Northern NY Agricultural Development Program
2015-2016 Project Report

Precision Crop Load, Irrigation and Harvest Management to Optimize Fruit Size and Quality of NNY Apples

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- Jay Tuhill, Chazy Orchards, Chazy, NY
- Mason, Seth and Mac Forrence, Forrence Orchards, Peru, NY

Background:

Apples are New York's largest fruit crop. Over the last 40 years, NY's apple growers have re-invested huge sums of money into new high-density orchards where crop load plays a key role with a large economic impact on the returns that growers get per acre of apples. If they do a very good job, meaning that every apple is perfect and yield is high, that could mean a gross income of approximately $15,000 per acre.

Growers spend a lot of time trying to manage the crop load on the tree with considerable maneuverability built into production practices; growers can either make or break their crop with this singular effort . In the last six years an improved method of conducting

chemical thinning that utilizes both the carbohydrate model and fruit growth model has been successfully used. The carb model uses the carbon balance model as a predictive tool for predicting response prior to application; the fruit growth rate model is used for early assessment of thinning response immediately following application.

To precisely manage fruit size requires precision in chemical thinning and irrigation. Growers attempt to achieve desired fruit size by properly reducing crop load in the spring, but if the summer is dry the desired fruit size and crop value will be severely compromised. Good water status is essential to maximize fruit size at any given crop load.

Irrigation is also critical for improving and maximizing tree growth of newly planted or young apple trees. The economic success of high-density orchards depends on obtaining significant yields in the third, fourth and fifth years to repay the establishment costs. Water stress impacts yield potential and limits uptake of calcium into the fruit which can result in a more bitter pit. With more precise water management growers are able to limit plant water stress and more consistently achieve the optimum economic fruit size and quality.

The goal of this project was to further develop and promote precision orchard management strategies to Northern NY apple growers. Three regional apple growers participated in this project through the use of on-farm research plots.

Methods:

The project's two main focus areas were (1) precision thinning and (2) precision irrigation. Hedging experiments were cancelled in 2016 due to an aggressive fireblight outbreak. In addition, irrigation in the Champlain Valley was delayed to ease shoot growth set, thus, first season assessments of tree stress were cancelled.

(1) Precision Thinning:

The chemical thinning strategies recommended over recent years involve making applications at multiple times. Growers from NNY's Champlain Valley region are advised to follow a sequence of thinning sprays to achieve their desired target crop load beginning with a spray at bloom, followed by a spray at petal fall, then, if needed, another spray at 10-12mm fruit size and/or at 18mm fruit size. Due to a spring 2016 freeze event experienced in most NY areas (see Results section), we asked growers to be cautious and adopt a very conservative wait-and-see approach to thinning. Project educators work with growers throughout the growing seasons to build their confidence: when to apply chemical thinners or when not to apply.

The precision chemical thinning protocol recommended to apple growers in 2016 incorporated two precision thinning models: the carbohydrate model developed by Alan Lasko, Cornell University, and the fruit growth rate model, developed by Duane Greene, University of Massachusetts. Growers followed several simple steps to accomplish both models. The first step is to establish a target fruit number (target crop load) and an initial flower bud number. This requires the fruit grower to count five representative trees after

pruning and know the number of flower buds on those five trees. Since each flower bud has five flowers it is simple to calculate the potential number of fruitlets to start with. The target crop load is defined by each grower according to their experience, variety, tree vigor and age and desired fruit size.

Each day the grower planned to spray he logged into the Cornell Network Environment and Weather Applications website and followed the steps of the apple carbohydrate model, which returns a recommendation on whether or not to spray, how to adjust the application rate, and what days to avoid application.

The fruit growth rate model requires growers to tag some spurs, and measure the diameter of the little fruitlets in each spur twice. With these two measurements, this model estimates how many of those fruitlets are still growing and expected to persist, and how many are not growing and categorized to fall off in about one week. This provides the growers with some confidence about whether to apply, or not, the next thinner.

Due to the frost, the program proposed for 2016 was slightly modified. In certain parts of the state where there was very little damage, we recommended starting with the full and aggressive precision thinning program. If damage existed, we asked growers to avoid the bloom spray and possibly the petal fall spray, but still measure fruit, so we could determine how many fruits they would have before the 10mm spray.

The protocol sent to growers is described below:

1) At pink or bloom or even as late as petal fall, 5 representative trees should be selected and all the flower clusters on each tree counted to determine the potential number of fruitlets supposedly expected.
2) About 3-4 days after petal fall (when fruit are about 5mm fruit size) 15 flowering clusters on each of 5 trees should be marked and the diameter of each fruitlet in each cluster should be measured with a caliper. This measurement should be done whether or not petal fall spray was applied.
3) 7 days after petal fall (3-4 days after the first measurement) growers should measure again the same fruitlets.
4) These diameter data should be sent electronically to Poliana Francescatto, Cornell University, who analyzes the data with the fruit growth rate model. Within 24 hours the results are sent back to the growers with Dr. Poliana's recommendation. Even if no petal fall thinning was applied these fruit growth measurements would allow determination of how many fruits were really growing on each tree and how many would fall off naturally from frost damage. Through this effort we know how many fruit will be within each cluster and how large or small a thinning job is needed.

As noted, we normally deal with 5 fruit per cluster, however, in 2016 some areas did not have that many fruit. The initial tagging let growers know that they were starting with much lower fruit, and we calculated how much thinning growers should do at 10mm or maybe no thinning based upon the measurements. If another thinning was required at 10-

12 mm, then growers kept measuring the same fruit 3-4 days after spray, again at 6-7 days and kept checking the carbohydrate model to adjust rates and timing.

In 2016 we included one more output in the fruit growth rate model – the cluster distribution. The model tells the grower the cluster population of a particular block. It shows the percentage of cluster with 0, 1, 2, 3, 4 or 5 fruitlets, and helps inform growers' thinning decision.

Anna Wallis with the Cornell Cooperative Extension Eastern NY Commercial Horticulture Program, which serves growers in northeastern NY, assisted growers on how to set up the protocol on their farm, how to use the models, how to take the measurements, and how to interpret the results.

