Northern NY Agricultural Development Program
2013-14 Project Report

Precision Orchard Management Strategies for NNY Apple Growers to Increase Profitability

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. Adam Sullivan, Champlain Valley Orchards, Peru, NY

Background:
The Northern New York apple industry is an important segment of New York agriculture (5,000 acres and a farm gate value of $16 million). To remain competitive in the world apple market NNY apple growers need continue to improve orchard production efficiency (by planting more efficient high-density orchards) and improve fruit quality (by improved thinning, improved irrigation and improved control of pre-harvest drop).

We have developed several new management concepts in the last few years, which will increase the long-term competitiveness of the NNY apple industry. These include: (1) the Tall Spindle planting system managed as a fruiting wall and (2) precision management strategies to manage crop load, irrigation and harvest with greater precision to achieve higher crop values from each orchard block.

The new high-density apple planting system named the Tall Spindle has higher yield potential than traditional orchards and is rapidly gaining popularity among NNY apple growers. Many growers are making large investments in new orchards using this system but there continues to

be a large extension need to help growers capitalize on the increased profit potential of the Tall Spindle fruiting wall system.

We have developed several improved management strategies for use with the Tall Spindle system, which we have packaged together under the title of precision orchard management. They include more precise ways to control crop load (fruit thinning), irrigation, and harvest. These precision management strategies can help a fruit grower maximize the crop value of each orchard block by increasing the percentage of the crop in the highest price categories of fruit size and fruit color and can reduce the variability of fruit quality within each block and between years.

The goal of this project was to further develop and promote the adoption of precision orchard management strategies including precision thinning, precision irrigation and precision harvest management of Honeycrisp.

Methods:
During the chemical thinning period of 2014 (May and June) we organized a statewide group effort to manage chemical thinning of Gala and Honeycrisp more precisely. We enlisted the cooperation of 19 growers and 2 private consultants (3 growers from Clinton County) along with the extension field staff from Cornell to manage fruit chemical thinning according to the precision crop load management protocol, which we have developed. A list of the persons in NNY who participated in this group precision thinning effort is given in Table 1.

At each location the cooperator counted the number of flower buds on 5 representative trees at pink and then calculated the target number of fruits per tree needed to achieve a desired high yield. The cooperators then tagged 15 representative spurs per tree on the 5 test trees.

At petal fall each fruit in each cluster was marked with a number or dot to identify its position in the cluster. After the petal fall spray the fruit diameter of each fruit in the 15 tagged clusters on each of the 5 trees (375 fruits) was measured 3 days after spraying and then again 7 or 8 days after spraying. These diameter data were sent electronically to Terence Robinson who analyzed the data with the fruit growth rate model and within 24 hours sent the cooperator the results with his recommendation for the next spray. The cooperators then sprayed the test blocks sequentially with one of two spray protocols (bloom + PT +12mm +18mm sprays or PF +12mm+18mm sprays).

After each spray the cooperators measured fruit diameters at 3 and 7 days after spraying then the data were analyzed by Terence Robinson and a new recommendation was sent back to the cooperators.

In 2014 we organized a precision harvest project in August and September at Forrence Orchards, and Chazy Orchards in Clinton County using Honeycrisp. At weekly intervals starting the last week of August we collected a 40 apple sample from each of 30 orchard blocks across the 2 farms where we measured fruit dry matter content, mineral nutrient concentration, firmness, color, starch degradation pattern, soluble solids and DA meter readings on 10 apples from each Honeycrisp sample. The remaining 30 apples were divided into 2 groups and half were treated with 1-MCP (Smartfresh) and the other half were left untreated. Both halves were then stored in

air at 1°C for 6 months after which they were again evaluated for fruit color, fruit firmness, soluble solids, internal disorders and fruit taste. The results after storage were correlated to preharvest measures to determine if we could predict fruit quality and storability at harvest to assist farmers in segregating fruit for long and short-term storage.

Results:

Precision Thinning:

The 2014 season brought a good apple bloom but not excessive bloom to Northern NY State. Bud loads on trees involved in the precision thinning project for Honeycrisp ranged from 1.5 to 1.9. This is much lower and more manageable than in 2013 which had excessively high bud loads (3.0- 5.0).

