, % of spurs that are flowering, and carb balance over 7 days. The thinning recommendation cells in the table are also color-coded to indicate red=high risk of overthinning, blue= mild thinning expected, yellow= caution possible aggressive thinning efficacy and green=good thinning efficacy.

**Updates to NEWA for 2021**

In 2021, the NEWA website underwent many updates and improvements. The newest version, NEWA 3.0, is available at https://dev.newa.cornell.edu. Note this website address has dev in the front indicating it is a 'development' website, meaning there could be some occasional bugs or issues. If you discover a glitch, have a problem, or want to ask questions, contact the NEWA Help Desk right away by sending an email message to support@newa.zendesk.com.

There are three important steps to complete before using NEWA 3.0 models. Quickstart video tutorials are available for each at the NEWA Help Desk https://newa.zendesk.com/hc/en-us.

- How to start using NEWA https://newa.zendesk.com/hc/en-us/articles/360054268454
- Customize your NEWA dashboard https://newa.zendesk.com/hc/en-us/articles/360054268354
- How to use your NEWA dashboard https://newa.zendesk.com/hc/en-us/articles/360057357553

**Fruitset Model**

The Fruitset Model was developed by Duane Green and others at the University of Massachusetts. The model is based on the concept that fruitlets whose growth is slowing (growing at less than 50% of the fastest growth rates) will abscise, while others will set and remain on the tree. To determine which/how many fruitlets are actively growing and which will abscise, measurements are taken at 3 and 8 days after thinning applications are made. Originally, this was conducted by tagging clusters and using calipers to measure pre-marked fruitlets, but new technologies using computer vision are being developed to make this process easier.

This model is available as an Excel Spreadsheet downloadable on the MSU Extension Apple website: https://www.canr.msu.edu/news/updated-apple-cropload-management-models-are-available

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 and diameter measured every three to four days. The diameter growth will be used to predict fruitlet abscission. 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. |

## Environmental Factors

### Effect of Environmental Conditions on Thinners

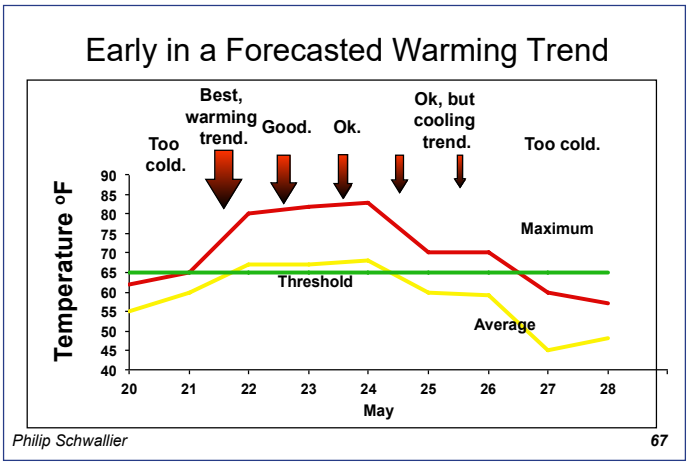
Thinners work best when temperatures are warm especially for four days following the thinning application. Slow drying conditions when the thinners are applied will increase uptake and response. Cloudy, hot conditions will increase stress and thus, increase thinning. Young trees (under 4 or 5) will thin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



## Season-specific Recommendations

### 2020 Review

In 2020, a light frost early in the season significantly impacted viable flower buds. Drought conditions throughout the season may have led to small fruit size, especially in 'Gala'. A number of Honeycrisp and Jonagold blocks have been observed with very light bloom, including many blank floral buds in 2021, despite having significant bloom in 2020. This is a pattern being describe across the Northeast and Midwest. While many factors can affect return bloom and these varieties have a strong biennial tendency, we attribute suspect this is partially due to hot dry conditions immediately following bloom, during the floral bud induction and initiation period.

### 2021 Outlook

The beginning of the 2021 season has been a rollercoaster, not that that is unusual for the Michigan apple industry. Very warm conditions in early spring led to rapid heat accumulation. For most of the spring, we have been approximately two weeks ahead of the average conditions based on accumulation of Degree Days (DD) Base 42°F. A frost on the morning of April 2nd led to some damage to king flowers, now evident as absent or poorly developing flowers. A hard freeze on the mornings of April 21st and April 22nd led to additional damage. This was particularly damaging to sensitive varieties, such as Red Delicious. Additional frosts and freezes in the first week of May will continue to challenge bloom integrity.

The extent of the 2021 spring cold damage is highly variable, based on cultivar, microclimate of specific blocks, growth stage, and frost mitigation measures. King damage has been observed in many locations, but in many locations there are fully healthy blossom clusters. In most blocks, plenty of healthy laterals are present and there is the potential for a full crop. It is important to quantify frost damage in order to make appropriate adjustments to thinning programs. In addition, the bloom period has been very extended due to cool conditions. This has meant pollination conditions have been less than optimal. Based on the seasonal conditions, the appropriate adjustments should be made to thinning programs.

Frost Damaged Blocks

- Delay thinning until fruitset can be observed.
- Use standard to reduced rates.
- Only thin the tops of trees.
- If thinners seem to under thin, plan on another later thinner application at to the tops of trees.

Non-Frost Damaged Blocks

- Apply thinners as usual.
- Apply 2/3 of spray solution to the top 1/3 of the tree.
- Look for warm weather trends.

## Reference Tables

### Table 1. Chemical Apple Thinning Materials and Comments.

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

**Table 2. Apple Thinning Windows Considerations.**

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

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

| Stage | Material Choices (red = preferred choice) | Predicted % Thinning (red = expected) | | | |
|---|---|---|---|---|---|
| **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)<br>NAA (10-20 ppm, 8-20 oz/acre) | 10 to 25%<br>**15%** | 15 to 30%<br>**20%** | 15 to 30%<br>**20%** | 10 to 25%<br>**15%** |
| | Sevin+NAA (standard rates)<br>Sevin+MaxCel (standard rates) | 15 to 35%<br>**30%** | 25 to 50%<br>**40%** | 25 to 50%<br>**40%** | 15 to 35%<br>**25%** |

## References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