(2) Precision Irrigation

In 2016 we conducted an irrigation management trial on four apple farms (one each in Ulster, Orleans, Wayne and Clinton counties) and one at the NYS Agricultural Experiment Station (NYSAES) in Geneva, NY, by using the Cornell Apple Irrigation Model.

The orchards were set up as follows:

- Geneva (NYSAES): Empire/B9 orchard, planted in 2011 at 1,156 trees/acre,
- Hudson (Ulster County): Gala/M9 orchard, planted in 2011 at 1,117 trees/acre,
- Orleans County: Plumac/B9 orchard, planted in 2015 at 1,980 trees/acre,
- Wayne County: Gala/B9 orchard, planted in 2009 at 838 trees/acre, and
- Champlain Valley (NNY: Clinton County): NY1/B9 orchard, planted in 2010 at 1,037 trees/acre.

At each site we managed soil water level according to the Cornell Apple Irrigation Model to minimize tree water stress. To assess the value of the model, some trees were left unirrigated so growers could compare and visually access the benefit of the irrigation. We assessed tree growth, tree stress, and crop yield, fruit size and fruit quality (flesh firmness and sugars) with irrigation and no irrigation.

Results:

(1) Precision Thinning:

The year 2016 brought several adverse weather events to NY, creating one of the most challenging growing season in memory for apple growers, who had to learn how to cope with the impact and escape without having too much damage on their crops.

Here is a growing season summary for the Champlain Valley according to the 2016 New York State Apple Crop Survey Report by Cornell University Cooperative Extension:

"Winter conditions were extremely mild prior to the 2016 growing season in the Champlain Valley. Temperatures rarely dropped below 0°F, with the exception of two cold nights in February that reached nearly -20°F. Throughout the growing season, environmental conditions posed major challenges this year. Bud swell began very early, due to warmer than average temperatures in March. In the first week of April, the region experienced frost conditions several nights in a row. Fortunately, tree growth was not advanced enough to cause

significant bud injury; most farms experienced minimal to zero damage, for the most part restricted to loss of a few king flowers and/or some lopsided fruit in the most advanced varieties and blocks. Very warm conditions and rain events at the tail end of bloom led to severe fire blight infections in most orchards. Growers responded by using cultural, mechanical, and chemical practices to slow down plant growth, in order to minimize further spread of infection. These management decisions have had an effect on vegetative growth, crop load, and fruit development. Conditions were exacerbated by severe isolated thunderstorms including very high wind gusts (>40MPH) and hail. Very dry conditions for most of May, June, and July caused severe drought stress. Rain at the end of July and beginning of August have provided relief to dry weather and are contributing to fruit sizing. Harvest is anticipated to be a few days earlier than average, due to warmer than average conditions over the course of the season."

As apple flowers started to expand, varying degrees of damage were noted. More severe damage was observed in the phenologically advanced areas and where the freeze event was more intense. In several instances individual flowers were killed in the flower clusters. Spur leaves appeared to remain small, crinkled, chlorotic, and generally unhealthy looking (Photo 1). It is well documented in the literature that spur leaves, through carbon supply to the flowers, play a critical role in assuring initial fruit set. However, there is little information in the literature documenting the photosynthetic capability of frost damaged leaves and the effect on fruit set.

Photo 1: Apple flower buds. Various levels of the frost injury occurred in the spring of 2016 throughout New York State. Photos: Poliana Francescatto

The precision thinning concept of counting the number of flower clusters on 5 representative trees helped establish the starting point of potential fruits after the 2016

freeze event. The fruit growth rate model helped growers know how many fruit would naturally fall off.

As described by the survey, most areas in NNY did not show significant flower injury, however, in a few areas spur leaves injury was still very pronounced. Apple phenology in the Hudson Valley was far advanced compared to all other NY regions, especially the Champlain Valley, and flower/leaf damage was much more affected. Growers from Hudson Valley were advised to follow a "modified" thinning program – skipping the bloom and/or petal fall spray. The results provided by the fruit growth model for that region showed that the damage caused to spur leaves did not interfere with fruit set and growers could continue the regular thinning sprays (Figure 1). This challenging period experienced by Hudson Valley growers provided NNY growers some confidence to start chemical thinning at bloom.

According to Dr. Duane Greene, the cool sunny weather following bloom resulted in a heavier initial set than would normally be expected from trees with extensive spur leaf damage. We interpreted this result as the spur leaves remained sufficiently functional to produce sufficient carbohydrate to allow good initial set.

Hot weather and warm nights registered around bloom/petal fall caused an extended poor supply-to-demand carbohydrate balance (Figure 2) in the NNY orchards. Trees were respiring heavily and "burning" carbohydrates. During this period, the model for most of the regions was recommending to reduce the thinner rate and in some areas not to thin. An alert was passed to growers through the Champlain Valley Thinning Meeting 5/26 and E-Alert Champlain Valley sent out by Anna Wallis (Figure 3).

The heat had a significant effect on thinning. In those places where thinner was applied at standard rates prior to the heat forecast, it was evident that trees were thinned heavier than expected (personal communication with growers). The carbohydrate deficit played a significant role in thinning in 2016.

Due to all these weather events (frost, hot weather, fire blight alert, etc.) and the uncertainty related to injury to flower/leaves, fewer growers completed the 2016 thinning program compared to those in 2015. However, most did follow the carbohydrate model regularly. Many growers hesitated to put any spray on at early stages of flower/fruit development and put a very late thinner on at 15-18mm fruit size when weather conditions had settled down, or hand-thinned.