The weather in 2014 when entered into the carbohydrate model showed a negative carbohydrate balance between bloom and petal fall but thereafter there was little deficit to aid in thinning (Fig. 1). This suggested several sprays would be necessary and relatively high doses of chemical thinners for each spray.

The results from the sequential thinning sprays using the precision thinning protocol showed that the bloom and petal fall sprays provided significant thinning on Honeycrisp but that additional thinning was still needed. In general fruit set was reduced from 100% down to about 30% by those two sprays (Figs. 2-6). The 12mm spray gave significant thinning in Clinton County due to a low carbohydrate balance while in Albany County there was little thinning from the 12mm spray (Figs. 4 and 5). The 18mm spray gave a little more thinning but did not over thin. With 3 or 4 sprays Honeycrisp trees in Clinton County ended up with slightly more fruit than optimum but none were over thinned. The number of extra fruits was low enough that they could be removed efficiently with hand thinning.

At each location, participants in the group precision thinning project did their own fruit diameter measurements and then sent the data electronically to the project leader who analyzed the data and sent the participants the results and a recommendation within 24 hours, which allowed them to apply an additional thinning spray if needed. These fruit diameter measurements and the fruit growth rate model gave good estimates of the thinning effect of the previous thinning spray. The real-time recommendations allowed cooperating growers to make real time decisions about the next spray. That information combined with the results of the carbohydrate model gave much greater confidence concerning the timing and dosage of thinning sprays in 2014 and an excellent outcome.

Table 1. Participants in the 2014 Precision Thinning Group Effort in NNY.

Person	Location	Variety
Peter Ten Eyck/Joe Nuciforo	Albany	Honeycrisp
Jay Tuhill	Clinton	Honeycrisp
Seth Forrence	Clinton	Honeycrisp
Tom Everett	Clinton	Honeycrisp
Barney Hodges	Vermont	Honeycrisp

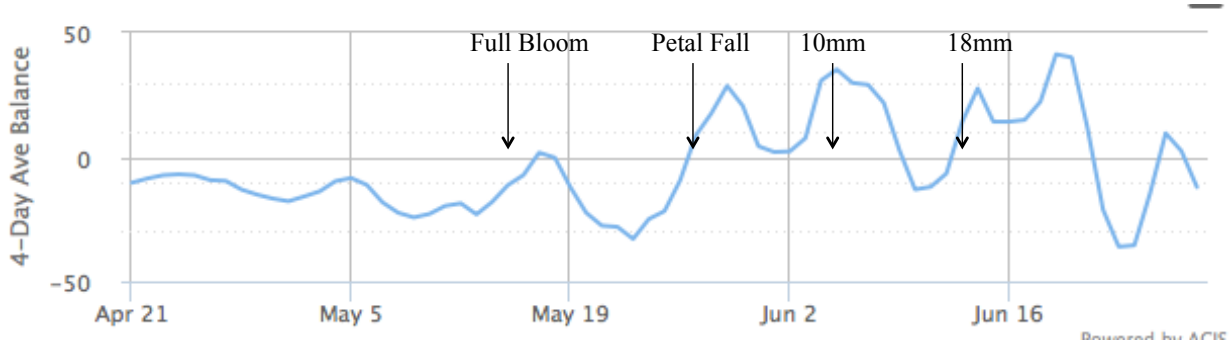

Fig. 1. Carbohydrate balance at Peru NY in 2014 from bud break (April 21) through the end of the thinning window on June16.

