A Multi-Pronged Strategy for Managing Honeycrisp in 2020

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The Year in Review - 2019

- •Bloom of Honeycrisp in 2019 was poor in many orchards
- For many farms that have planted a lot of Honeycrisp it was a large financial setback
- Bloom is likely to be excessive in 2020 which will lead to poor bloom in 2021
- •Thus, 2020 is a Critical Year for Managing Honeycrisp



The Economic Impact of No Bloom or Light Bloom of Honeycrisp on Farm Revenue

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Three scenarios for Honeycrisp Blooming

Six 100-Acre Farms:

Farm	Acres HC	Acres Other
0%HC	0	100
10%HC	10	90
20%HC	20	80
30%HC	30	70
40%HC	40	60
50%HC	50	50

3 Honeycrisp Bloom Scenarios:

Scenario	Bushels HC/Acre	Gross/Acre
Regular Bloom	1000	\$25,000
Light Bloom	300	\$7,500
No Bloom	0	\$0

Honeycrisp grosses \$500/bin.

The acres of other fresh varieties gross \$10,800/acre. (\$250/bin x 864 bu/acre).

Gross Revenue for Regular Bloom, Light Bloom, and No Bloom Scenarios

	Regular			
Farm	bloom	Li	ght bloom	No bloom
0%HC	\$ 1,080,000	\$	1,080,000	\$ 1,080,000
10%HC	\$ 1,222,000	\$	1,047,000	\$ 972,000
20%HC	\$ 1,364,000	\$	1,014,000	\$ 864,000
30%HC	\$ 1,506,000	\$	981,000	\$ 756,000
40%HC	\$ 1,648,000	\$	948,000	\$ 648,000
50%HC	\$ 1.790.000	\$	915,000	\$ 540,000



Summary

- With zero acres of Honeycrisp planted, gross revenue was \$1,080,000.
- With 30% acres of Honeycrisp planted, a light bloom dropped gross revenue to \$981,000, and no bloom dropped gross to \$756,000.
- With 50% acres of Honeycrisp planted, a light bloom dropped gross revenue to \$915,000, and no bloom dropped gross to \$540,000.

Six key strategies to managing Honeycrisp in 2020

1) Precision pruning to manage biennial bearing (Robinson) 2) Bloom Thinning to manage biennial bearing (Robinson) 3) Precision Post bloom thinning to manage crop load (Robinson) 4) Fruit mineral analysis to adjust fertilizer programs (Cheng, Miranda and Henning) 5) Passive bitter prediction assay to determine pre-storage conditioning, storage temperature and marketing strategy (Watkins) 6) Using PGR's to manage harvest (Kahlke)



What caused the poor bloom in 2019

- •Too little pruning in 2018 and excessive number of flower buds.
- •Snow ball bloom of Honeycrisp with no bloom thinning.
- Crop loads were too high until hand thinning season, but by then it was too late. The damage was done.
- At harvest fruit numbers were significantly too high.



Flower Initiation in Apple Buds





Timing of Flower Initiation in Apples



Varieties widely differ in the time of flower induction/initiation.

The 18-Year Thinning Study at Geneva

From 2000-2017 we studied fruit thinning by applying the same thinning treatments every year to Gala/M.9, McIntosh/M.9 and Delicious/M.26 at Geneva, NY

One important conclusion

<u>The Final number of fruits per tree over 18 years was positively</u> <u>related to initial flower clusters per tree</u>. This means that with more flower clusters on the tree the final number of fruits is greater. With fewer flower clusters per tree the final number of fruits is less.

To achieve a target number of final fruits requires not starting with too many flower clusters. <u>Thus precision pruning is essential.</u>

Precision Pruning

- 1. Precision pruning is a process of reducing the number of flower buds to a predetermined number through pruning using the rules of Tall Spindle pruning and then spur extinction pruning. (Robinson, et al., 2013).
- 2. The first step in precision pruning is to establish a target of final fruit number desired at harvest.
 - Identify a goal for fruit size and yield based on the potential of the orchard and the climate.
 - HC Example 1: (1200 bu/ac * 72count / 1,320 trees/acre = 65 fruits /tree
 - •HC Example 2: (1200 bu/ac * **80** count / 1,320 trees/acre = 73 fruits /tree
 - HC Example 3: (1200 bu/ac * **88** count / 1,320 trees/acre = 80 fruits /tree



Precision Pruning

How many flowering spurs to leave?Target Final Fruit Number65 frt 73 frt 80 frt

- 1 bud per final fruit number. (65) (73) (80)
- 1.5 buds per final fruit number.(98) (110) (120)
- 2 buds per final fruit number. (130) (146) (160)
- 3 buds per final fruit number. (195) (219) (240)
- 4 buds per final fruit number. (260) (292) (320)



Gala and Honeycrisp Bud Load Study



- Leaving more than 2 buds : final fruit resulted in a large job of hand thinning
- Suggested target for Gala=1.5 buds/final fruit
- Suggested target for Honeycrisp=1.8 buds/final fruit

Precision Pruning

How many flowering spurs to leave?

