Wisconsin Fruit News

Supplemental Apple Thinning Issue – May 11, 2018

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Precision apple thinning part II: ***Calculating target crop load***

By: Janet van Zoeren and Amaya Atucha

This article is part of a series we are running this spring discussing the precision apple thinning process. For an overview of what precision apple thinning is and how it works, please see part I of this series, published in the last issue of this newsletter. Also in that issue, you can read about Sunrise Orchard owner Allen Teach's wealth of experience with precision thinning. In today's article we will discuss **how to calculate the target crop load** of a tree, and how to determine what percent of fruitlets should be removed during the thinning process to achieve that target crop load.

Calculating target crop load:

This week, with apple trees somewhere between tight cluster and king bloom, is an ideal time to calculate the target crop load for the trees. As discussed in last week's article (linked to above), precision thinning protocols allow us to thin a little of the crop at every opportunity, until the crop load has been reduced to the desired target level. But how do we determine what that desired target level is?

The target yield for an orchard is based on a number of factors, including cultivar, planting density, and age of the trees. The goal of calculating the **target crop load** for any orchard block is to determine the **optimum number of high quality fruits that can be matured on each tree, while at the same time promoting adequate vegetative growth and minimizing alternate bearing**. You can read more about the science behind determining how many apples trees can ripen in Terence Robinson's article "Crop Load Management of New High-Density Apple Orchards".

Deciding how to estimate target crop load in your orchard blocks will depend on the age of the trees, if they are in a high-density system, and your knowledge of the history of the block. In particular, young high-density blocks require extra attention to avoid overcropping, and so it is especially important to use tools like measuring trunk diameter (discussed below) to set a very specific crop load target for blocks with young trees. Older blocks can use either trunk or limb diameter measurements, along with your knowledge of the block's history, to set a target yield per acre and determine the number of fruits to mature per tree.

Estimate the target crop load per block.

There are two main ways to calculate the target crop load: using the trunk or branch diameters of a tree to determine the recommended number of fruit that tree can ripen, or using your target yield per acre and fruit size to calculate backward the number of fruit necessary per tree to achieve that goal. We will discuss both methods below.

Figure 3. Measuring the diameter of a tree trunk with calipers. The diameter reading will be used, along with the table provided below, to estimate target crop load for this tree. Photo by Benjamin Jaffe.

Trunk cross sectional area. Trunk cross sectional area has been found to correlate to the number of fruits a tree is able to adequately ripen in a season. This is especially relevant for young trees, but can also be used in mature high-density blocks. You can calculate the tree's trunk cross sectional area by measuring the diameter of the trunk using calipers (measure about a foot above the graft union). A table, such as **Table 1** below, can translate that measurement to a recommended number of fruit per tree. Table 1 is based on a table published in Philip Schwallier and Amy Irish-Brown's article "Predicting Apple Fruit Set Model". I calculated the target crop load for a block, using five representative trees, in about half an hour.

Table 1: Determining target crop load (fruits per tree) based on **trunk cross sectional area**. Table originally published in Philip Schwallier and Amy Irish-Brown's article "Predicting Apple Fruit Set Model"

Limb or Trunk Diameter		CSA (Cross-sectional Area)	Target fruit density/cross-sectional area (sq. cm)						
			4	5	6	8	10	12	15
mm	inches	sq. cm	Fruit/tree or Limb for above target density						
8	0.31	0.5	2	2	3	4	5	6	7
10	0.39	0.7	3	3	4	6	7	9	11
12	0.5	1.2	5	6	7	10	12	15	19
19	0.75	2.8	11	14	17	22	28	34	42
25	1	5	20	25	30	40	50	60	76
31	1.25	7	31	39	47	63	79	95	118
38	1.5	11	45	57	68	91	114	136	171
44	1.75	15	62	77	93	124	155	186	232
50	2	20	81	101	121	162	202	243	304
63	2.5	31	126	158	190	253	316	380	475
76	3	45	182	228	273	364	456	547	684
101	4	81	324	405	486	648	810	972	1216

Target Fruit Density Guide-line	Mature Trees	Comment	Young trees
Honeycrisp	7 to 8	Biennial and large fruited.	5 to 6
Gala	8 to 10	Small fruited.	6 to 8
Jonagold	8 to 11	Biennial and large fruited.	6 to 7
Most Varieties	8 to 9	Standard varieties.	6 to 7

For large fruit size, target the lower of density range, i.e. for tray Gala's, target 8 fruit/CSA. For bag fruit size, target the higher of density range, i.e. for bag Gala's, target 10 fruit/CSA.