Cornell ENYCHP Tree Fruit E-Alert for May 18th, 2016 @ 9:00 pm

Precision Fruit Set Evaluations at the Hudson Valley Lab *Gemma Reig, Dan Donahue, Poliana Francescatto*

In general, **fruit set a the Hudson Valley Lab looks to be stronger than most other parts of the Hudson Valley.** Since there is so much uncertainty about how the trees will respond to thinners after the early April freeze, we decided to use precision thinning techniques to monitor fruit set at the Lab in Gala, Empire, and Ruby Mac. Fruitlets were measured on May 10th, and again on May 16th. **No thinners have been applied.** Here are the results:

Hudson Valley Lab Apple Fruit Set May 16, 2016

	Data per Tree				
Variety	Target Set	Predicted Set	Ave. Top 15 Fruitlets (mm)	Ave. All Fruitlets (mm)	Thinning Plan
Empire	92	164	10.8	4.5	48 oz. BA (per 100 gallons)
Gala	106	323	9.3	6.3	64 oz. BA + 1 pt. carbaryl (per 100 gallons)
Ruby Mac	139	835	11.3	7.3	5 ppm NAA + 1 pt. carbaryl (per 100 gallons)

- Empires appear to be setting, but the small average fruit size is disconcerting, as is the reduced number of flower clusters observed. Apply BA at a reduced rate.
- Galas appear to be setting and fruit size is fine, apply BA and carbaryl at "normal" rates.
- Ruby Macs appear to have a strong set, apply NAA at an increased rate, carbaryl at the usual rate.

We made the thinning applications today, May 18th. Temperatures from tomorrow onwards are expected to reach into the 70's, good weather for BA thinners. According to the P-Thinning Protocol, we will re-measure fruitlets on Saturday May 21st, and again on Thursday May 26th, and report the results in an E-Alert.

Figure 1. Results from fruit growth rate model using three apples varieties at Hudson Valley Lab showing percentage of fruit set after frost (predicted set) – no thinners applied. The model helped to understand the ability of apple trees to compensate for the reduced spur leaf efficiency from damaged spur leaves.

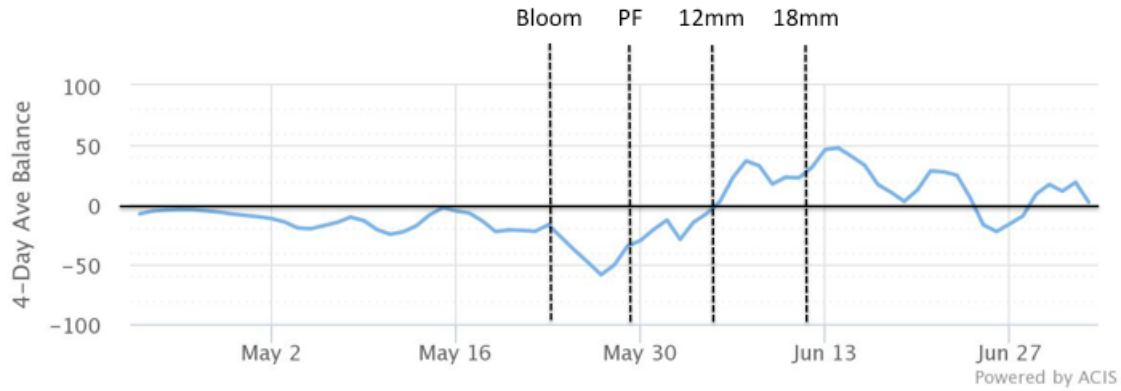

Figure 2. Predicted daily carbohydrate balance during spray applications in Peru, NY, according to weather data and the MalySim model, 2016. A severe carbohydrate deficit was registered between Bloom and Petal Fall (PF).

Location	Carbohydrate Model Output for 5/27/16 9AM
Chazy	Deficit predicted through the weekend but improving through Monday, decrease chemical thinner by 50% today, check back in tomorrow
Peru	Deficit predicted through the weekend, decrease chemical thinner 50% both today and tomorrow.
Crown Point	Deficit predicted through the weekend but improving through Monday, decrease chemical thinner by 50% today, check back in tomorrow
Clifton Park	Deficit predicted through the weekend but improving through Monday, decrease chemical thinner by 50% today, check back in tomorrow.

Figure 3. Grower Alert May 27, 2016: Carbohydrate Model – Deficit predicted through the weekend for the Champlain Valley. Source: E-Alert Champlain Valley, 05/27/2016, 10AM, Anna Wallis.

Figure 4 shows how Gala and Honeycrisp trees responded to two thinning sprays at Everett Orchards. Cold injury in the Gala block was at minimum and slightly higher in the Honeycrisp block. The grower felt confident keeping the precision thinning program on and decided to keep the bloom thinning at full recommendation on both varieties. As the carbohydrate model was predicting a considerable carbon deficit due to high temperatures during the following days, he postponed petal fall spray to about 5 days later or until the carbohydrate model predicted a carbon surplus. Both varieties were considerably thinned as seen on Figure 4, however, the Honeycrisp block was over-thinned and probably a lower rate at petal fall or hand thinning to finish the job should have been used. Follow-up hand thinning was performed on Gala to reach target number.