Target Final Fruit Number65 frt 73frt 80frt

- 1 bud per final fruit number (65) (73) (80)
- 1.5 buds per final fruit number (98) (110) (120)
- 1.8 buds per final fruit number (117) (131) (144)
- 2 buds per final fruit number (130) (146) (160)
- 3 buds per final fruit number (195) (219) (240)
- 4 buds per final fruit number (260) (292) (320)



Range of Pruning Severities for Honeycrisp in 2013

Orchard	Ratio of Floral Buds : Final Target Fruit Number
1	1.49
2	1.83
3	2.00
4	2.43
5	2.44
6	2.50
7	2.72
8	2.88
9	2.88
10	3.25
11	3.44
12	3.46
13	5.22
14	5.80
Average	3.02

Conclusions - Pruning

- With more flower clusters on the tree the final number of fruits is greater. With fewer flower clusters per tree the final number of fruits is less.
- To achieve a target number of final fruits requires not starting with too many flower clusters. <u>Thus precision pruning is essential.</u>
- Precision pruning allows pre-thinning of the tree so that chemical thinning is more successful.
- •Calculate target spur number and then count representative trees after pruning to ensure that workers are pruning to the target level.
- With computer vision to count buds, precision pruning will become a much simpler task.

Using Pruning to Pre-thin the Trees

- 1. Eliminate 1-3 branches larger than ³/₄" diameter.
- 2. Columnarize (simplify) the rest of the branches.
- 3. Count number of bud and then
- 4. Remove spurs (ASE) until your reach the target bud number.



Strategies for reducing flower bud load

- 1. Eliminate complete branches
- 2. Simplify branches
- 3. Remove individual spurs



How to do precision pruning

- Sample 2 branches from each of 3 representative trees
- Dissect each spur bud and determine if it is floral or vegetative.
- Calculate the percentage of spurs that are floral.
- Multiply the target fruit number by an insurance factor (1.8) and then divide by the fraction of buds that are floral

Example 1 – target final fruit number is 80 per tree X 1.8=144 spurs (90% are floral) thus divide 144 by 0.9=160 is the target number of spurs per tree after pruning.

Example 2 – target final fruit number is 80 per tree X 1.8=144 spurs (50%) are floral thus divide 144 by 0.5=288 is the target number of spurs per tree after pruning.

How to do precision pruning (cont.)

- \bullet Require pruners to count the spurs remaining after pruning every $100^{\rm th}$ tree
- Adjust the severity of pruning to achieve the target number of spurs.

Thinning to manage crop load is essential for return bloom of Honeycrisp



What is Precision Chemical Thinning?

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

- 1.Using multiple applications of chemical thinners to reduce the fruitlet number in a stepwise manner to the target number
- 2. Using the pollen tube growth model to guide blossom thinning
- 3. Using the carbohydrate model to guide post-bloom thinning.
- 4. Using the fruit growth rate model to assess thinning results
- 5. Re-apply chemical thinners if needed.



Steps in Precision Chemical Thinning



Chemical Thinning Options

- Bloom
 - Ammonium Thiosulfate (ATS)
 - Lime Sulfur and Oil
 - Promalin
 - Maxcel
 - NAA
 - Amide-Thin
- Petal Fall (fruits at 5-6mm)
 - Sevin
 - AmideThin
 - Maxcel + Sevin
 - NAA + Sevin
 - Maxcel + NAA
 - Metamitron
- Fruits at 11-13 mm
 - NAA + Sevin
 - Maxcel + Sevin
 - Maxcel + NAA
 - Metamitron
- Fruits at 15-20 mm
 - NAA + Sevin
 - Maxcel + Sevin + Oil
 - Ethrel + Oil
 - ACC+Maxcel
 - Metamitron

Bloom Thinning

- Will blossom thinning ever be accepted in the East?
 - The addition of the PTGM is a significant advance
 - Measurement of style length is critical
 - If sepals are removed the visible length of the pistil is longer than shown in this picture
 - If style measurement is too long then chemical application is delayed and too little thinning achieved
- Bloom Thinning is essential for return bloom of Honeycrisp
- Washington uses bloom thinning with Lime Sulfur and Fish Oil on all of their Honeycrisp and have less biennial bearing.
- <u>To control biennial bearing in NYS</u> <u>we need to learn to do blossom</u> <u>thinning!!!</u>



Photo from Greg Peck presentation

Honeycrisp Return Bloom in 2004 was Improved with ATS at Bloom or ATS at Bloom plus Maxcel/Sevin at 10mm stage.



