Apple and Pear Crop Load Management

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Learning Objectives

- Crop load management and abscission (fruit drop)
- Why and when to thin
- Precision thinning
- Available chemical thinners and overview of how they work
- Factors that affect thinning variability
- Thinning with Accede®
- Chemical thinners for pears

What is Crop Load Management?

Jonagold trees with excessive fruit

The process of reducing the fruit number to an acceptable level (*thinning)*

Builds upon *the natural process* that occurs in the tree

Underlying physiology of fruitlet abscission

Natural Fruit Abscission

- 'June drop' represents the period of natural abscission (shedding of fruits)
- Abscission is an internal mechanism regulated by the tree

Fruitlet thinners

Enhance earlier fruit drop -> augmenting the natural process

The shift toward hedgerow orchard systems provides new crop load management opportunities

Free-standing low density, globular

Higher density spindle, narrow canopy widths

Target fruit size calculator

	Imperial		Metric	
Target Yield	1000	bu/acre	51.8	t/ha
Bins	50	bins/acre	124	bins/ha
Row Spacing	13.13	ft	4.00	m
Tree Spacing	4.1	ft	1.25	m

Density	809	trees/acre	2000	trees/ha
Yield	1.24	bu/tree	1.24	bu/tree
Yield	52	lbs/tree	23.6	kg/tree

	Minimum Diameter		**Target**	
Count Size	**(in)**	**(mm)**	**Fruit per Tree**	
196	2¼	57.0	242	Cee grade
175	2⅜	60.0	216	Cee grade
163	2½	64.0	201	
150	2⅝	67.0	185	
138	2¾	70.0	170	
125	2⅞	73.0	154	
113	3	76.0	140	
100	3⅛	79.0	124	
88	3¼	83.0	109	
80	3⅜	84.5	99	
72	3½	89.0	89	
64	3⅝	92.0	79	
56	3¾	95.0	69	
48	3⅞	98.0	59	

Optimizing Crop Value

The number of fruit that remain on the tree directly affects:

- yield
- fruit size
- Colour
- Fruit quality
- Return bloom

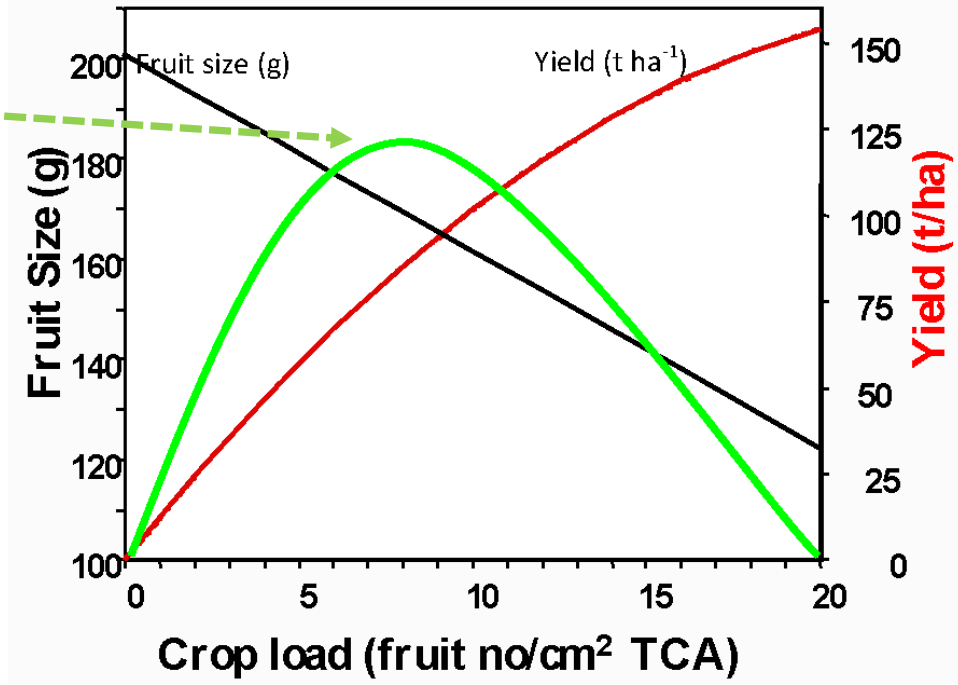
Crop Value

Calculations of crop value at various crop load levels have shown that at very high crop loads, yield is very high but fruit size and crop value are low (Robinson, 2013)

When crop load is reduced to more moderate levels through thinning, then crop value rises dramatically even though yield is lower because fruit size is larger and has greater value.

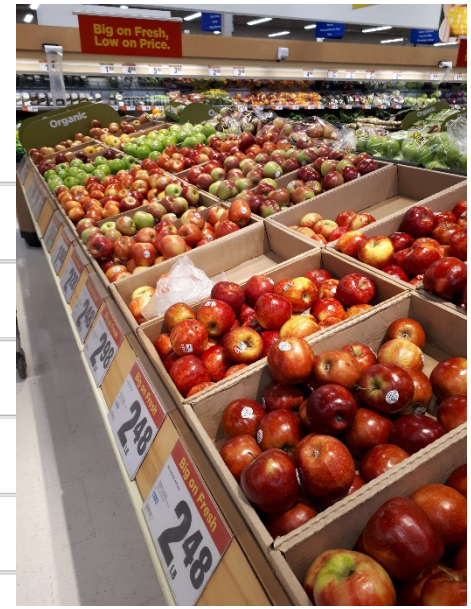
At some point crop value peaks when yield and fruit size are balanced and then with further reductions in crop load, crop value declines due to the lower yield not being fully compensated by larger fruit size

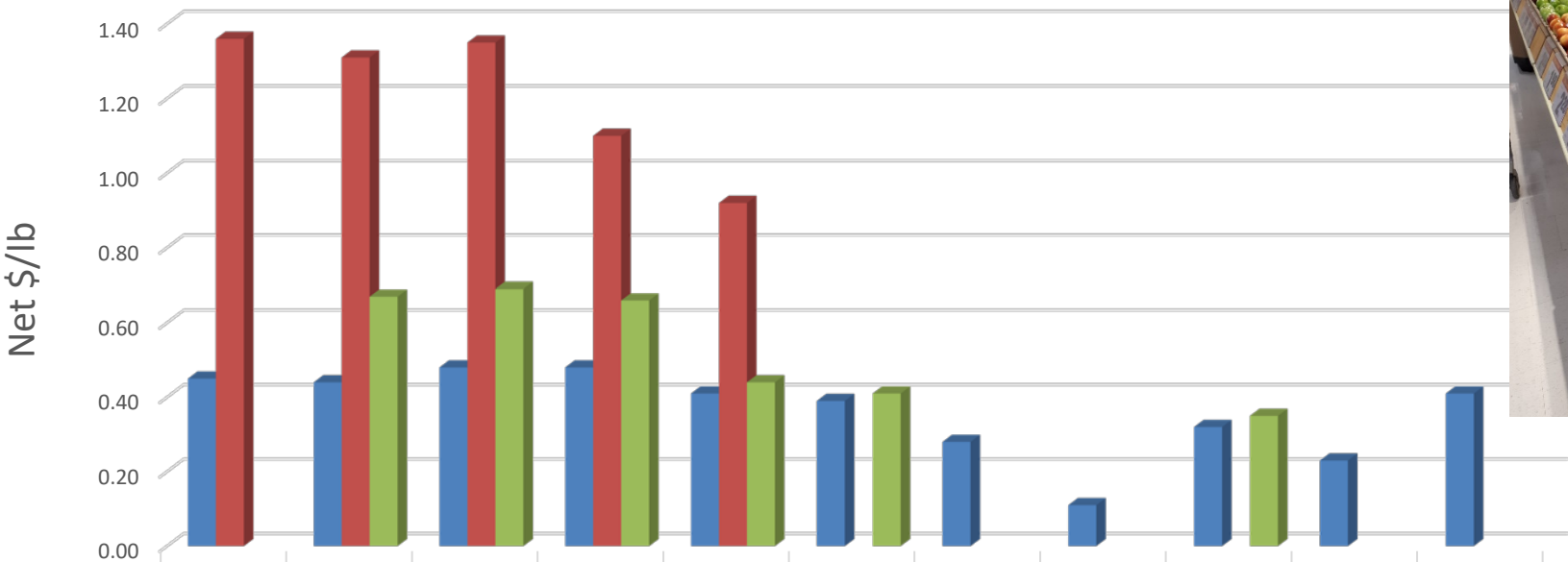
Managing crop load is a balancing act between reducing crop load (yield) sufficiently to achieve optimum fruit size and adequate return bloom without reducing yield excessively (Robinson et al., 2014).