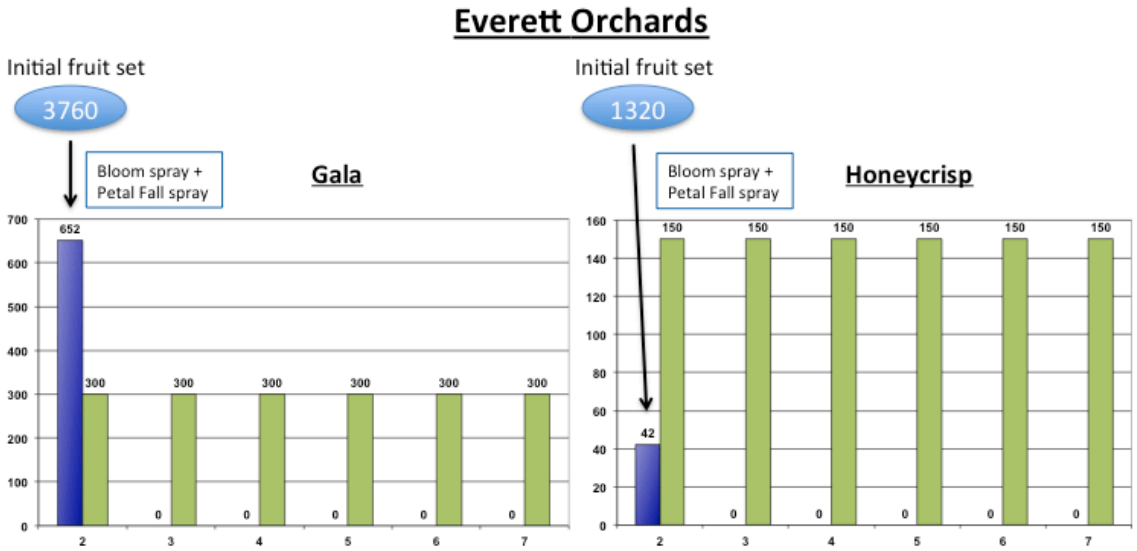

Figure 4. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Gala and Honeycrisp apple trees after 2 thinning sprays (bloom and petal fall) at Everett Orchards, Plattsburgh, NY, 2016. Blue circle = initial number of fruit per tree. Hand thinning was performed for Gala. The model predicted an over-thinning in the Honeycrisp block.

Over the years, our recommendation to growers is that they should be a little more aggressive at pruning. Based on preliminary data we are currently suggesting that growers prune using a bud load factor of 1.5 to 1.8 flower buds for each final fruit number to make the thinning job easier and reduce the number of sprays. Also, reducing the number of fruit buds on the tree early through pruning can reduce competition among flowers and fruitlets resulting in increased resources for the remaining fruit and improved fruit size and quality.

Our target is that all spurs be thinned to one fruit per spur and half of the flowering spurs be completely thinned or "blanked" to zero fruit per spur. Thus, when growers see only 1-2 fruits per spur they think the thinning job is done, but, when they start with more flowering spurs than their target, growers will have to "blank" much more flowering spurs than they think.

Figure 5 shows the cluster distribution for the Gala block at Everett Orchards – an output, included last year in the fruit growth rate model. This grower had an initial fruit set of 3,760 fruit; his target was 300 fruit per tree. That means at pruning he left 2.5 flower buds per fruit. In this case, the grower had to blank 60% of the clusters and leave only 40% of the clusters with one single fruitlet. After the bloom spray, more than 50% of the clusters had 5 fruitlets and only less than 5% of the clusters with single fruitlet. The graph clearly shows that after bloom and petal fall spray this grower still had to blank almost another half amount of spurs to reach the 60% (35% of the clusters had zero fruitlet).

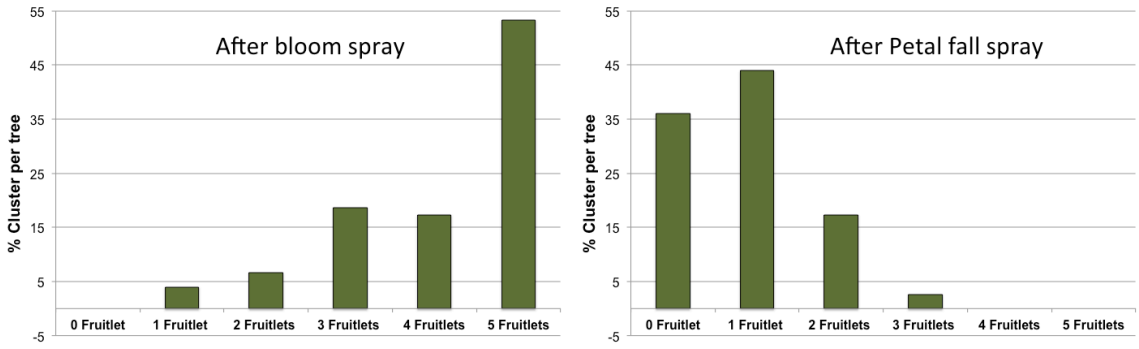

Figure 5. Cluster distribution predicted by Fruit Growth Rate Model after bloom spray (left) and after petal fall spray (right) of precision-thinned Gala apple trees at Everett Orchards, Plattsburgh, NY, 2016.

The opposite happened to the Honeycrisp Everett block (Figure 6). The initial bud ratio in this block was about right, 1.75 flower buds per fruit and only 43% of the total fruit clusters should be blanked. In this block, most of the clusters had between 1 to 3 fruitlets right after the bloom spray. Bloom thinning was more effective on Honeycrisp than Gala. After petal fall spray the model showed (predicted) that 84% of the clusters had no fruit, which means thinners dropped around 50% more fruit than needed.

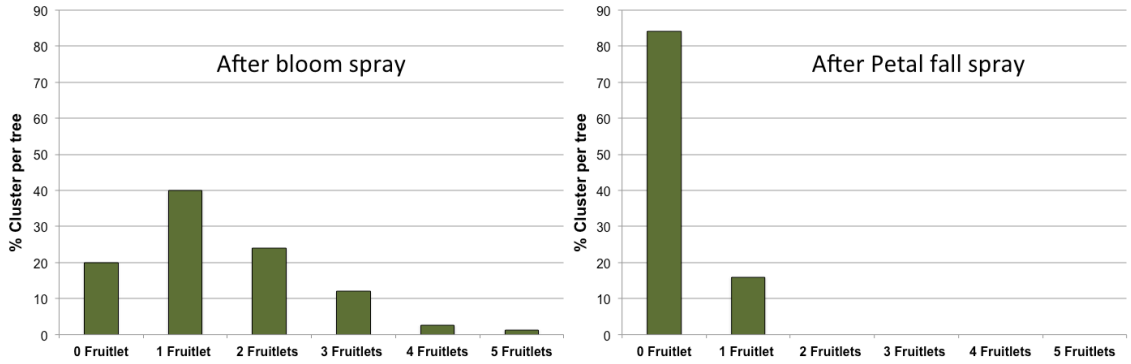

Figure 6. Cluster distribution predicted by Fruit Growth Rate Model after bloom spray (left) and after petal fall spray (right) of precision-thinned Honeycrisp apple trees at Everett Orchards, Plattsburgh, NY, 2016.

