Predicting Fruitset Model, Ferri Version

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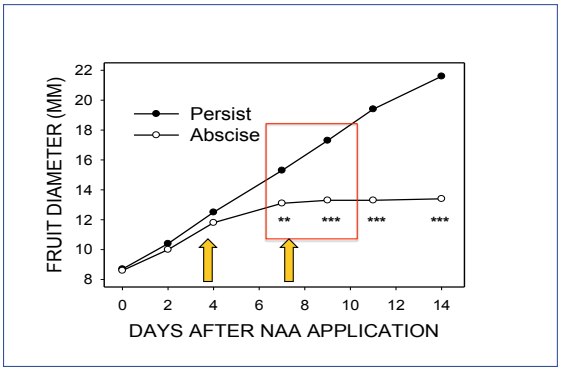
Chemical thinning is a very critical annual apple orchard practice, yet the most stressful and difficult practice to implement. Over time, new approaches to cropload management have been developed. The most recent approach involves the use of a spreadsheet tool called Predicting Fruitset. This model will allow growers to evaluate ongoing fruitset and/or help to assess the effectiveness of their chemical thinning applications. This model is based on the assumption that setting fruitlets grow faster than abscising fruitlets (Table 1).

Table 1. Fruitset prediction 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	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.

Abscising fruitlets will stop growing many days before they will drop. A typical growth pattern is depicted in Figure 1. Abscising fruit slow down growth in three to four days and stop growth within four to six days following a thinning application. This slowing of growth is temperature dependent - warmer temperatures will hasten the stopping and cold temperatures will delay the stopping of growth. The growth rate difference between setting fruitlets (fast growing) and dropping fruitlets (slow growing) is all that is needed to predict fruitset. Two measurements usually will suffice to predict set. The first diameter measurement should be performed three days after the time of a thinning application or no earlier than the 6 mm stage. The second diameter measurement should be performed three to four days later as indicated in Figure 1. This will maximize the difference in growth rates. The slowing fruitlets will reveal themselves as abscising fruitlets. The model calculates the growth rates and predicts set.

Figure 1. Typical growth pattern of persisting and abscising fruitlets.



This model starts you planning your thinning program early. It encourages a more precise approach to cropload management. It also gives you confidence to strategize, evaluate and achieve a successful thinning plan. The model will encourage appropriate actions based on the predictions. The predictions may require additional thinning applications to reduce cropload.

Predicting Fruitset Model

This model was developed by Dr. Duane Greene, of UMASS, et.al. and a Predicting Fruitset Excel spreadsheet was designed by Philip Schwallier, MSU, and is downloadable (Table 2). The Ferri version of the model is also downloadable at the same site.

Table 2. Predicting Fruitset Model and Ferri Version Download Sites.

Both models can be downloaded at:	
1	**https://www.canr.msu.edu/apples/** (click on "Horticulture" scroll down to "Thinning").
2	
3	

Growth diameter rate disparity is the earliest indication of abscising and persisting fruitlets during the fruitset period (30 DAFB). Fruitlets that are abscising either on their own or due to the chemical thinning stress are the ones growing at less than half the diameter of the fastest growing fruitlets (Table 1).

Abscising fruitlets will normally start slowing their growth rate four or five days after a thinner application. Abscising, slow growing fruitlets stop growing all together at day seven. The abscising fruitlets appear normal until a few days later (day 9 or 10) when they start turning an off color (dark green or yellow). This is the first visible evidence that fruitlets are going to abscise. Dropping fruitlets will have sepals that fold outward and setting fruitlets will have sepals that fold closed inward over the calyx. Seeds will sometimes turn an off color, but all these visible symptoms are inconsistent and can be misleading. The Predicting Fruitset Model will predict fruitset based on the diameter growth disparity of fruitlets. It is quite accurate and provides a decision point for thinning before you can visually determine fruit set.