Robinson et al. 2016

Details of net returns are required to determine target fruit size





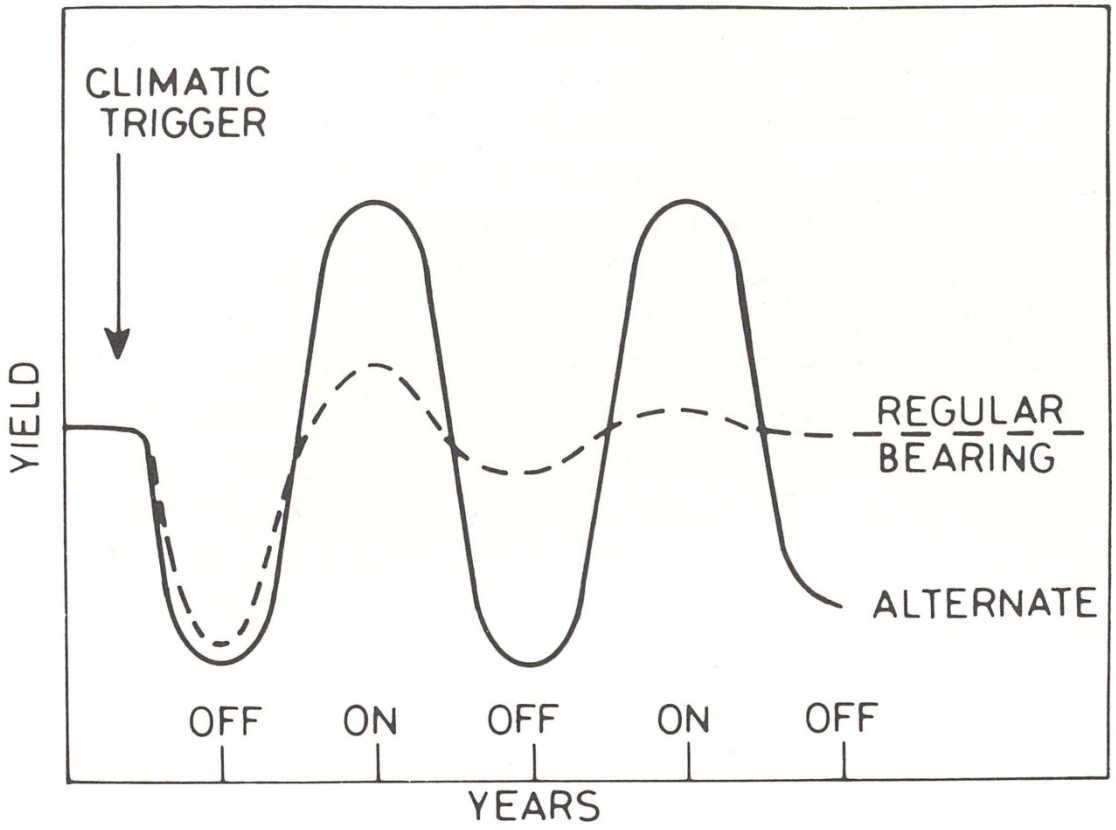
	64 Box	72 Box	80 Box	88 Box	100 Box	113 Box	163 Box	198 Count	12 x 3lb Bags	8 lb bag	10 lb bag
Gala	0.45	0.44	0.48	0.48	0.41	0.39	0.28	0.11	0.32	0.23	0.41
Honeycrisp	1.36	1.31	1.35	1.1	0.92						
Ambrosia		0.67	0.69	0.66	0.44	0.41			0.35		

Example of $/lb in relation to fruit size

Why is Crop Load Management Important

- Apples trees bear an overabundance of flowers
- Thinning (reducing crop load) is necessary to enhance fruit size and quality at harvest
- Early chemical thinning is important to reduce labour costs of hand thinning and optimize fruit quality
- Labour availability and cost are significant growing concerns

Biennial Bearing- justification alone for thinning



Biennial Bearing

- Honeycrisp
- Fuji
- Northern Spy

Annual Bearing

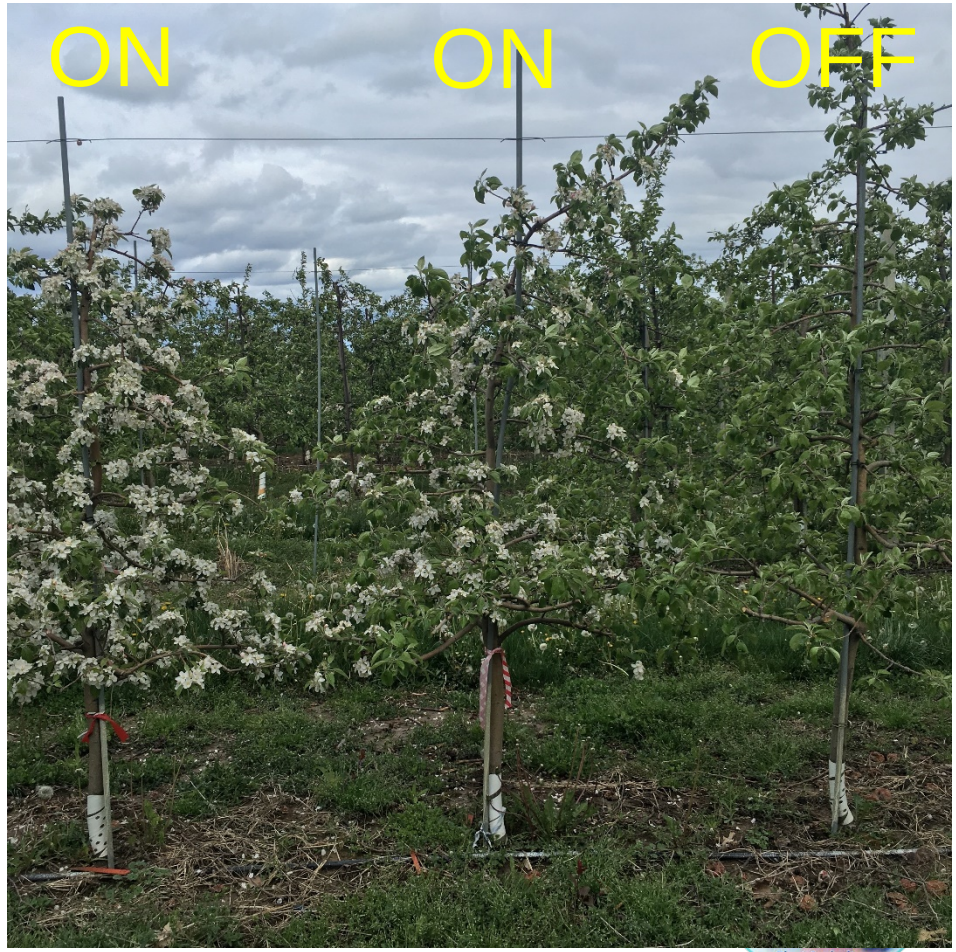
- Gala
- Empire

Schematic diagram showing differences in cropping on a regular and alternating cropping year. The off year can be caused by a climatic trigger such as frost, poor pollination, or hormonal imbalance the previous year. After Monselise and Goldschmidt, 1982.