The bloom spray also achieved significant thinning in the two Honeycrisp blocks at Chazy Orchards (Figure 7). Both blocks started with a high percentage of flowers; most of the clusters (80-90%) had around 5 flower/fruitlets right after the bloom spray. A petal fall spray was applied but the grower missed the second measurement in both blocks. As noted in the Figures 8 and 9 (between petal fall spray – just prior to the second missing measurement), clusters were already thinned substantially. In personal communication with the grower the petal fall sprays were quite effective and few fruit remained on the tree for hand thinning.

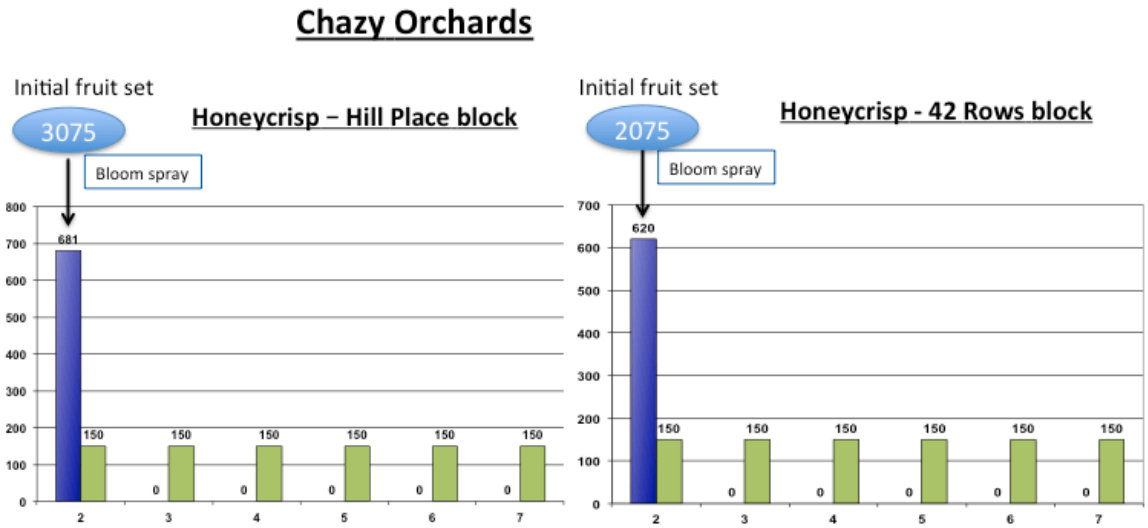

Figure 7. Number of fruit/tree (blue bars) predicted by Fruit Growth Rate Model and target fruit number (green bars) of precision-thinned Honeycrisp apple trees after 1 thinning spray (bloom) at Chazy Orchards, Chazy, NY, 2016. Blue circle = initial number of fruit per tree. The grower did not take the second measurement after the petal fall spray.

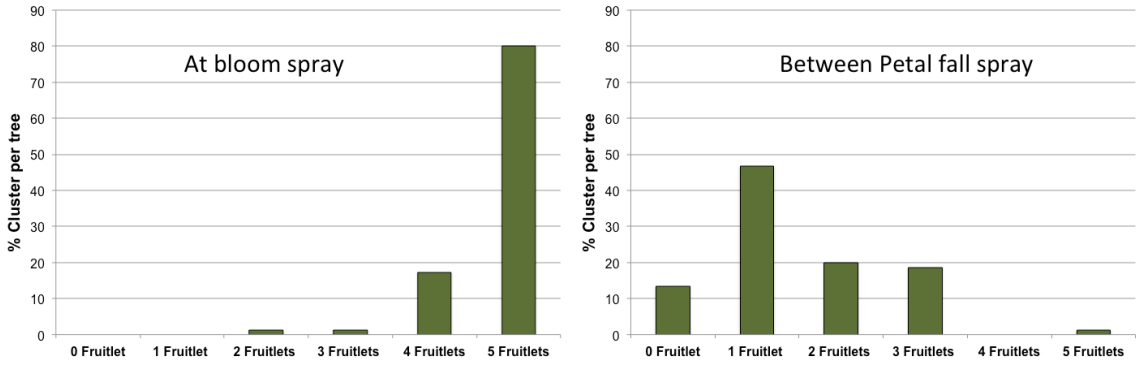

Figure 8. Cluster distribution predicted by Fruit Growth Rate Model after bloom spray (left) and between petal fall spray (right) of precision-thinned Honeycrisp apple trees at Everett Orchards, Plattsburgh, NY, 2016 – Block 42 Rows.

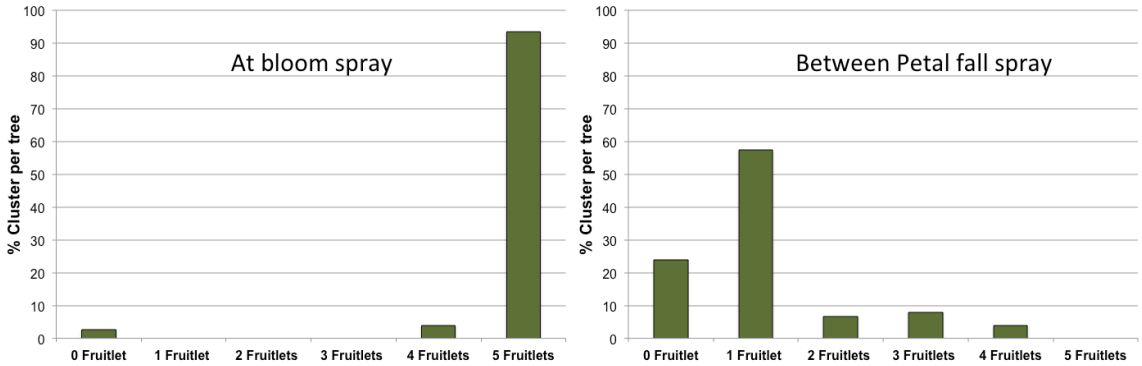

Figure 9. Cluster distribution predicted by Fruit Growth Rate Model after bloom spray (left) and betweem petal fall spray (right) of precision-thinned Honeycrisp apple trees at Everett Orchards, Plattsburgh, NY, 2016 – Block Hill Place.