Table 2: Determining target crop load (fruit per tree) based on **tree density and desired yield**. Table originally published in Philip Schwallier and Amy Irish-Brown's article "Predicting Apple Fruit Set Model"

#	Steps	Example (Gala)	
1	Determine Desired yield/acre	1500 bu.	
2	Desired fruit size (100 count)	100 count	
3	Target Fruits/acre	150,000	1500 x 100
4	Trees/acre (3 x 12)	1260	
5	Target Fruits/Tree	119	150,000 / 1260
6	Flower Clusters/Tree	200	
7	Potential Fruits/Tree (Clusters x 5)	1000	200 x 5
8	Target % Fruitset (Target / Potential)	11.9 %	1000 / 119

Target Fruits/Tree (100 count)					
Tree Spacing		2.2 x 10	3 x 10	3 x 12	4 x 12
Trees /Acre		2016	1512	1260	945
Desired Yield (bu/acre)	Target Fruits /Acre	Fruits/Tree (100 count)			
1600	160,000	79	105	126	169
1500	150,000	74	99	119	158
1400	140,000	69	92	111	148
1300	130,000	64	85	103	137
1200	120,000	59	79	95	126
1100	110,000	54	72	87	116
1000	100,000	49	66	79	105

Target % Fruitset at Various Flowers Clusters/Tree.					
Flower Clusters/Tree	100	200	300	400	500
Potential Fruit/Tree	500	1000	1500	2000	2500
Target Fruit /Tree	Target % Fruitset				
126	25.2	12.6	8.4	6.3	5.0
119	23.8	11.9	7.9	6.0	4.8
111	22.2	11.1	7.4	5.6	4.4
103	20.6	10.3	6.9	5.2	4.1
95	19.0	9.5	6.3	4.8	3.8
87	17.4	8.7	5.8	4.4	3.5
79	15.8	7.9	5.3	4.0	3.2

Thinning disks. Several commercially available thinning disks have been designed to measure the diameter of either a trunk or branch, and immediately provide, on the disk itself, the number of fruits that tree or branch should be able to grow. These are very quick and convenient to use and are especially helpful to determine crop load in young trees. You can learn more about thinning disks in the Good Fruit Grower article "Gauging apple crop load", or in Leslie Huffman's article "Cropload and hand thinning".

Total branch cross sectional area. For mature trees, the sum of diameter of all the branches on a tree (instead of the trunk diameter) could be a better indicator of target crop load per tree. This strategy is discussed in depth in an article in The Orchardist entitled "Precision management of apple crop load".

Tree density and desired yield. Another way to calculate the recommended number of fruit per tree is to calculate backwards based on your desired yield per acre, and target fruit size. This requires familiarity with your orchard and block, so is a better method to use for older blocks where you have previous year's crop information. **Table 2**, also from the article mentioned above, can help calculate target fruit set based on tree density and desired yield.

Determining total number of flower clusters

Once you have determined the ideal crop load for a given block, you need to determine how many flowers, or flower clusters, your trees currently have, so that you can estimate the percentage of those potential fruits that will need to be thinned to achieve the target crop load.

In order to do this, you will have to select five representative trees per block, and count the total number of flower clusters – in high density systems it's best to count all the clusters on the entire tree, but with larger trees it would be ok to count on individual branches. The trees chosen should be typical of the block in terms of cultivar, rootstock, height, age, bloom density, and other factors. I chose five trees along a diagonal transect across the block, so that trees varied in terms of location in the block and being near to the edges or the center. I chose the individual trees to use based on their being similar to the other trees in that section of the orchard. The recommended number of trees to choose per block is five to seven, in order to provide an accurate estimate of target crop load for the block. However, it is better to find time to measure just two or three trees per block, rather than not using precision thinning at all due to time constraints.

Figure 1. Record the number of flowers or clusters per branch by writing with a sharpie on the base of each branch, to help keep track of which branches have already been counted.