Fruitlet Growth Model Ferri Version 2020

Tom and Joe Ferri of Clarksburg, Ontario, Canada have improved the spreadsheet to provide additional predictions. Data clusters are numbered (14/tree on 5 data trees). It is optional to use a whole tree (14 clusters) or split the tree between top (8 clusters) and bottom (6 clusters). Fruitlets are not marked. Only 14 clusters are numbered on each of the 5 data trees for a total of 70 clusters measured. The spreadsheet includes a sorting routine that will arrange each cluster's fruitlets in order from the largest to the smallest. An error check is also included in the spreadsheet. Non-numeric characters and 0's (zeros) are replaced with an empty cell function. Missing measurements are calculated to be halfway between the prior measurement and the following measurement (6, missing and 12 is corrected to 6, 9 and 12). The Ferri version takes the predicting fruitset prediction one step further by predicting the actual fruits setting per tree using actual cluster counts (see Tree Cluster Counts section below). To get a prediction of the apples setting, the whole tree's clusters have to be counted and entered with each measurement. Also, the spreadsheet calculates the largest fruitlet dropping. Fruitlets less than that diameter are probably dropping.

Figure 2. Sample Summary Output Ferri Version.

Variety: 08 Gala

Spray Dates	Jun 16	Jun 21	Jun 25	Jun 29

Measurements		Persisting Fruitlet Diameter (mm)					5 Trees - 14 Clusters Fruitlet Count			Cluster Count	Predicted Set per Tree	
Date	Days Between Samples	Average Overall Fruitlet Diameter	Average Largest 3 Fruitlets/Tree Diameter	Average Smallest 3 Fruitlets/Tree Diameter	Average Growth Rate (3 Fastest Fruitlets/Tree)	50% of Average Growth Rate	Greater Than 50% of Average Growth Rate (Will Set)	Less Than 50% of Average Growth Rate (Will Drop)	Original Fruitlet Count (Measured)	Average Number of Clusters per Tree	Based on Original Tree Fruitlet Count	Average Number of Apples per Tree
1st Jun 17	(10)	(11)							(12) **303**	(13) 149		**646**
2nd Jun 21	4	10.6	12.6	8.2	4.03	2.02	184	84	268	136	(14) 60.7%	(15) 357
3rd Jun 25	4	14.4	16.6	12.3	4.53	2.27	139	78	217	132	45.9%	262
4th Jun 28	3	18.5	20.4	16.8	4.40	2.20	65	120	185	122	21.5%	113
5th Jul 02	4	22.3	23.9	20.8	4.00	2.00	37	111	148	118	12.2%	**62**
6th												
7th												

Fruitlets smaller than 19.7 mm should drop (16)

Tree Bottom # Clusters 6

Average Overall Fruitlet Diameter	Average Largest Fruitlets Diameter	Average Smallest Fruitlets Diameter	Original Fruitlet Count (Measured)	Average Number of Clusters per Tree Bottom	Average Number of Apples per Tree Bottom
1st			**126**	62	**259**
2nd 10.5	12.2	8.3	110	53	145
3rd 14.5	15.8	13.2	85	50	82
4th 18.1	19.4	17.0	72	45	45
5th 22.0	22.2	21.8	53	42	**25**
6th					
7th					