Benefits of a successful thinning program
Reduced Biennial Bearing

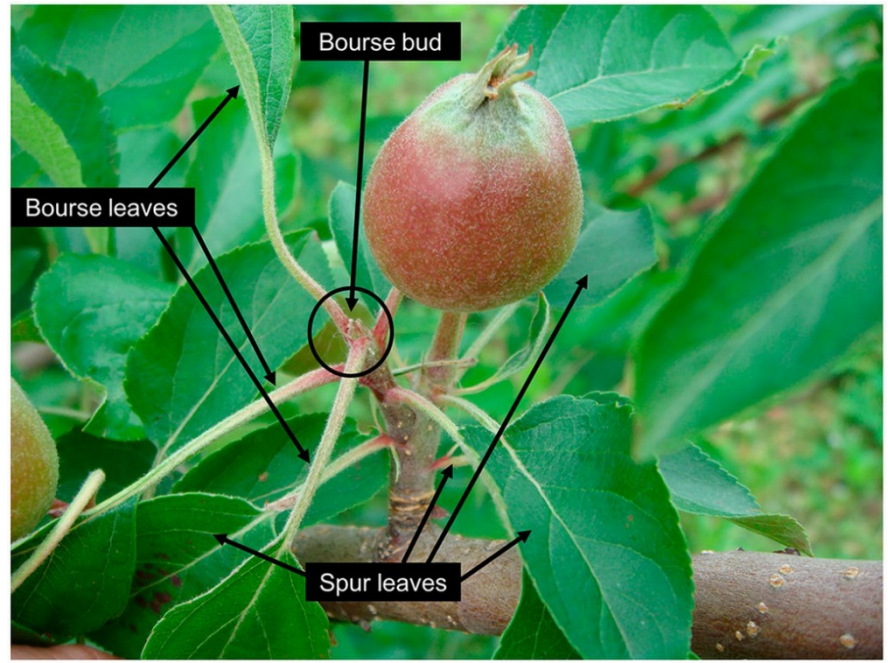
For biennial bearing cultivars:

-reduce the crop load early to avoid less bloom the following year



Why thin early?

- Flowers begin to develop one year prior to bloom (June)
- Many factors within the tree determine if the bud will become floral or remain vegetative

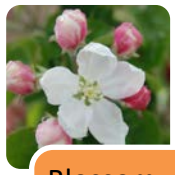


Hand Thinning – Least Desirable

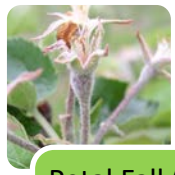
Also, least effective for return bloom and final fruit size at harvest

Precision thinning

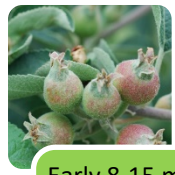
Pruning – remove flower buds



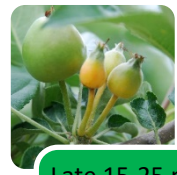
Blossom thinning
- Lime sulphur
- ATS
- String thinner



Petal Fall (5 mm ø
- NAA



Early 8-15 mm ø diameter
- 6-BA
- Carbaryl
- NAA
- (1-ACC)
- (Metamitron)



Late 15-25 mm fruitlet diameter
- (1-ACC)
- (Metamitron)
- (Ethephon)

Hand thinning

Target Fruit size

Precision thinning is the orchard management process of using <u>multiple</u> strategies to reach a target crop load with minimal need for hand-thinning

Precision Pruning

Reduce the bud load to 1.5-2.0 times the target bud load, assuming a set of one fruit per flower bud.

Example, if the target fruit number is 100 fruits per tree, prune to leave 150 to 200 flower buds per tree

Precision Crop Load Management

Blossom and fruitlet thinning

- Apply sequential chemical thinning sprays and assess response after each spray (full bloom – 20 mm fruit diameter)

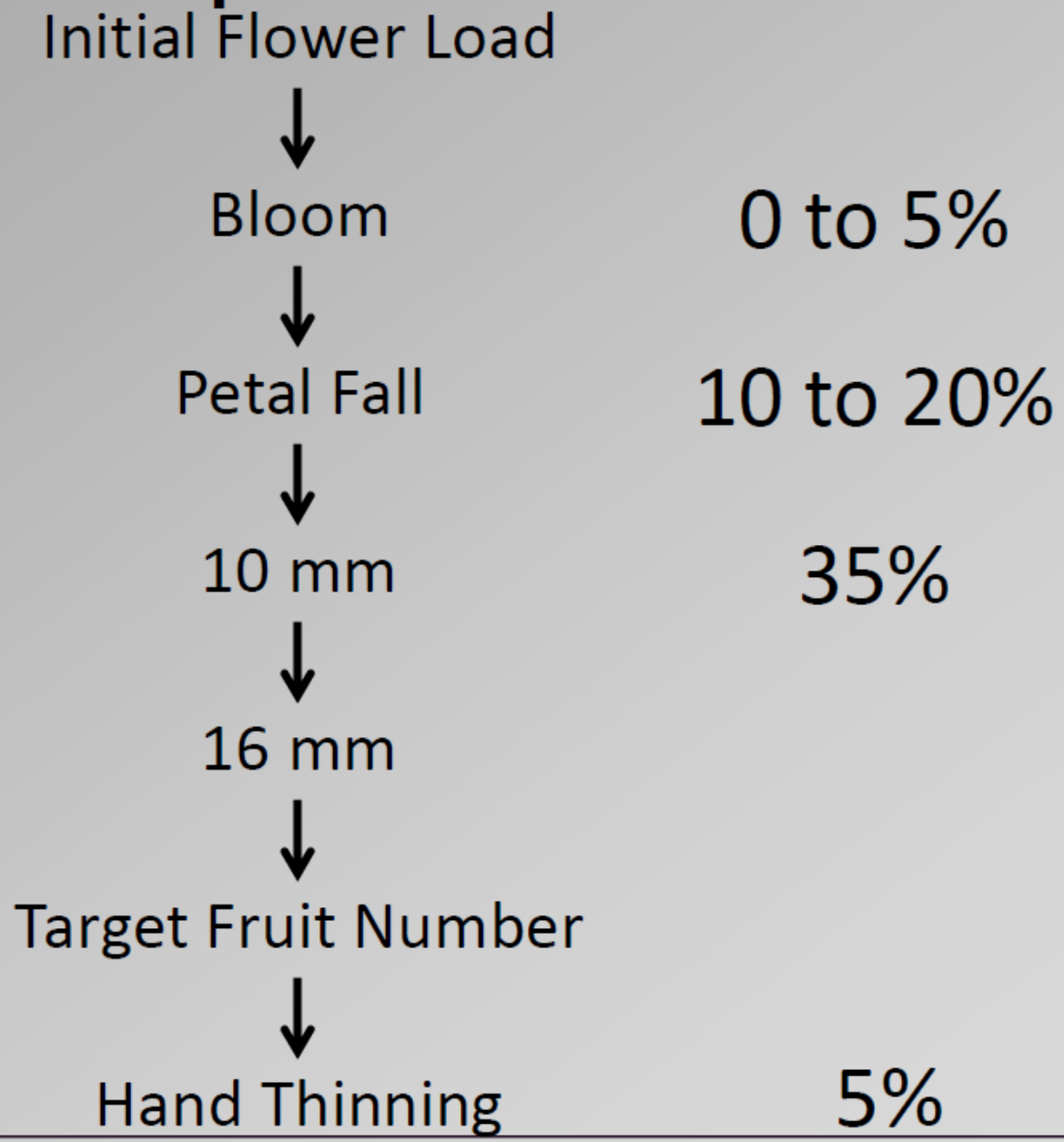
Hand thinning

- reduce final fruit number to the target fruit number

Steps in Precision Thinning (after Robinson)

Prediction Models	Initial Flower Load	Timing
	↓	
Pollen Tube Growth Model	1.Blossom Thinning	60% full bloom
	↓	
Carbohydrate model, fruit growth rate model	2. Petal Fall	6-7 mm
	↓	
Carbohydrate model, fruit growth rate model,(BreviSmart)	3. 10-15 mm	10-15
	↓	
Carbohydrate model	4. 16-20 mm	16-20 mm
	↓	
	5. Hand thinning	After June drop (25-30 mm)

Precision Croploading Flow Chart



Source: T. Robinson

Action Steps for Precision Crop Load Management

1. Set the desired target crop load - number of fruit per tree
2. Dormant prune to 1.5-2.0x bud load
3. Start blossom and chemical thinning early
4. Use models to predict fruit set
5. Repeat chemical fruitlet thinning sprays as needed (and according to label and efficacy)
6. Hand thin

Chemical Thinner Options

Blossom Thinners	Fruitlet Thinners	Future Products
Lime-Sulphur (tanked mixed with) mineral oil	Carbaryl - Sevin XLR (carbamate insecticide)	Metamitron (Brevis)
Ammonium thiosulphate (12-0-0-26S)	6-BA (MaxCel, Cilis Plus) – Cytokinin	
NAA – Fruitone, Refine	NAA – (Fruitone-N/L, Maintain)	
NAD – Amid-Thin	ACC (Accede®), Valent BioSciences	

The list of formulated commercial products is not complete. Other product manufacturers may be available in the USA.