Once you have your representative trees per block, you will need to count the total number of flower clusters in each one of those trees. It is critical to be methodical and take your time during this process, in order to keep track of which flowers have already been counted. I start at the tip of each branch, and carefully follow the main branch to the trunk, being sure to count blossoms on each branchlet as I come to it. Once I reach the trunk, I write the total number of flowers clusters at the base of the branch, to remind myself that I already counted that branch. This entire procedure is explained very well in a Cornell video, which is narrated in Spanish with English subtitles (available at https://www.youtube.com/watch?time_continue=26&v=VoC2rRIsb-g).

This process, for five trees, took me about four hours. Although this may seem time consuming, it leads to much more precise calculations, and hopefully will pay off in terms of fruit quality and reduced time hand thinning in the summer.

Calculate the target percent of fruit to remove in the block

Using the information from the previous two sections: desired crop load and total number of flower clusters, you can calculate what percent of fruit you will need to remove during the thinning process in each block, by dividing the target crop for that tree by the number of flower clusters currently on the tree. For example, for tree #1, the trunk diameter was 62 mm (measured about a foot above the graft union), giving me a target crop load of 253 fruits per tree (from table 1), and I counted a total of 506 flower clusters or inflorescences. By dividing 253/506, I calculated that we will have to thin about 50% of clusters to achieve the 253 fruits per tree. Another way to look at this is that if there are 506 flower clusters, and each cluster has about 5 flowers, there is a total of 2530 flowers in the tree. If I only want 253 fruits per tree, that represents 10% of the total flowers currently on the tree. I did the same calculation for the other four representative trees I selected in the block and estimated a target percent fruit set of 7% - 9%, with the average target percent for the block being 8.6%. In future weeks, as I describe how to use the fruitlet growth model and the spreadsheet developed by MSU to calculate the

percent of fruit that will drop following each thinner application, 8.6% fruit set will provide a target, and will inform me when I have achieved the target crop load.

Relevant Articles and Videos:

Anonymous. 2012. Gauging apple crop load. Good Fruit Grower.

Huffman, L. 2014. Cropload and hand thinning. Ontario Ministry of Agriculture, Food and Rural Affairs.

Lehnert, R. 2015. Videos teach precision crop load management. Good Fruit Grower.

Robinson, T. 2008. Crop Load Management of New High-Density Apple Orchards. New York Fruit Quarterly 16: 3-7.

Schwallier, P. and A. Irish-Brown. 2015. Predicting Apple Fruit Set Model. New York Fruit Quarterly 23: 15-18.

Tustin, S., van Hooijdonk, B. and K. Breen. 2015. Precision management of apple crop load. The Orchardist 88: 34-40.

Current carbohydrate model outputs

By: Janet van Zoeren and Amaya Atucha

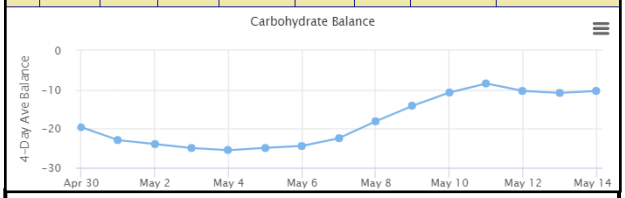
Following are screen shots of the current NEWA carbohydrate model outputs from across the state. The green bar shows the current day's temperature and solar radiation data, and the model's estimate of tree's carbohydrate balance. Below the green bar, in tan, is the forecasted weather data and corresponding forecasted carbohydrate balance. Following full bloom, this information will be taken together to provide a recommendation of whether to increase or decrease the strength of your thinner application.

Richland County

Current phonological stage: early pink
Green tip: 4/30
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
5/3	66	55	7.7	0.00	21.58	-21.58	-24.96	-
5/4	76	53	23.4	0.44	27.14	-26.69	-25.51	-
5/5	81	46	23.5	1.86	26.80	-24.94	-24.89	-
5/6	75	54	20.4	1.86	28.50	-26.64	-24.38	-
5/7	81	46	23.6	4.35	28.13	-23.78	-22.43	-
5/8	81	50	23.9	5.06	29.28	-24.22	-18.11	-
5/9	70	55	12.7	1.83	24.73	-22.90	-14.12	-
5/10	70	54	14.9	4.15	23.00	-18.84	-10.74	-
5/11	54	37	6.7	2.59	9.06	-6.47	-8.42	-
5/12	58	42	8.3	3.43	11.70	-8.27	-10.34	-
5/13	71	44	14.3	7.70	17.08	-9.38	-10.85	-
5/14	79	51	22.0	11.74	21.29	-9.55	-10.32	-
5/15	78	55	14.1	5.42	19.56	-14.15		-
5/16	80	57	16.2	7.19	17.50	-10.31		-
5/17	72	54	17.7	12.45	19.72	-7.27		-