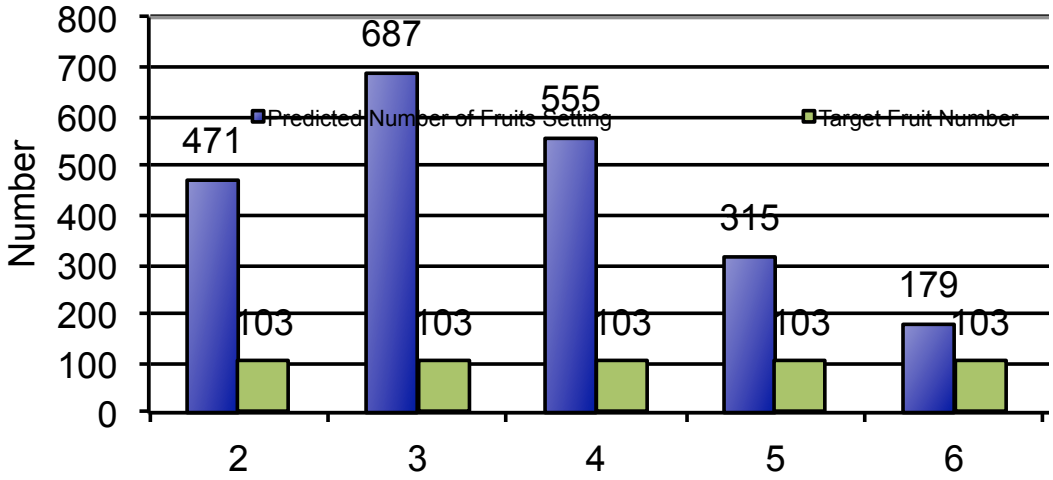

Fig. 2. Number of fruits/tree (blue bars) and the target fruit number (green bars) of precision thinned Honeycrisp apple trees after 2, 3 or 4 thinning sprays at Chazy Orchards in Chazy, NY in 2014.

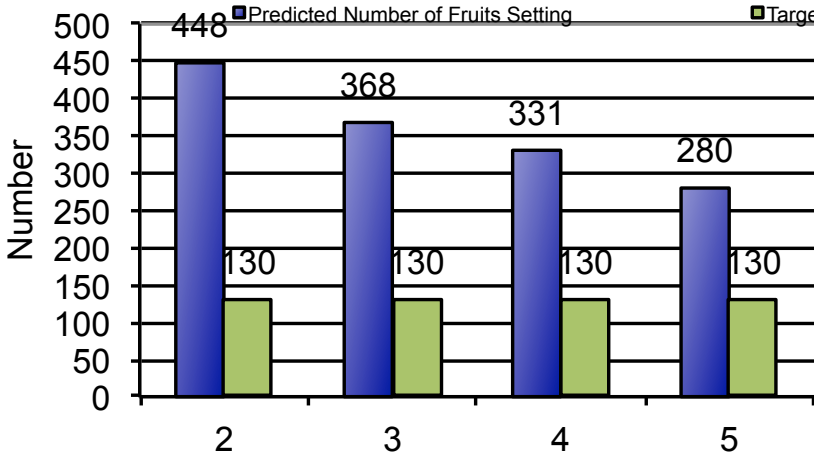

Fig. 3. Number of fruits/tree (blue bars) and the target fruit number (green bars) of precision thinned Honeycrisp apple trees after 2, 3 or 4 thinning sprays at Forrence Orchards in Peru, NY in 2014.

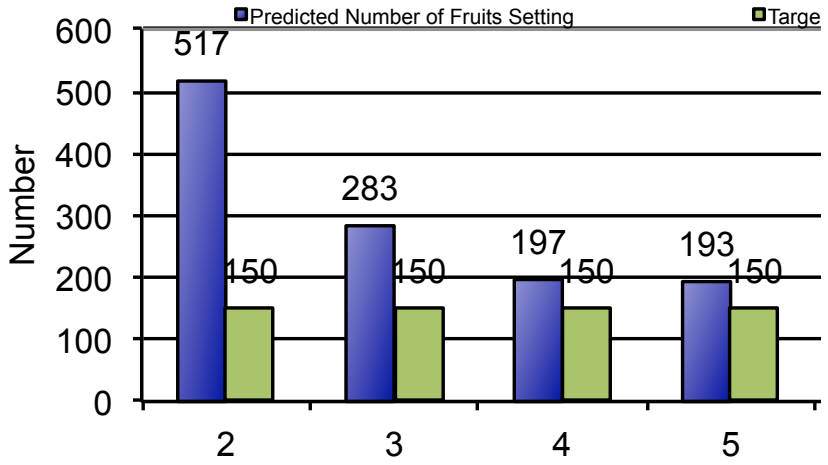

Fig. 4. Number of fruits/tree (blue bars) and the target fruit number (green bars) of precision thinned Honeycrisp apple trees after 2, 3 or 4 thinning sprays at Champlain Valley Orchards in Peru, NY in 2014.