Physiology

Cloudy weather (shading)

High night temperature

Drought

Excessive crop load

Stress within the fruit

6-BA, NAA, Carbaryl, Metamitron

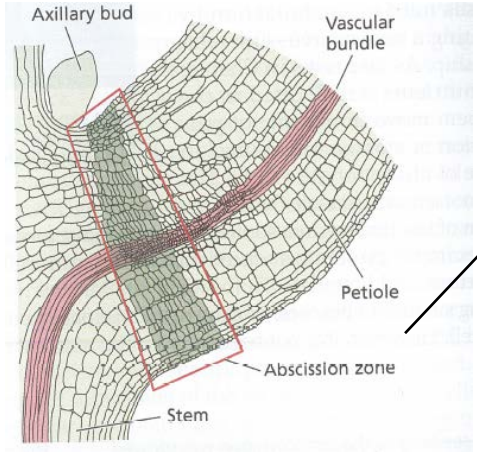
Increased sensitivity of the abscission zone to ethylene

(5-20 mm)

Promotion of ethylene

6-BA, NAA, Ethrel, 1-ACC

Activation of the fruit abscission zone

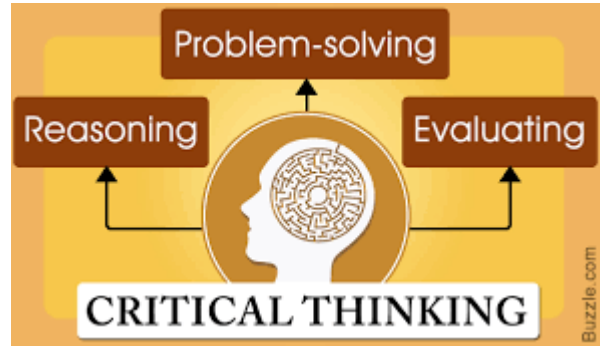


Abscission zone of a leaf

Reasons for thinning variability

Table 1. A summary of the key features of fruit trees that are either easy or difficult to thin (after Williams 1979; Williams and Edgerton 1981).

Trees are easy to thin when:	Trees are difficult to thin when:
1. Fruit spurs on the lower, shaded, inside branches are low in vigor.	1. Fruit set on spurs in well-lit areas of tree (tops and outer periphery).
2. Moisture and nitrogen supply are inadequate.	2. Trees are in good vigor with no mineral deficiencies.
3. Root systems are weakened by disease or physical damage.	3. Older trees in good vigor have a mature bearing habit.
4. Bloom is heavy, especially after previous heavy crops.	4. Light bloom or light fruit set occurs with the exception of young trees.
5. Young trees have many vigorous upright branches.	5. Trees have horizontal fruiting branches.
6. Thinners are applied to self-pollinated or poorly pollinated fruits.	6. Insects are active on cross-pollinated cultivars.
7. Fruit set is heavy on easily thinned cultivars such as 'Delicious'.	7. Limbs and spurs have been slightly girdled following moderate winter injury.
8. Cultivars tend to have a naturally heavy June drop.	8. Biennial bearing trees are in the off year.
9. Fruit sets in clusters rather than as singles.	9. Fruit sets in singles rather than in clusters.
10. Bloom period is short, and blossom-thinning sprays are used.	10. Cultivars such as 'Golden Delicious' and heavy-setting spur types are to be thinned.
11. High temperature is accompanied by high humidity before or after spraying.	11. When ideal fruit growth occurs before and after time of thinning.
12. Blossoms and young leaves are injured by frost before or soon after spray application.	12. Low humidity causes rapid drying, and decreased absorption occurs before and after spraying.
13. Foliage is conditioned for increased chemical absorption by prolonged cool periods.	13. Cool periods follow bloom without any tree stress.
14. Rain occurs before or after spray application.	14. Endogenous ethylene production is low.
15. Prolonged cloudy periods reduce photosynthesis before or after application of chemicals.	15. Bloom is light, and a high leaf-to-fruit ratio exists.



Weather is a key component (temperatures, rain, solar radiation)

Some important factors that promote and supress the response to chemical thinners

Promoters

- Lower light conditions
- Heavy bloom
- Cuticles of leaves formed under cooler periods lead to greater absorption of chemicals
- Higher night temperatures
- Fruit set in clusters rather than singles

Suppressors

- Lower temperatures reduced plant metabolism and activity
- Light bloom
- Highly tree vigour leading to maximal fruit growth before and after thinner application
- Biennial bearing trees in their ‘off’ year
- Less differentiation in size between the central fruit (king) and lateral fruit


Apple fruitlets developing from a cluster
– about 10 days after bloom

Thinning Models/Tools

Model/Tool	Input	Output	Comments
Fruit Growth Model (Greene)	Fruit diameter	A predication of the final number of fruit that will remain after thinning	Very accurate Time consuming Difficult to implement with large acreage
Carbohydrate Model (Malusim) (Laskso and Robinson)	Amount of bloom, temperature, solar radiation	Timing and efficacy of thinners – adjustment in the rate of chemical thinner	Requires local weather and weather forecasts Not available in Canada
Pollen Tube Growth Model (Yoder and Peck)	Style length, temperature	Best time to apply blossom thinners	Requires local weather Not available in Canada
BreviSmart (Adama)	Temperature, fruit diameter, cultivar, past and forecasted weather	Timing and efficacy of Brevis - adjustment in the rate of chemical thinner	Requires local weather and weather forecasts (not currently available in Canada

Cornell Apple Carbohydrate Thinning Model

- Web-based (newa.cornell.edu) and mobile version (MaluSim.org) are available in the USA
- The model uses sunlight and temperature to estimate carbohydrate availability for fruit growth
- Thinning efficacy for any given spray uses a carbohydrate balance 2 days before and 4 days after the spray
- Output: Provides a recommendation on:

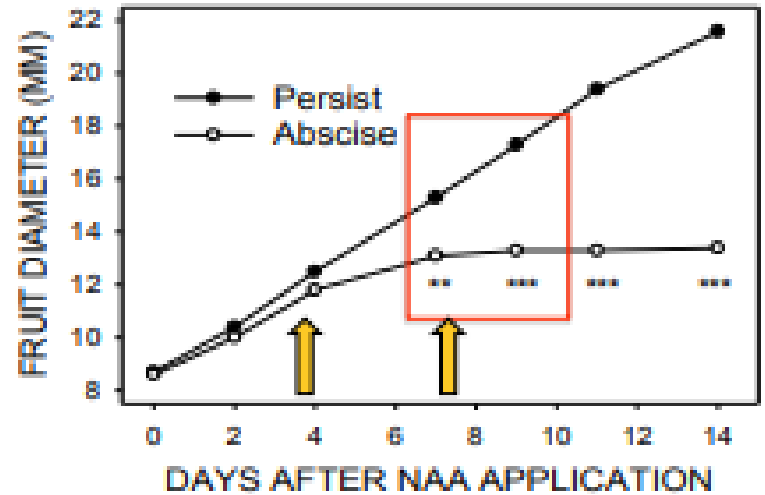
  i) whether to thin

  ii) adjustment in chemical thinning rate +/- 30%

Fruit Growth Rate Model

Basic assumption/hypothesis

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 (drop)	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.



https://www.canr.msu.edu/uploads/files/PredictingFruitset1-21-14.pdf

Abscising fruit slow down growth in 3-4 days days and stop growth within a 4-6 days following a thinning application.