Bloom Thinning Options (Caustic Thinners)

- Ammonium Thiosulfate (ATS)
 - Burns stigma of pistil
 - Causes mild leaf phytotoxicity but no effect on fruit finish
 - Requires 2-3 applications
 - When used with the PTGM can achieve a substantial portion of thinning job
 - Has a neutral effect on fruit size
 - Not registered as a thinner in NY but can be legally used as a bloom time foliar fertilizer
 - Improves return bloom of Honeycrisp

• Lime Sulfur and Oil

- Burns stigma of pistil and also the style
- Kills pollen tube growth in the style
- More "reach back" to kill pollen tubes that are growing than ATS
- Causes mild leaf phytotoxicity but can also cause some fruit finish problems in some weather conditions
- Requires 2-3 applications
- Fish oil or soybean oil or summer spray oils (highly refined) work almost equally well with a slight edge to fish oil
- When used with the PTGM can achieve the majority of thinning job
- Has a neutral or negative effect on fruit size
- Not registered in NY but can be applied as a fungicide. However the Miller Chemical brand of Lime Sulfur prohibits use during bloom

		Fruit	Fruit	Cropload
Trt		No./	Size	Adj. Fruit
No.	Treatment Description	Tree	(g)	Size (g)
1	Unthinned Control	288	146	149
2	2.0 gal ATS/100 gal @ 80% FB	156	154	150
3	2.5 gal Lime Sulfur+2.0 gal Fish Oil/100 gal @ 80% FB	181	150	146
	LSD P≤0.05	94	11	10
	Contrasts			
	FOLS @ FB vs ATS @ FB	NS	NS	NS
	Fish Oil vs Ultra Fine Oil	NS	**	*
	Fish Oil vs Vegetable Oil	NS	* *	*
	Fish Oil vs Regulaid	NS	NS	NS
	Fish Oil vs Silwet	NS	**	*

Table 1. Effect of Alternatives of Fish Oil on Thinning Efficacy of Lime Sulfur.(Empire at Geneva NY 2003 Data)

Table 2. Effect of Organic Thinners on Gala Fruit Size at Geneva NY. (2003 Data)

			Cropload
	Fruit		Ādj.
Trt	No./	Fruit	Fruit
No Treatment Description	Ттее	Size (g)	Size (g)
1 Unthinned Control	608	139	153
2 2.0 gal ATS/100 gal @ 80% FB	472	143	142
3 2.5 gal Lime Sulfur + 2.0 gal Fish Oil/100 gal @ 80% FB	457	153	156
11 7.5ppm NAA + 1pt Sevin XLR @ 10mm Fruit Size	442	152	154
12 100 ppm BA + 1pt Sevin XLR @ 10mm Fruit Size	426	162	161
LSD P≤0.05	118	14	12
<u>Contrasts</u>			
ATS vsFOLS	NS	NS	*
FOLS vs Unthinned Control	*	*	NS
ATS vs Unthinned Control	*	NS	*
ATS vs BA/Sevin	*	*	*
FOLS vs BA/Sevin	NS	+	*

Bloom Thinning Options (Hormone Thinners)

- BA+GA4+7 (Promalin, Perlan, Typy)
 - Causes more typey fruit for Delicious, Gala and other varieties
 - In some years can cause some thinning
 - When temperatures are warm it has a good effect.
 - Timing is at early king bloom and well before full bloom
 - Use rate of 2pt/acre gives a low amount of BA compared to Maxcel use rates
- BA (Maxcel, Exilis, Riteway)
 - Causes more blocky fruit (not elongated)
 - Is a very mild thinner at bloom but can increase fruit size
 - Increases cell division to create a potentially larger fruit
 - Works well in warm conditions during bloom but poorly in cool conditions (1 year out of 2-3 there is a great response).
 - Use rate of 8pt/acre gives a high amount of BA compared to Promalin use rates
- NAA (Fruitone, Pomaxa, Refine)
 - A mild thinner (safe) when used at bloom
 - Can be sprayed safely at high rate of 10ppm
 - Has a neutral effect on fruit size
 - Little or no depression of photosynthesis at bloom
 - Can help improve return bloom on Honeycrisp
- NAD (Amide-Thin W)
 - A mild thinner (safe) when used at bloom
 - Can be sprayed safely at high rate of 8 oz/100
 - Has a neutral effect on fruit size
 - Little or no depression of photosynthesis at bloom
 - Can help improve return bloom on Honeycrisp