Fruitlets smaller than 17.2 mm should drop

Tree Top # Clusters 8

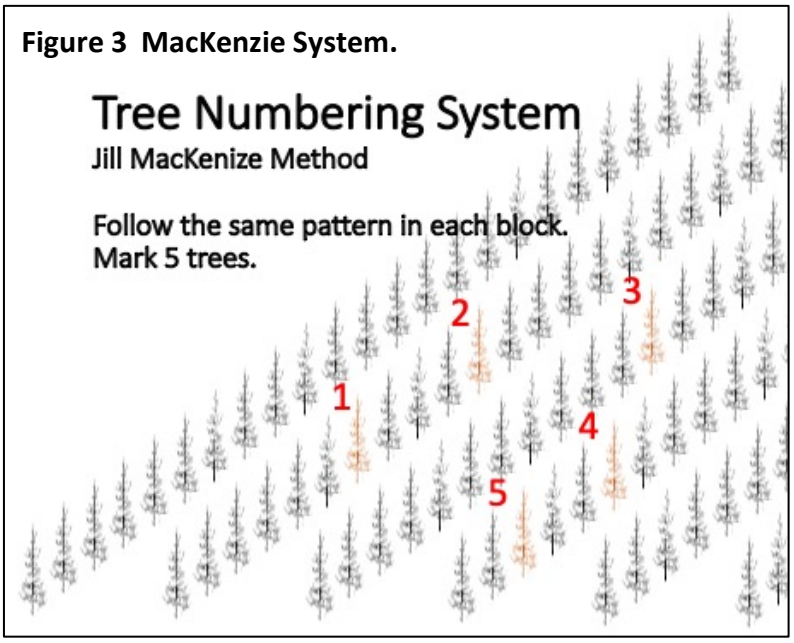
Average Overall Fruitlet Diameter	Average Largest Fruitlets Diameter	Average Smallest Fruitlets Diameter	Original Fruitlet Count (Measured)	Average Number of Clusters per Tree Top	Average Number of Apples per Tree Top
1st			**177**	88	**388**
2nd 10.3	12.3	8.4	158	83	264
3rd 14.3	16.3	12.5	132	82	184
4th 18.2	19.8	16.8	113	77	82
5th 22.5	22.9	21.8	95	76	**36**
6th					
7th					

Fruitlets smaller than 19.2 mm should drop

Tree & Cluster Selection

Jill MacKenzie of Appleton, NY explained her method of conducting her Precision Cropload Management program with. Her recommendations includes: 1) use the same pattern in each block to select data trees (Fig. 3) to better find each data tree in the same order, 2) flag data trees with ribbons around the lower trunk, for ease to see ribbons, 3) count flower clusters using a clicker, 4) do not mark fruitlets, (the model will automatically sort fruitlets from largest to smallest). To use the Ferri model version, mark the sampling clusters in a consistent manor on every tree (Fig 4). Start numbering at the bottom on one side (west side for example) and number to the top cluster numbered 1-7 and on the other side clusters numbered 8-14.

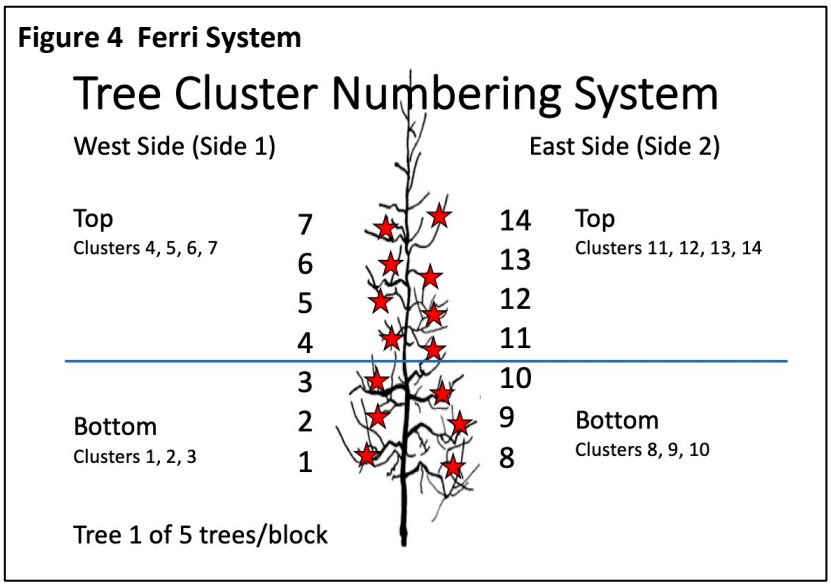
Figure 3 MacKenzie System.