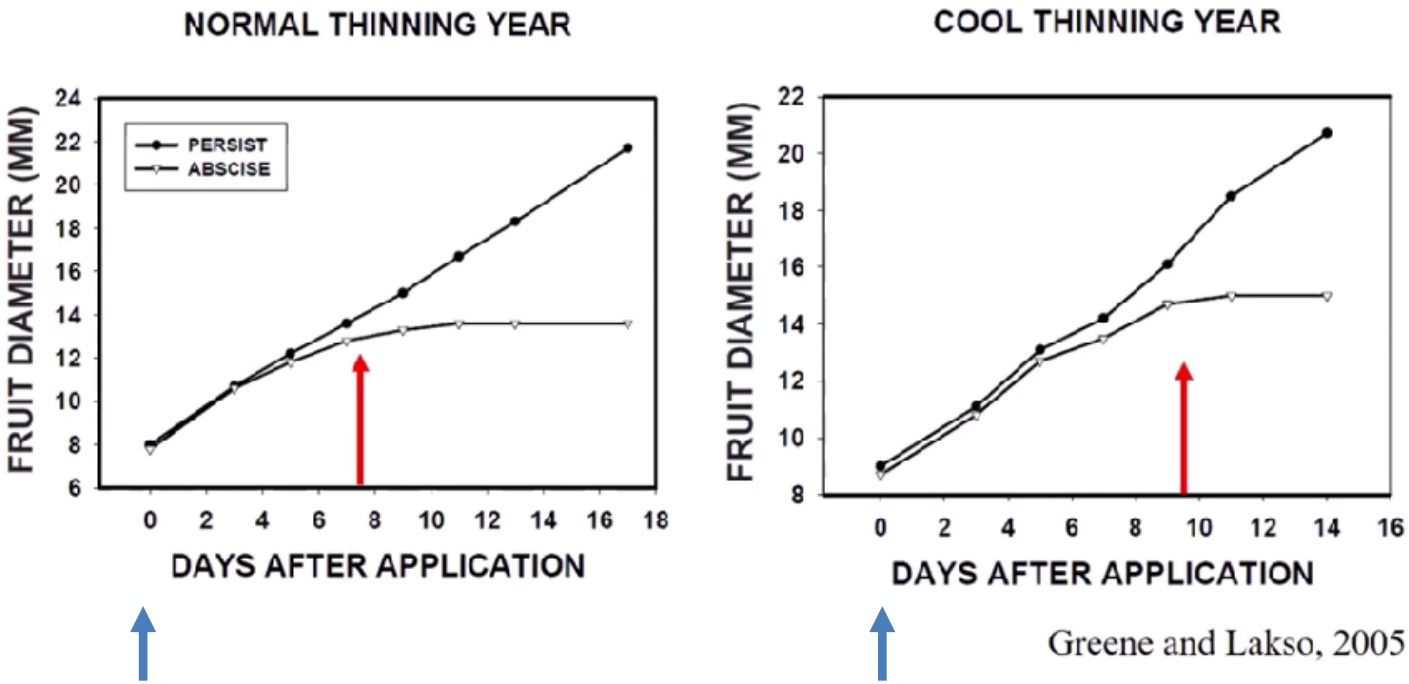
This slowing of growth is temperature dependent

Two measurements usually will suffice to predict set.

The first diameter measurement should be performed three days after the time of a thinning application and no earlier than the 6 mm stage.

The second diameter measurement should be performed three to four days later as indicated above

Fruit set prediction based on actual data (Greene and Lakso, 2005)



Thinner applied

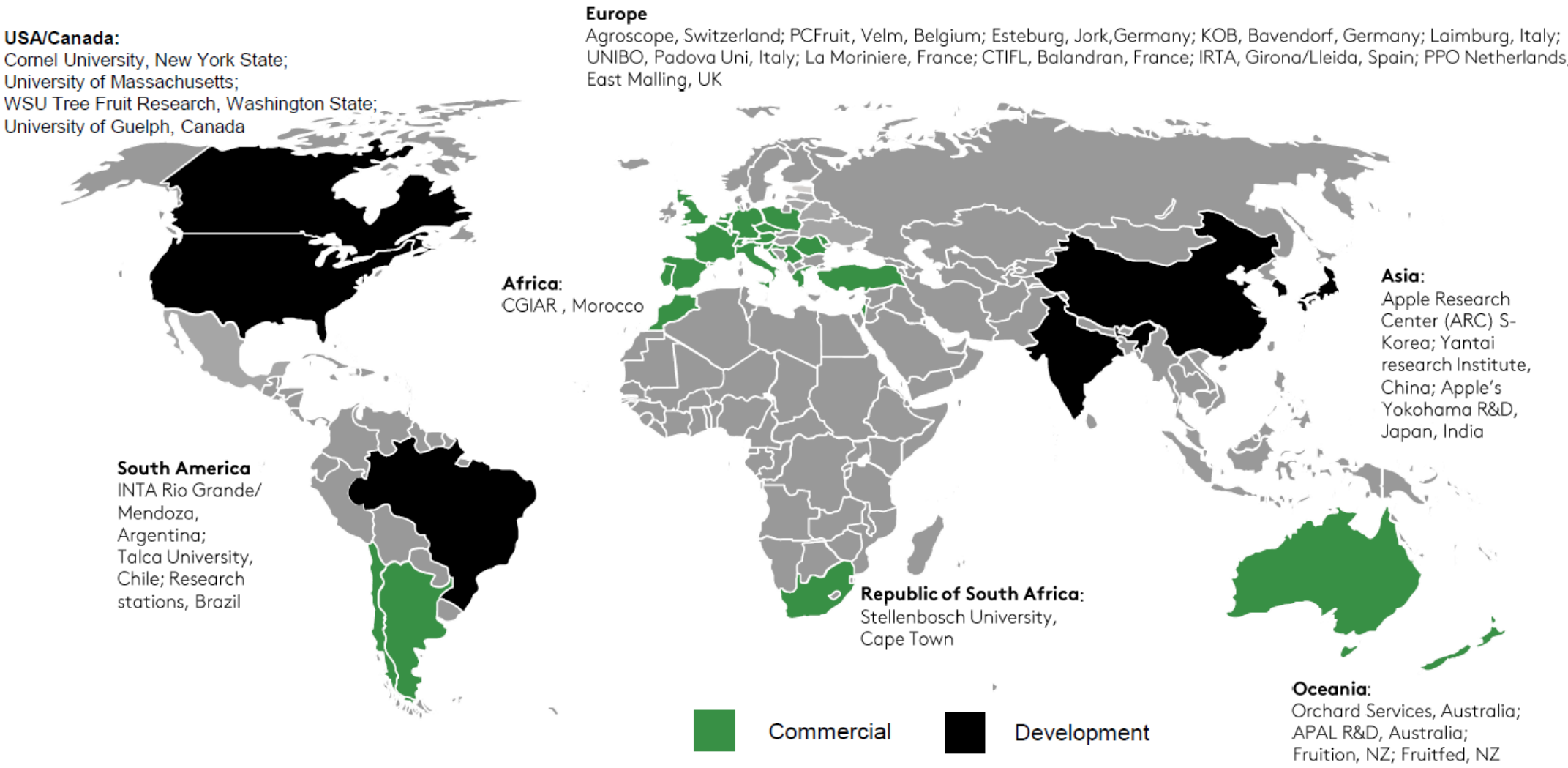
Thinner applied

Slowing of fruit growth (that precedes abscission) can be detected 7 to 10 days after thinner application (weather dependent)

New Fruitlet Thinners (not OMRE approved)

Product	Company	Mode	Ideal Timing	Status
Brevis (metamitron)	Adama Agricultural Solutions	Photosynthesis inhibitor	Petal fall – 20 or 25 mm	Product launch 2024 likely Currently registered in other countries (Australia, Israel, New Zealand, Chile, Argentina, parts Europe, S. Africa)
1-ACC (Accede)	Valent BioSciences	Stimulates ethylene	Petal fall – 20 or 25 mm	Approved in Canada and the USA

Metamitron (Brevis™ status globally (as of 2021) Source: Ton Bresseling, ADAMA



Accede® for Thinning Apples

Accede Label states:

- Apply at 200-400 ppm
- Timing: from full bloom until the average diameter of the king fruitlets is 25 mm.
- Accede SG is most active when king fruitlet diameter is 15- 20 mm.