Bloom Thinning Conclusions

- Use the PTGM and spray ATS or Lime Sulfur and oil (if legal) 2or 3 times during bloom for large fruited varieties:
 - Honeycrisp
 - Fuji
 - Evercrisp
 - Delicious
 - Other large fruited varieties
- Use a hormone type thinner for small fruited varieties during bloom
 - Gala
 - NY 1
 - Jazz
 - Empire
 - Macoun
 - Pink Lady
- Do not spray caustic thinners under slow drying and wet conditions or if there is frost
- Frost causes damage to fruit skin and caustic thinners then cause russetting

Post-bloom Chemical Thinning



The Only Treatment which was Effective in the Champlain Valley in 2007 was Aggressive Petal Fall Thinning with High Rates of NAA



Status of Carbohydrate Model for 2019:

- Both a new Web-based version and a new mobile phone version (MaluSim) became available in May 2019
- The improved model uses relative bloom density to adjust predicted thinning efficacy for any given spray.
- The model uses bloom date to calculate degree days and adjust predicted thinning efficacy according to the number of DD from full bloom for any given spray.
- The model predicts thinning efficacy (thinning index) using a running 7-day carbon balance (2 days before spraying plus 4 days after spraying)

Honeycrisp Return Bloom was Improved with NAA/Sevin at PF plus Maxcel/Sevin at 10mm stage plus Summer NAA or Summer Ethrel in 2004.





NAA spray program to enhance flower formation in Honeycrisp



Rates based on 100 gallon trees

Honeycrisp Return Bloom was Improved by Early Hand Thinning



Take-Home Plan to Manage Crop Load in 2015:

1. Precision Prune

- 1. Prune Honecyrisp at green tip-1/2 inch green.
- 2. Calculate target fruit number
- 3. Count flower buds on 5 representative trees per variety.
- 4. Prune to 1.8 buds per desired fruit number by removing 1-3 of large limbs, then columnarize (simplify) all remaining branches and then spur prune
- 2. Chemically thin using the "Precision Thinning Program"
 - 1. Begin with a full bloom sprays
 - 2. Apply a petal fall thinning spray
 - 3. Assess response
 - 4. If necessary, apply a thinning spray at 10-13mm
 - 5. Re-assess response
 - 6. If necessary apply a thinning spray at 18-20mm
- 3. Apply summer return bloom sprays of NAA or Ethrel
- 4. Use precision hand thinning
 - 1. Hand thin Honeycrisp early (25mm or June 15)
 - 2. Count number of fruits per tree
 - 3. Zone thin using multi-level platform with each person removing his assigned number of fruits.

Is precision crop load management worth the effort?

- It will help control biennial bearing
- The annual returns will compensate for the extra effort
- With Honeycrisp mostly 100's returns \$20,000 per acre
- mostly 72's returns \$30,000 per acre





New Automation Project for Precision Crop Load Management

1. Autonomous vehicle with computer vision to geo-reference each tree in orchard and then count

- -dormant flower buds
- -floral buds at green tip to pink
- -flowers at bloom
- -fruitlets at 10-20mm size
- -fruits at 25-35mm size
- -fruits pre-harvest.

2. Convey to human workers actionable information to assist in crop load management during dormant pruning and hand thinning.

3. Fully autonomous crop load management vehicles that can count crop load, calculate optimum crop load and then adjust crop load.



Thank You for Your Attention

Questions?

Irrigation.

The Multi-pronged Strategy for Managing Honeycrisp in 2020:

- 1. <u>Precision Prune</u> trees to 1.8 flower buds per final target fruit number.
- 2. <u>Blossom Thin</u> using ATS and the PTGM.
- 3. <u>Chemically Thin</u> using the "Precision Thinning Program" and measure response with fruit growth rate model.
- 4. <u>Apply summer return bloom sprays of Ethrel (2X) and NAA</u> (2-3X).
- 5. <u>Use precision hand thinning</u> when fruits are 25mm or June 15
- 6. <u>Measure Fruit Mineral Concentration</u>. Sample fruitlets in early July and measure peel levels of K/Ca (<25) and N/Ca (<10). Use this information to adjust nutrition program.
- 7. <u>Passive Bitter Pit Prediction:</u> Sample 100 fruits on Aug. 15 and store at 68°F and evaluate bitter pit after 3 weeks.
- 8. <u>Segregate fruit</u> based on bitter pit risk and precondition when risk is low and don't precondition when risk is high.