(2) Precision Irrigation:

Overall, the trees not irrigated had lower water potential than those irrigated (Figure 10). Tree stress was observed both years in the Hudson Valley, and in 2016 in Geneva, while no water stress was observed in Geneva 2015, Champlain 2015-2016 and Orleans 2015-2016 (Figure 10).

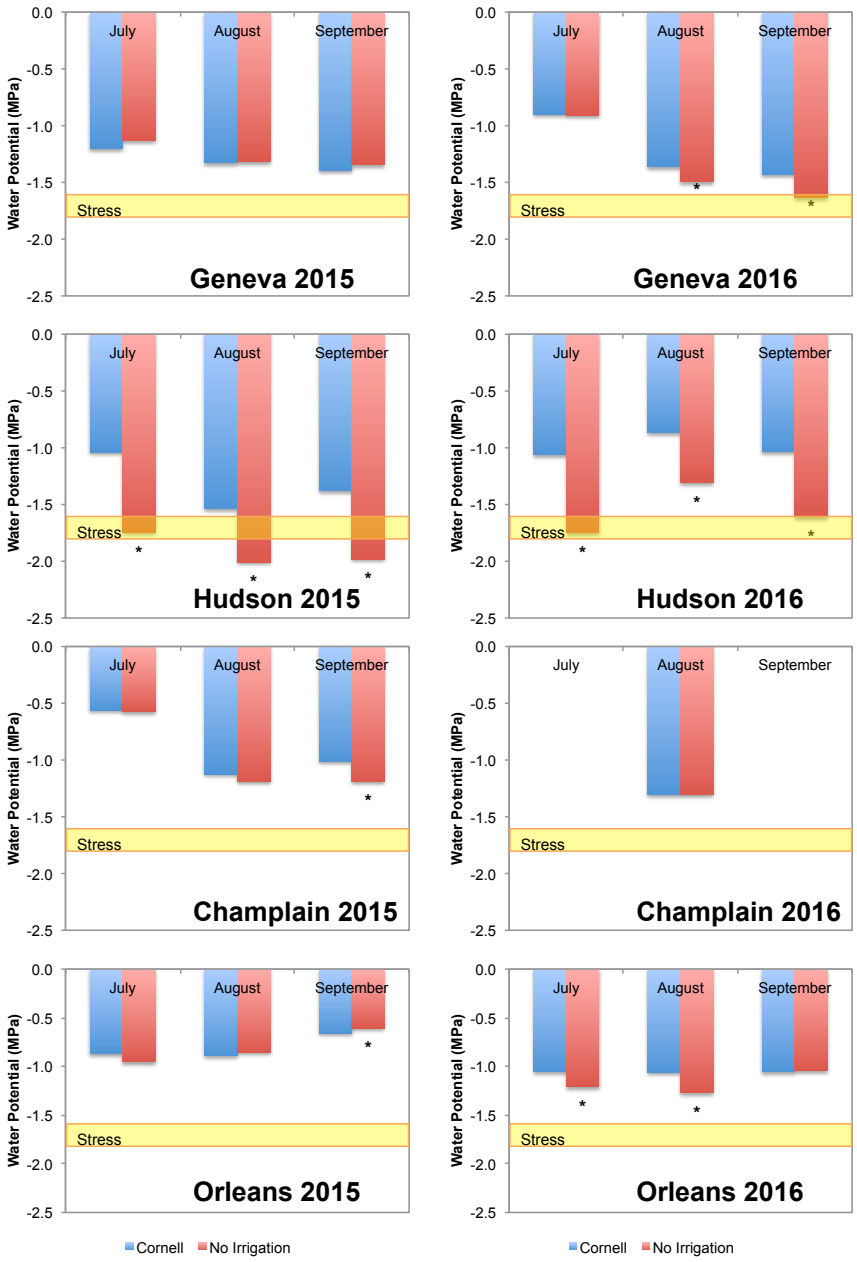

Figure 10. Tree stress during summer at orchards in Geneva, Orleans County, and Hudson and Champlain valleys in 2015-2016. Asterisks indicate significant differences. Blue bars (Cornell) represent trees irrigated according to Cornell Apple Irrigation Model, while red bars represent trees left unirrigated (No irrigation).

No significant differences were observed regarding trunk size in Geneva, Champlain and Orleans (Figure 11) trials. In the Hudson Valley, irrigated trees had significantly greater trunk sizes and higher shoot growth than unirrigated trees (Figure 11).