<u>Our own research findings</u>

Has not thinned adequately in several studies conducted on Ambrosia and Gala, particularly at 20 mm fruitlet diameter.

It is recommended to apply other thinning products separately or in combination with Accede® for effective thinning.

Metamitron for Thinning Apples

- Apply at 1.8 L/ha (base rate)
- Adjust rates using BreviSmart computer model
- Timing: petal fall to 20 mm
- Wait approx. 8 days for second applications
- A non-ionic surfactant may increase thinning efficacy

<u>What has our research shown?</u>

Metamitron is an effective thinner

Most effective when king fruitlet diameter is 8-15 mm

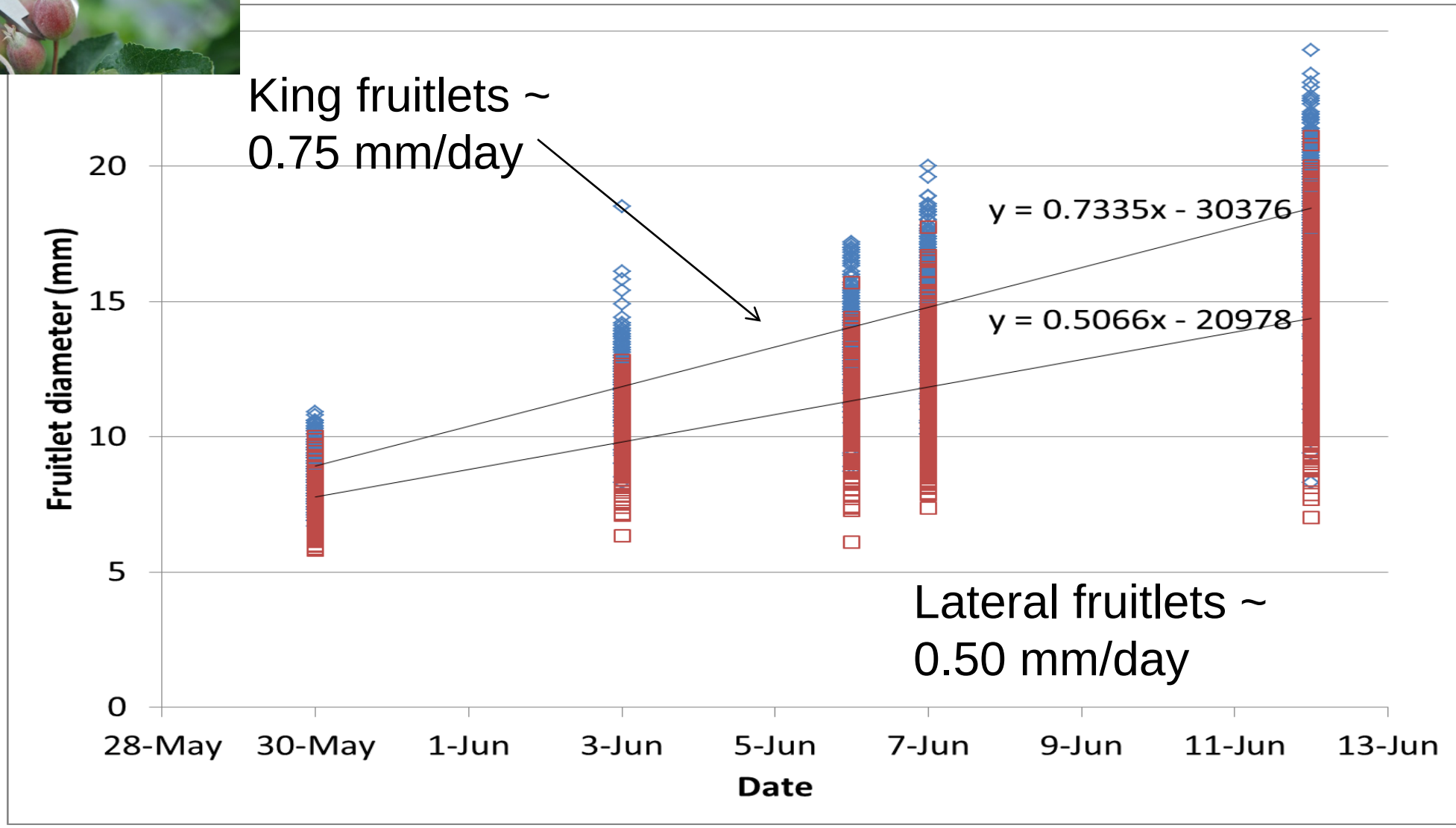
Thinning response is linear with increasing concentration

Generally, rate above 1.8L/ha are required

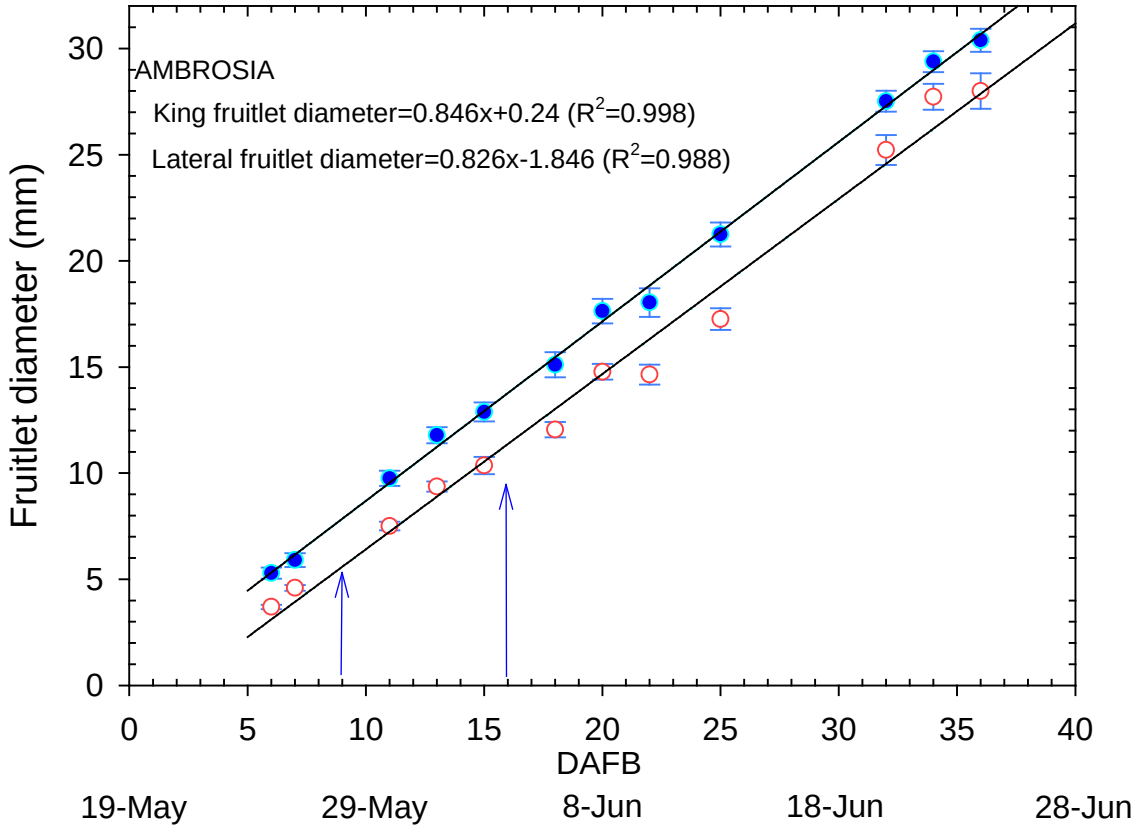
Steps for Successful Thinning
General Key Learnings