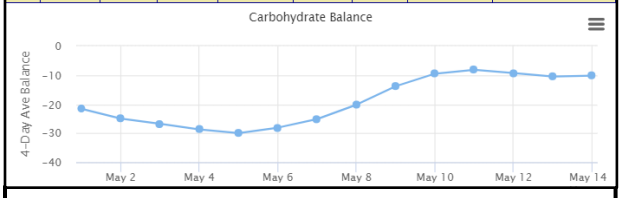
Green tip occurred on 4/30, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.

Trempealeau County

Current phonological stage: full pink
Green tip: 4/28
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
5/3	73	54	19.0	0.00	21.44	-21.44	-26.81	-
5/4	79	55	23.3	0.00	27.80	-27.80	-28.7	-
5/5	82	57	23.4	0.00	32.32	-32.32	-30.01	-
5/6	77	52	23.9	2.14	27.81	-25.67	-28.09	-
5/7	85	50	23.6	2.58	31.61	-29.03	-25.14	-
5/8	81	61	23.7	2.26	35.26	-33.00	-20.19	-
5/9	69	57	7.9	0.00	24.65	-24.65	-13.82	-
5/10	67	55	21.7	7.67	21.56	-13.89	-9.5	-
5/11	57	41	6.9	1.88	11.11	-9.23	-8.21	-
5/12	59	43	10.1	4.66	12.16	-7.51	-9.31	-
5/13	72	45	17.6	9.67	17.05	-7.38	-10.52	-
5/14	80	51	22.9	11.77	20.48	-8.71	-10.17	-
5/15	78	57	14.9	5.24	18.88	-13.64		-
5/16	81	59	16.8	6.35	18.70	-12.35		-
5/17	71	54	19.0	13.62	19.60	-5.98		-



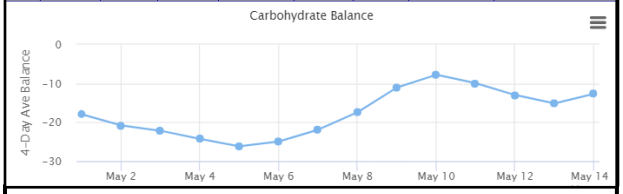
Green tip occurred on 4/28, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.

Eau Claire County

Current phonological stage: tight cluster
Green tip: 5/1
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
5/3	74	45	22.3	0.00	17.46	-17.46	-22.19	-
5/4	75	53	26.3	0.00	23.38	-23.38	-24.3	-
5/5	79	51	23.8	0.24	27.43	-27.19	-26.21	-
5/6	73	47	26.2	2.51	23.26	-20.75	-24.95	-
5/7	82	48	26.6	2.91	28.81	-25.90	-21.92	-
5/8	76	57	12.1	0.00	31.00	-31.00	-17.42	-
5/9	62	54	8.6	0.00	22.17	-22.17	-11.06	-
5/10	60	47	23.7	8.43	17.03	-8.60	-7.78	-
5/11	50	40	6.8	1.78	9.70	-7.92	-9.96	-
5/12	63	38	17.3	8.44	13.98	-5.54	-12.99	-
5/13	73	41	21.6	10.61	19.69	-9.08	-15.14	-
5/14	82	50	23.5	9.93	27.22	-17.29	-12.67	-
5/15	80	54	15.8	5.58	25.63	-20.06		-
5/16	80	57	20.5	9.55	23.68	-14.13		-
5/17	70	50	21.5	15.85	15.03	0.81		-



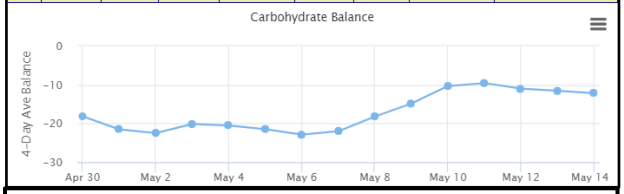
Green tip occurred on 5/1, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.