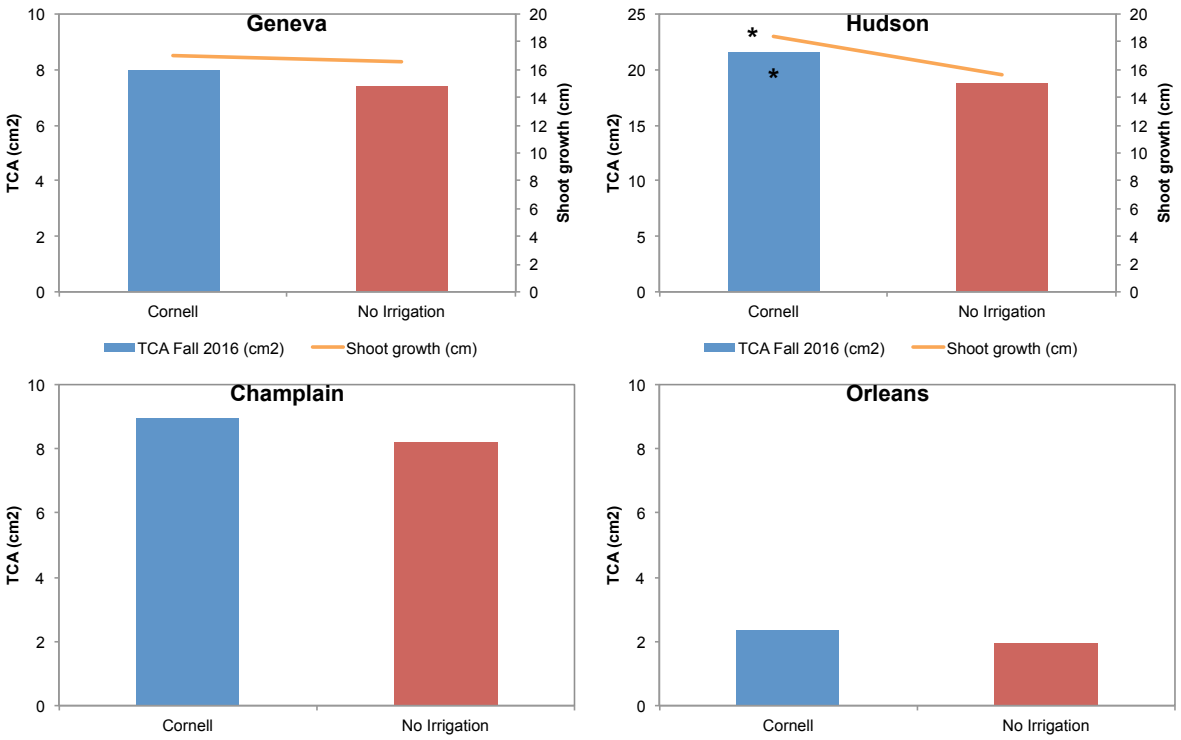

Figure 11. Trunk cross sectional area (TCA) and shoot growth (cm) orchards in Geneva, Orleans County, and Hudson and Champlain valleys in 2016. Asterisks indicate significant differences. Cornell represent trees irrigated according to Cornell Apple Irrigation Model, while no irrigation represents trees left unirrigated.

No significant differences were observed regarding yield, fruit size and fruit quality in Geneva (Figure 12). In the Hudson Valley, irrigated trees had significantly more yield per tree (4 kg), with no differences regarding fruit size, and with a little bit lower firmness (Figure 12).

In the Champlain Valley, no significant differences regarding fruit size were observed, but irrigated trees had considerably higher yields (5 kg more per tree on average) (Figure 12). Significant differences were observed regarding fruit quality; however, those differences were small: irrigated trees had slightly less sugars (13% vs 14%) and lower firmness (14.7 vs 15.2) (Figure 12).

No yield differences were observed in Orleans, with a tendency of bigger fruit sizes on irrigated trees (Figure 12). On the other hand, while no significant differences were observed regarding soluble solids, the trees not irrigated had slightly higher firmness values (16 vs 17) (Figure 12).

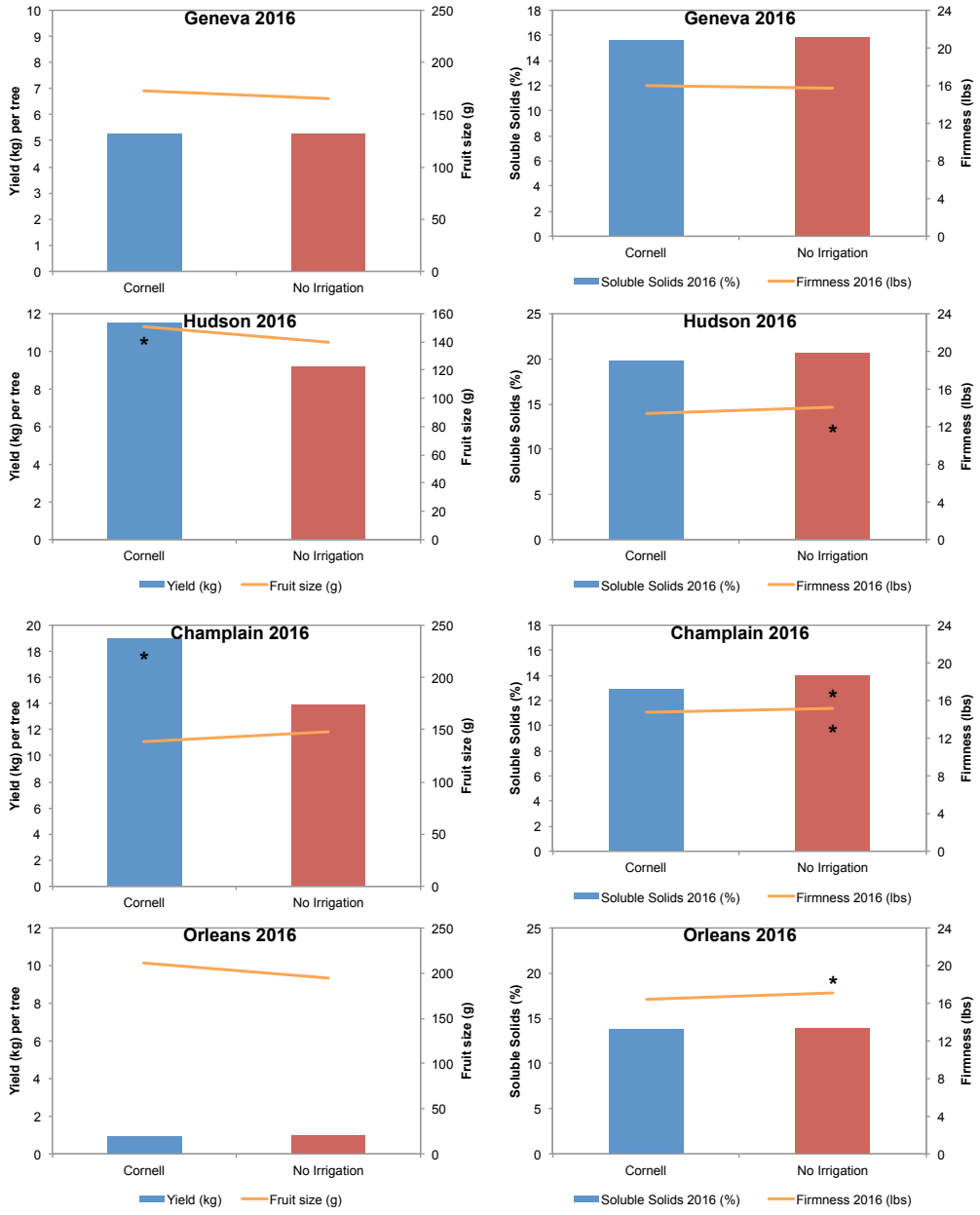

Figure 12. Yield, fruit size, soluble solids and firmness in Geneva, Orleans County, and Hudson and Champlain valleys in 2016. Asterisks indicate significant differences. Cornell represent trees irrigated according to Cornell Apple Irrigation Model, while no irrigation represent trees left unirrigated.