- Applications will be most effective when the maximum temperature on the day of application and for the following 2-3 days are ~20°C (68°F) or higher.
- Apply tree row volume dilute
- Use the appropriate product and rate (check grower recommendation guides)
- Spray upper 2/3 of the tree if fruit set is poor in the lower canopy
- Use a non ionic surfactant such as Agral 90 (0.05-0.10% by volume)
- When hand thinning, leave only one fruit per flower cluster
- 50% of the spurs need to be resting (no fruit) to have good return flowering
- Fruit are most sensitive to chemical thinners when 8-15 mm fruitlet diameter
- Its better to slightly over-thin than to under-thin.

Gala king and lateral fruitlet growth (2013)



2022 Ambrosia Fruit Growth Rates Simcoe, ON



Growth rates

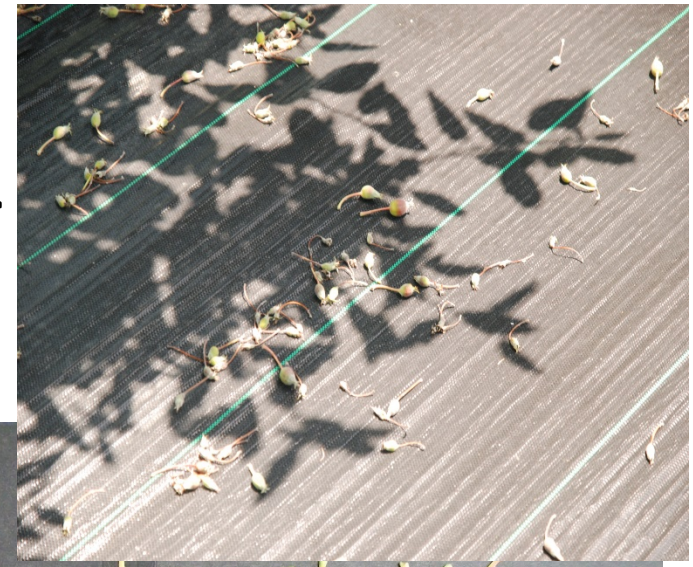
King fruitlets: 0.75-1 mm/day

Lateral fruits: slightly low rate

Thinning window 5 (PF)-15 mm

King fruit mm/day	Thinning window (days)
0.75	13
0.85	12
1.0	10

It takes 12-14 days to visually see fruit drop after applying a chemical thinner



Cultivar Sensitivity to Chemical Fruitlet Thinners

Easy	Moderate	Difficult
Ambrosia non-spur Red Delicious Idared Mutsu/Crispin Jonagold strains Jerseymac Honeycrisp Gingergold Silken Creston Cameo Golden Supreme	Empire McIntosh Northern Spy Cortland	Golden Delicious Paulared Gala strains Fuji Goldrush Spartan Wealthy spur-type McIntosh spur-type Red Delicious.

Source: http://www.omafra.gov.on.ca/english/crops/hort/thinning.htm#apples

Thinning with 6-BA and Carbaryl

Table 3. Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin XLR

Desired response[1]	Concentration of 6-BA (ppm)[2]	Concentration of carbaryl (ppm)[2]	Number of applications	MaxCel (L/1,000 L water/ha)	Cilis Plus (L/1,000 L water/ha)	Amount of Sevin XLR (L/1,000 L water/ha)
Enhance size only[3,4]	10-50	-	2 to 4	0.5-2.65	0.5-2.5	-
Mild thinning and sizing	50-75	-	1 to 2	2.65-3.95	2.5-3.75	-
Moderate thinning and sizing	75-100	-	1 to 2	3.95-5.3	3.75-5.05	-
	50-75	500	1 to 2	2.65-3.95	2.5-3.75	1
Aggressive thinning and sizing	100-150	-	1 to 2	5.3-7.95	5.05-7.55	-
	75-100	500-1,000	1 to 2	3.95-5.3	3.75-5.05	1-2
Very aggressive thinning and sizing	150-200	-	1 to 2	7.95-10.65	7.55-10.1	-
	100-125	1,000	1 to 2	5.3-6.6	5.05-6.3	2

http://omafra.gov.on.ca/english/crops/hort/thinning.htm#apples

Thinning recommendations by cultivar

Table 3–13. Suggested Rates for Chemical Thinning of Mature Apple Trees[1] (cont'd)

Cultivar	Sevin XLR (L/1,000 L water)[2]	Fruitone-L (NAA) (ppm)[3]	Sevin XLR (/1,000 L water) + Fruitone-L (NAA) (ppm)[2,3]	MaxCel or Cilis Plus (g BA/ha)[4]	Sevin XLR (L/1,000 L water) + MaxCel or Cilis Plus (g BA/ha)[2,3,4]
Fuji	–	3.6–9.7	1–1.5 + 10–12	100–150	1–2 + 50–75
Gala	–	2.4–9.7	1 + 5–10	75–100	1–2 + 50
Gingergold	1–1.5	2.4–9.7	1 + 2.5–5	75	1 + 50
Golden Delicious, Wealthy	1–2	3.6–9.7	1 + 5–10	75–100	1–2 + 50
Golden Supreme	1	2.4–9.7	–	–	–
Goldrush	–	–	1 + 10	–	–
Honeycrisp	1–1.5	2.4–9.7	1 + 2.5	–	–
Idared	–	1.2–7.3	–	50–75	–
Jerseymac	1–1.5	2.4–9.7	–	–	–
Jonagold	1–1.5	2.4–9.7	–	50–75	–
Jonamac	–	3.6–9.7	–	–	–
Lodi	–	3.6–9.7	1 + 10–15	–	–
Macoun	–	3.6–9.7	–	–	–
McIntosh, Early	–	3.6–9.7	1 + 5–105	50–75	–
McIntosh, Non-spur	1–2	1.2–7.3	–	50	–
McIntosh, Spur-type	–	1.2–7.3	1–2 + 2.5–5	50–75	1 + 50
Northern Spy	0.5–1.5	1.2–7.3	–	–	–
Paulared	1–1.5	3.6–9.7	1 + 10–15	75	1 + 50
Red Delicious	0.5–1.5	1.2–7.3	–	–	–
Red Delicious, Spur-type	–	1.2–7.3	1–2 + 5–10	–	–
Silken	1–1.5	–	–	–	–
Spartan, Russets	1–2	2.4–9.7	1 + 10–15	–	–

– = Treatment information not available.

[1] These rates are suggested for trees with a settled cropping history. Chemically thinning a first crop tree or immature trees is considered very risky.
[2] Sevin XLR is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl per litre. 1 L of Sevin XLR is roughly equivalent to 1 kg of Sevin 50 W.
[3] Sufficient water volumes must be used to thoroughly wet trees. For actual amount of NAA, refer to the label.
[4] Consult Table 3–14. *Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin XLR* to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective.
[5] At petal fall
Table developed by John Cline, University of Guelph.

http://omafra.gov.on.ca/english/crops/pub360/pub360A.pdf

Pear Thinning

Goals of thinning

- Reduce fruit set to minimize the amount of hand thinning
- Improve size and quality at harvest
- promote return bloom to encourage annual cropping.

Many pear varieties largely self-regulate their crops without chemical intervention, but well-managed chemical and hand thinning programs can increase the long- term profitability of some varieties including Bartlett.

Fruit set in some pear blocks can be low and it may be advisable to clearly assess pear set before applying chemical thinners, especially when conditions have been cool and/or wet during bloom leading to poor fruit set.