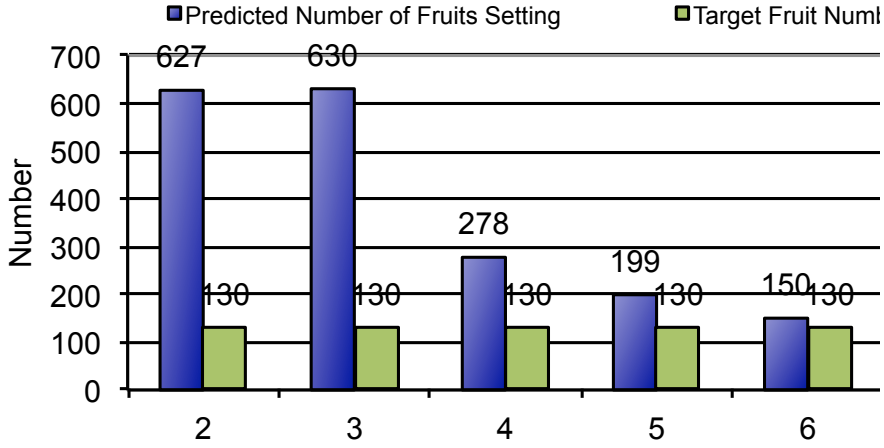

Fig. 5. Number of fruits/tree (blue bars) and the target fruit number (green bars) of precision thinned Honeycrisp apple trees after 2, 3 or 4 thinning sprays at Indian Ladder Farms in Albany, NY in 2014.

Precision Harvest

Each season fruit growth and development is affected by the climate of that year and the crop load on the tree. In climates such as in New York State this results in variable fruit quality from year to year. Our research with Honeycrisp apple indicates that when crop load is too high the tree cannot supply sufficient carbon and other nutrients to give optimum fruit quality (taste, appearance and storageability). Similarly, if weather patterns are cloudy, tree carbon acquisition is reduced and carbon supply for fruit growth is limited resulting in less than adequate resources for optimum fruit growth and fruit quality.

Based on the work by Dr. John Palmer we began a study in 2014 of Honeycrisp quality and its relation to fruit dry matter content. In 2014, 30 orchards in the Champlain, NY, area were

evaluated for dry matter content one week before harvest. The dry matter contents among orchards ranged from 11% to 18%.

We also measured fruit mineral concentrations for macro and micronutrients. An assessment of potential fruit storageability for each block was made based on fruit dry matter content and fruit N, Ca and Ca/N ratio. Fruit samples were treated with MCP or left untreated and then stored until late March and evaluated for fruit quality (appearance and internal quality and taste). We then correlated measures of fruit dry matter content or fruit mineral concentration with fruit taste and quality after storage with and without MCP. Fruits treated with MCP had slightly increased acidity but there was little difference in fruit firmness or taste. Fruits from earlier harvest dates had poorer taste. The best taste was achieved at the next to the last harvest date (late September). The best harvest date coincided with a DA meter reading of 0.3-0.5.

Correlations of preharvest fruit attributes with taste and internal quality after storage showed that fruits with higher dry matter content had the best taste and fruits with low N and high Ca had the least internal and external disorder incidence.

Discussion

Controlling the crop load (fruit number on an apple tree) is a critical management practice in profitable fruit growing. Only about 3-10% of the initial population of flowers and fruitlets should be carried to harvest to give the optimal balance of good fruit size for economic value along with sustained cropping (flower development for the subsequent year).

Many fruitlets abscise naturally, but without active crop thinning, too many fruits remain, reducing fruit size and return yield potential. Fruit thinning is accomplished by spraying various plant growth regulator sprays when fruitlets are small (10mm) about 2-3 weeks after bloom. However, chemical thinning is unpredictable and variable within a season and between years.

Optimizing fruit numbers within a very narrow range is exceedingly difficult. Although thinning is one of the most economically critical management practices, it is difficult to control and predict.

Over the last decade we have developed a program we call “precision thinning” which uses 2 thinning prediction models we have developed (carbohydrate model and fruit growth rate model) which when used together can give predictive guidance about the timing and rates of chemicals to use and can also give very precise estimates of thinning effect of a spray within 7 days to allow re-treatment if necessary.