Racine County

Current phonological stage: full pink
Green tip: 4/30
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
5/3	61	48	7.0	0.00	16.04	-16.04	-20.15	-
5/4	73	48	16.1	0.00	23.44	-23.44	-20.54	-
5/5	80	46	26.4	1.95	25.99	-24.04	-21.46	-
5/6	69	46	25.2	3.84	20.91	-17.08	-22.88	-
5/7	76	40	25.4	5.05	22.64	-17.59	-22.01	-
5/8	80	52	24.2	4.06	31.20	-27.14	-18.2	-
5/9	77	54	9.9	0.00	29.71	-29.71	-14.85	-
5/10	68	46	17.0	6.28	19.87	-13.59	-10.32	-
5/11	58	39	18.3	9.56	11.94	-2.38	-9.58	-
5/12	62	44	7.3	1.60	15.33	-13.73	-11	-
5/13	66	44	11.2	5.15	16.72	-11.57	-11.55	-
5/14	73	50	19.8	10.62	21.25	-10.63	-12.21	-
5/15	76	50	21.1	12.44	20.52	-8.07		-
5/16	75	54	11.0	3.31	19.26	-15.95		-
5/17	70	54	8.3	1.27	15.45	-14.18		-



Green tip occurred on 4/30, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.

Door County

Current phonological stage: early tight cluster
Green tip: 5/2
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
5/2	70	46	16.9	0.00	11.79	-11.79	-12.5	-
5/3	58	42	19.0	0.00	8.99	-8.99	-13.07	-
5/4	72	43	15.8	0.00	14.61	-14.61	-13.65	-
5/5	69	41	25.2	0.00	14.61	-14.61	-16.41	-
5/6	62	44	21.7	0.37	14.43	-14.06	-16.11	-
5/7	63	37	25.6	1.60	12.92	-11.32	-15.7	-
5/8	79	46	22.6	0.60	26.24	-25.64	-13.95	-
5/9	53	45	4.2	0.00	13.41	-13.41	-9.18	-
5/10	58	43	17.2	2.63	15.06	-12.42	-8.44	-
5/11	45	35	11.9	2.53	6.87	-4.34	-10.57	-
5/12	53	37	19.2	4.42	10.97	-6.55	-14.63	-
5/13	60	40	20.8	5.02	15.46	-10.44	-16.33	-
5/14	72	47	24.1	5.52	26.46	-20.94		-
5/15	69	49	21.0	5.92	26.52	-20.60		-
5/16	62	47	20.6	7.92	21.24	-13.32		-

Green tip occurred on 5/2, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.

Dane County

Current phonological stage: full pink
Green tip: 4/29
Full bloom: not yet happened

Apple Carbohydrate Thinning Model Results

Date	Max Temp (°F)	Min Temp (°F)	Solar Rad (MJ/m2)	Tree Carbohydrate Status (g/day)				Thinning Recommendation
				Production	Demand	Balance	4-Day Ave Balance	
4/29	63	30	23.1	0.00	6.52	-6.52	-16.69	-
4/30	80	45	21.6	0.00	15.32	-15.32	-20.64	-
5/1	77	56	12.5	0.00	20.78	-20.78	-23.25	-
5/2	74	58	10.1	0.00	24.12	-24.12	-25.42	-
5/3	63	57	6.1	0.00	22.36	-22.36	-25.6	-
5/4	72	53	17.1	0.09	25.84	-25.75	-25.75	-
5/5	79	53	17.9	0.46	29.90	-29.44	-26.57	-
5/6	71	53	16.8	1.74	26.59	-24.85	-25.68	-
5/7	76	48	21.5	4.37	27.34	-22.97	-23.57	-
5/8	79	57	20.3	3.19	32.21	-29.02	-19.28	-
5/9	72	55	9.3	0.00	25.87	-25.87	-13.77	-
5/10	65	54	13.7	4.33	20.75	-16.42	-8.36	-
5/11	51	39	7.0	2.95	8.77	-5.81	-6.03	-
5/12	54	41	7.6	3.34	10.32	-6.98	-8.23	-
5/13	66	44	17.8	11.37	15.59	-4.22	-8.68	-
5/14	77	48	21.7	13.18	20.32	-7.13		-
5/15	80	54	15.1	6.58	21.17	-14.59		-
5/16	80	58	19.7	10.55	19.34	-8.79		-

Green tip occurred on 4/29, and full bloom has not yet occurred. Because full bloom has not occurred, there is no thinning recommendation output at this time.