Chemical Fruitlet Thinners for Pear in the USA

Active ingredient	Formulated products	Rates	Timing	Notes
1-naphthalene-acetamide (NAD)	Amid-Thin W	10-50 ppm (cultivar dependent)	Full bloom or within 7 days after petal fall	Apply when temperatures are 70-75°C. Do not apply below 60°F or above 80°F
1-naphthalene-acetic acid (NAA),	Refine®, PoMaxa®	10-15 ppm ideal. Can be applied early but will likely be less effective	10-15 mm fruit diameter	Apply when temperatures are 70-75°C. Do not apply below 60°F or above 80°F
6-BA	MaxCel®, exilis®	75-200 ppm	5-15 mm king fruit diameter (8-12 mm ideal)	Apply when the maximum temperature is above 65°C the day of application and the following 2-3 days.
ABA	Protone® (Organic)	100-500 ppm	5-20 mm fruit diameter	Apply within 2-3 days of significant cloud cover and/or 2-3 days of mid-70s°F. Do not apply above 85°F. May cause leaf yellowing and leaf drop

Cold Snap™

Research Orchards

Bosc

Niagara on the Lake

Four year old trees (planted 2011)

OHFx87 rootstock

Spacing In row :0.91 m

Between row: 3.65 m

Density: 3011 trees/ha

Irrigated: overhead

Training system: 3-wire trellis

Cold Snap™

St. David's, ON

Four year old trees (planted 2011)

OHFx87 rootstock

Spacing In row :0.91 m

Between row: 3.65 m

Density: 3663 trees/ha

Irrigated: overhead

Training system: 3-wire trellis

Fruitlet chemical thinning treatments

Only Cilis Plus/MaxCel registered in Canada

Treatments	Details
1. Untreated Control 2. Hand-thinned 3. 75 mg/L 6-BA* 4. 150 mg/L 6-BA* 5. 10 mg/L NAA - Fruitone L 6. 20 mg/L NAA - Fruitone L 7. 150 mg/L S-ABA (Protone) 8. 300 mg/L S-ABA (Protone) 9. 150 mg/L ACC (Accede®) 10. 300 mg/L ACC (Accede®)	• Applied 10-12 mm fruitlet diameter • Final fruit set not fully apparent • Applied using commercial air blast sprayer • Tree Row Volume dilute • 6 Replications • Single tree plots • 0.05% Regulaid surfactant included

* Cilis Plus (Fine Americas formulation). 6-BA products in the USA include MaxCel® and exilis

Summary of Pear Thinning Study
Three-Year Study in Ontario

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NRC Research Press
ARTICLE

Response of Bosc and Cold Snap™ pears to thinning with NAA, 6-BA, ACC, and s-ABA

J.A. Cline, K. Carter, A. Gunter, C. Bakker, and A.C. Green

Fruit Set

- Fruit set was relatively light in this 3-year study and little hand thinning was required

Thinning, crop load, fruit per tree

- Bosc and Cold Snap responded similarly to the thinning treatments except for 'Cold Snap' in 2016.
- Overall, all thinning products reduced crop load at least once in the 3-yr study, although this varied by year and cultivar.
- Higher concentrations were more effective than lower concentrations.
- 10 -20 ppm NAA, 150 ppm 6-BA, and 300 pppm s-ABA were the most consistent at thinning
- Applications of 10 or 20 ppm NAA consistently resulted in the lowest fruit set compared to the control
- ACC (Accede™) was a inconsistent thinner at the high rate (300 ppm)
- Few differences between the untreated and hand thinned were observed
- Thinning resulted in higher percentages of large sized fruit but decreased yield and crop value.
- No negative effects on fruit quality (maturity, BRIX, firmness, colour) were observed from any of the thinning treatments.

Thinning pears with metamitron

- Metamitron consistently thinned ‘Bartlett’ at rates of 200-300 ppm when applied between 10 and 15 mm fruitlet diameter (Elsysy et al., 2020).
- Thinning of ‘Conference’ pear was also optimized between 175 and 300 ppm (Maas et al., 2010).

Improving fruit set of European Pears

ReTain®
PLANT GROWTH REGULATOR

- Natural ethylene production of fruitlets occurs 7 to 14 days after bloom (Einhorn, 2020)
- ReTain (AVG) may increase crop load in years when fruit set in lights – due to weather and/or poor pollination.

ReTain® (~132 ppm 100 GAL/acre) is labelled to:

- Increase set: apply from white bud stage to full bloom. Do not apply after petal fall.
- Reduce June drop- apply at 10 mm fruitlet diameter

Further Reading

1. Clements, J., Cowgill, W. 2021. Precision Crop-load Management of Honeycrisp: Flower Bud Identification and Precision Pruning. FruitNotes 86:8-10
2. Clements, J. 2022. Fruit Growth 'Apple Fruit Set Predictor' app. FruitNotes 88:7-9
3. Clements, J. N.D. Predicting fruit set using the fruitlet growth rate model. [online]. https://ag.umass.edu/fruit/fact-sheets/hrt-recipe-predicting-fruit-set-using-fruitlet-growth-rate-model (accessed Feb 28, 2023)
4. Cline, J. 2020. Blossom Thinning Apples with ATS and Lime Sulphur. Orchard Network 24(2):6-8 https://onfruit.ca/wp-content/uploads/2021/01/2020_02_Apr.pdf
5. Cline, J. 2021. Preliminary Results of Blossom Thinning with Lime Sulphur and ATS 25(2):10-14 https://onfruit.ca/wp-content/uploads/2021/05/2021_02_Apr.pdf
6. Einhorn, T.C., 2019, February. Regulation of flowering and fruit set of European pear. In EUFRIN Fruit Thinning Working Group Symposium 1295 (pp. 1-12).
7. Elsysy, M.A., Hubbard, A. and Einhorn, T.C., 2020. Postbloom thinning of 'Bartlett'pear with metamitron. HortScience, 55(2), pp.174-180.
8. Greene, D.W., Lakso, A.N., Robinson, T.L. and Schwallier, P., 2013. Development of a fruitlet growth model to predict thinner response on apples. HortScience, 48(5):584-587.

Further Reading

9. Hillmann, L., L. Gonzalez Nieto, T. Kon, S. Musacchi, T. Robinson, S. Serra, and T. Einhorn. 2022. A modified apple fruit set prediction model to guide repeat thinner applications. New York Fruit Quarterly 30(2): 4-6
10. Miranda Sazo, M and Robinson, T. 2023. Intentional Delay of Dormant Pruning for 'Honeycrisp' & Other Important Biennial Cultivars (Fuji). [online]. https://blogs.cornell.edu/enychp/tree-fruit/apples/tree-fruit-blog-intentional-delay-of-dormant-pruning-for-honeycrisp-other-important-biennial-cultivars-fuji/ (accessed March 3, 2023)
11. Robinson, T., Francescatto, P., and Cowgill, W. n.d. Spray Mixing Instructions Considering Tree Row Volume – TRV. [Online]. https://rvpadmin.cce.cornell.edu/uploads/doc_569.pdf (accessed Jan 15, 2024).
12. Wallis, A., Schwallier, P., and Irish-Brown, A. 2022. Thinning Strategies for 2022. [Online]. https://www.canr.msu.edu/apples/uploads/files/Thinning%20Guide%202022%20updated.pdf (access Jan 15, 2024).
13. Washington State University. 2024. Apple chemical thinning. In 2024 Crop Protection Guide for Tree Fruits in Washington. [Online]. https://cpg.treefruit.wsu.edu/bioregulator-sprays/apple-chemical-thinning/ (Accessed Jan 15, 2024).
14. Washington State University. 2024. Pear chemical thinning. In 2024 Crop Protection Guide for Tree Fruits in Washington. [Online]. https://cpg.treefruit.wsu.edu/bioregulator-sprays/pear-chemical-thinning/ (Accessed Jan 15, 2024).

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ONTARIO APPLE GROWERS

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