Through this project we have introduced “precision thinning” to apple growers in Northern NY through an on-farm participatory research and extension program. The project involved growers measuring fruit diameters according to a specific protocol and from that data obtaining a precise assessment of crop load to guide their chemical thinner applications. This involvement also gave growers confidence to apply thinners when needed and to stop applications when enough thinning was achieved.

A second benefit of this project has been an increased awareness by growers of the interrelationship between pruning and crop load. We have shown them with their own data how some orchards were pruned insufficiently which then gave too many flower buds and inadequate thinning. Data from a trial in Geneva (Fig 6) has shown that with a high bud load final fruit number remains high above the target fruit number despite an aggressive chemical thinning program. The Geneva data also show that excessive pruning reduces bud load too low, which then leads to a fruit number below the target. The workshops for pruning we conducted helped teach growers how to assess bud load (count bud on 5 trees) and then adjust pruning to reduce the bud load to the proper level (2.0)

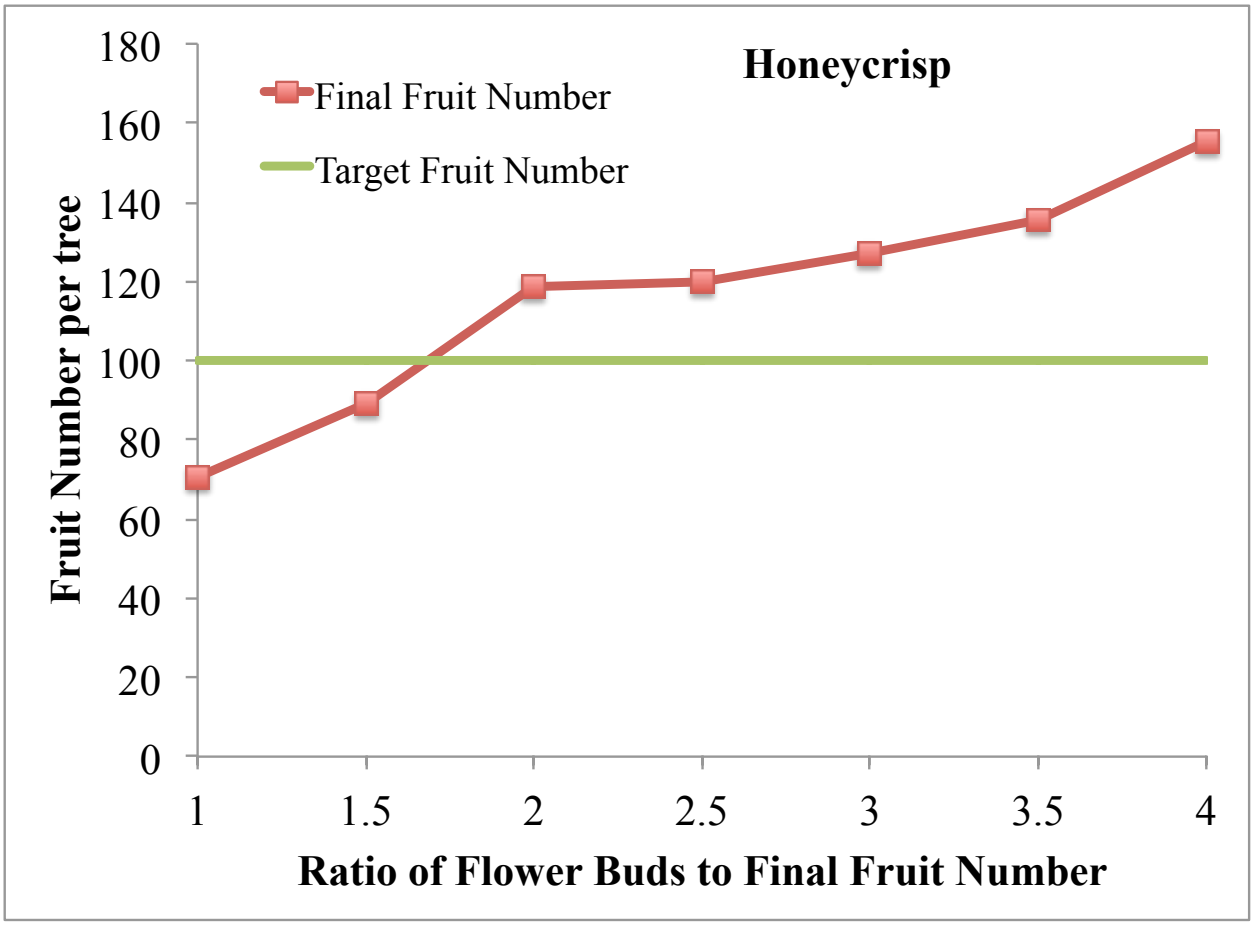

Fig. 6. Relationship of the ratio of flower buds to final target fruit number with the final fruit number harvested of Honeycrisp apple trees after 4 thinning sprays at Geneva, NY in 2014.