Conclusions/Outcomes/Impacts:

Precision thinning

The comprehensive concept of precision thinning, sometimes viewed as too complex or as requiring too much work, involves substantial effort by the individual fruit grower. Sometimes fruit growers have viewed this as a too complex or too much work. Our goal continues to be to demonstrate to growers that the potential income involved is

substantial enough to justify this intensive effort to manage crop load in a very precise manner.

The uncertainties related to whether trees in 2016 would have a crop or not after all the weather adversities experienced were clearly a challenge in terms of orchard management decisions. The apple carbohydrate model was an important and crucial tool, serving as a guide to let growers know whether or not to spray, how much to spray, and what days to avoid spraying.

The fruit growth rate model has been the best method to physically assess, in a more precise way, thinning efficacy. We believe the model was extremely valuable in 2016 to help growers to decide how aggressively to thin, using actual data showing the level of fruit in their blocks after the frost.

Lessons learned in 2016:

- Honeycrisp thinned much more easily than other varieties during the carbohydrate deficit period, especially young trees.
- Frost damage did not appear to have had a significant effect on thinning. Where king fruit were missing, there were less fruit remaining on the trees because fruitlets were compromised early on. However, crinkled spur leaves did not appear to have had a large effect on thinning.
- The carbohydrate model worked really well and should be used. At bloom and just after, the carbohydrate model predicted severe deficit. Thinners applied at this time had very heavy thinning effects.
- Two thinnings sprays (bloom and petal fall) were enough in most orchards in the Northern New York.

Economic implications of water deficit

Usually when the crop is light, some stress will have little effect, but when the crop is heavy any stress has a stronger effect. This extrapolation indicates how water deficit could affect the new high-density orchard plantings in Northern New York. For instance, since the crop was pretty light, tree stress did not affect yield in Geneva or Orleans in 2016. On the other hand, tree stress considerably affected yield in the Hudson and Champlain valleys. Considering the irrigation trial results from the Champlain Valley orchard site on its 7th leaf, we can estimate a loss of 308 bu/acre (1,117 trees/acre) or 546 bu/acre in a high density orchard, as in Orleans (1,980 trees/acre). In terms of crop value, the lack of irrigation showed a loss of $4,077– $7,227/acre depending on orchard density.

Losses due to tree water stress could even be worst for fully productive orchards and for late varieties with a longer growing season such as Fuji.

Outreach:

- February 2015: Northern NY Fruit School, presentation of thconcepts of precision orchard management.

- 2016 Winter Schools: irrigation management presentations to make growers aware of the importance of irrigation, explaining key concepts and methodology to properly irrigate orchards.
- Thinning meetings and orchard visits to growers to discuss current situation of each block and how to precisely manage thinning under weather conditions.
- Grower recommendations developed through this project were disseminated through Cornell Extension educators, including regional newsletters, publications and meetings.
- Some information was used in real-time as it developed during the crop load management window (thinning and drought periods). This timely information was disseminated through emails and Extension educators, in the NY Fruit Quarterly magazine sent to all tree fruit growers in the state, and in grower newsletters at various times during the season.

We made presentations on this project at the following events where NNY growers were present:

- 1/19/17: Empire State Producers Expo, Syracuse, NY: Lordan, J. and Robinson, T.L, "Importance of irrigation."
- 11/17/16: Great Lakes Fruit Workers Meeting, Collingwood, ON (Canada): Lordan, J., Francescatto P., Robinson T.L., "Effects of apple rootstocks on vigor, bud-break, yield, and hormone profile on the scion."
- 5/26/16: 2016 Champlain Valley Thinning Meeting: Francescatto, P.
- 5/20/16: 2016 Annual Capital District Thinning Meeting: Francescatto, P.
- 2/15/16: Northeastern New York Commercial Tree Fruit School: Francescatto, P. "PGR Strategies for Improving Production Practices."
- 2/15/16: Northeastern New York Commercial Tree Fruit School: Lordan, J., "Precision Management: How and Why We Should Irrigate."
- January 2016 Empire State Producers Expo, Syracuse, NY: Francescatto, P. and T.L. Robinson, "Precision Chemical Thinning of Honeycrisp and Gala."
- 5/28/15: 2015 Champlain Valley Thinning Meeting: T. L. Robinson
- 5/26/15: 2015 Annual Capital District Thinning Meeting: T. L. Robinson
- 4/29/15: WeBex Workshop: Robinson, T.L., "Precision Crop Load Management Workshop."
- 3/3/15: Champlain Valley Fruit School: Robinson, T.L., "Winter pruning demonstration."
- 2/9/15: Northeastern NY Commercial Tree Fruit School: Robinson, T.L., "Precision Orchard Management - Research Updates."

Next Steps:

This project will require several years of effort to extend the precision thinning and irrigation concept to apple growers in Northern NY. We hope to continue to improve these models and the protocol on how to manage crop load to avoid any over thinning. We plan to continue this effort with the support of the farmer-driven Northern New York Agricultural Development Program. In addition, we have applied for a grant from the NY Farm Viability Institute to develop a smartphone application to integrate the precision thinning and irrigation models, in order to reduce labor inputs and increase the

profitability of NY apple growers, by making it easier to adopt precision management techniques.

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Reports and/or articles in which results of this project have been published:

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