Conclusions/Outcomes/Impacts:

The new precision thinning program for managing apple crop load allowed growers in 2014 to first determine a target fruit number and the initial fruit number per tree and then apply sequential thinning sprays beginning at bloom to reduce fruit number per tree in a step wise manner down to the target fruit number.

The program utilizes the Cornell Apple Carbohydrate Thinning model and the Fruit Growth Rate model to provide real time information to growers of the progress in this step-wise thinning process. The program gave growers confidence to thin when appropriate and sound information about when not to thin. The program was successful in guiding chemical thinning decisions in 2014.

In 2014 we observed:
1. Both Gala and Honeycrisp needed more pruning to reduce bud load to 1:1.5
2. Most Gala blocks did not thin enough in both 2014 and had significantly more fruit than the target fruit number. This required significant hand thinning
3. Most Honeycrisp blocks did not thin enough in 2013 but thinned optimally in 2014
4. Bloom thinning sprays were quite effective in 2013 but less so in 2014. Bloom sprays were essential to obtaining good return bloom
6. The sequential sprays gave excellent crop load control.

The economic implications of optimum crop load and optimum fruit size are large and justify this more intensive management approach required by the Precision Thinning program. Precision thinning will be more easily applied to the simple trees in high-density orchards such as the Tall Spindle or Super Spindle where counting of whole trees is easier than large trees.

Outreach:

In February 2014, we began the project with a presentation at the Northern NY Fruit School. This was followed by a precision pruning workshop held in Peru on May 14, 2014. This was followed by an in-depth training school in early May which was broadcast from Geneva to 3 locations in the state where we taught growers the concepts of precision thinning. This launched the group thinning effort for 2014.

During the thinning season we also provided weekly communication via the Northern NY newsletter on thinning. During the summer we also organized a hand thinning workshop and a mechanized pruning workshop for growers in the Champlain Valley region in early July.

We published our results in the NY Fruit Quarterly magazine, which is sent to all tree fruit growers in the state. We also published our results in grower newsletters at various times during the season. We made presentations on this project at the following events where there were growers present from Northern NY.

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Robinson, T.L. 2014. "A Vision for Orchards of the Future". Champlain Valley Fruit School. Feb. 10, 2014.
Robinson, T.L. 2014. "Fruit Crop Physiology". Cornell Fruit In-depth School 2014, Geneva, NY. Mar. 25, 2014.
Robinson, T.L. 2014. "Precision Crop load Management Workshop". Geneva Workshop. May 1, 2014.
Robinson, T.L. 2014. "Pruning and Training Apple Trees". Champlain Valley Spring Field, May 14, 2014.

Robinson, T.L. 2014. “Precision Crop load Management Workshop”. Champlain Valley Spring Workshop. May 14, 2014.

Robinson, T.L. 2014. “Crop Load Management Strategies for 2014”. Saratoga County Spring Field Workshop. May 27, 2014.

Robinson, T.L. 2014. “Crop Load Management Strategies for 2014”. Champlain Valley Spring Field Workshop. June 4, 2014.

Robinson, T.L. 2014. “Summer Pruning Apples with Machines”. Champlain Valley Field Workshop. July 5, 2014.

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 plan to continue this effort with the support of the NNYADP.

Acknowledgments:

. NNY Agriculture Development Program
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Reports and/or articles in which results of this project have been published.

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Robinson, T. and M. Miranda Sazo. 2014. Precision Chemical Thinning in 2014 for Gala and Honeycrisp. Lake Ontario Fruit Newsletter 2014(12):5-6.

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Hoying, S., T. Robinson, and M. Miranda Sazo. 2014. Precision Hand Thinning. Lake Ontario Fruit Newsletter 2014(16):6-7.

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