Bottom and Tops of trees

The Ferri version introduces the idea of keeping track of individual tree clusters separately at both the top and the bottom of the data trees. In the model, answering "Yes" on the Data Sheet to the question "Split tree?" will calculate the data for whole tree and the top and the bottom. If using the split tree method, then clusters 1, 2, 3, 8, 9 and 10 are considered to be in the bottom of the tree and 4, 5, 6, 7, 11, 12, 13, and 14 are in the top (Fig. 4). Tops of tree set better than the bottom and this information is quite helpful when spray thinning. Ferri measures fruitlets the day after a thinning spray or when the fruitlets have grown at least 3 mm. When temperatures are warm, waiting 3 days to remeasure may be too long. Use your own good sense to monitor fruitlet growth.

Figure 4 Ferri System



Fruitlet measurements and Cluster Counts

Try to place the calipers on the widest portion of the fruitlet each time, measuring to the nearest 0.5 mm. Measuring to the nearest 0.5 mm will give accurate repeatable predictions. Don't remeasure fruitlets unless you have at lease 3 mm of growth to give a better prediction with less work. Fruitlets do not need to be measured in any order, once the diameters are entered into the spreadsheet the program will sort from largest to smallest and correct typo's and missing data. To get a prediction of the apples setting the whole tree's clusters have to be counted and entered with each measurement at each sampling date. The program cannot correct input data that is too large (missing a decimal point). It does correct measurements that shrink. For example, growth measurements (e.g. 6, 8, 7.5) will be changed to (6, 8, 8).

Figure 5. Data Sheet (Top Half).

Variety:	08 Gala ①						
Target Apples/Tree	② 50		# Trees	5 ③	# Clusters		14 ④
Spray Dates	Jun 16	⑤ Jun 21	Jun 25	Jun 29			
Split Tree?	⑤ yes	Cluster Counts					
Measurement		#1	#2	#3	#4	#5	#6	#7
Tree 1	Top	84	80	85	76	75		
	Bottom	58	⑥ 51	49	45	41		
Tree 2	Top	62	57	57	52	52		
	Bottom	47	41	41	36	32		
Tree 3	Top	83	80	80	76	75		
	Bottom	63	57	54	50	44		
Tree 4	Top	96	91	85	78	78		
	Bottom	88	72	67	64	62		
Tree 5	Top	113	107	101	101	99		
	Bottom	52	44	41	30	30		
Tree 6	Top							
	Bottom							
Tree 7	Top							
	Bottom							
Average Clusters		149	136	132	122	118	⑦	

Figure 6. Data Sheet Example (Bottom Half).

Measurement		#1	#2	#3	#4	#5	#6	#7
Tree Number	Cluster Number	Jun 17	Jun 21 ⑧	Jun 25	Jun 28	Jul 02		
Tree 1	Cluster 1	8.0	11.0	15.0	19.0	22.0		
		6.5	9.0	12.0	14.0			
		4.0	4.5					
		⑨	4.5					
			4.5					
Tree 1	Cluster 2	7.5	11.0	14.0	18.0	21.0		
		4.0	4.0					
		4.0						
		3.0						
Tree 1	Cluster 3	10.0	14.0	18.0	21.0	22.0		
		8.0	8.5	8.5	8.5			
		7.5	7.5	7.5	7.5			
		7.0	7.5	7.5				
		4.0						

Table 3. Predicting Fruitset Model Directions (Ferri Version).	
Developed by Dr. Duane Greene, UMASS, Philip Schwallier, MSU and Joe and Tom Ferri, Clarksburg, Ontario, Canada.	
This model can be downloaded at:	
	Apples.msu.edu
Select and Mark Trees	
	Select 5 trees that are a good representative of trees in your block.
	Flag these trees on the trunk for easy to see the flags. Setup your selection similarly across each block, again for ease to find flagged trees (Fig 3).
	You will mark 14 clusters/tree * 5 trees = 70 total cluster/block or 5 fruitlets * 70 clusters = 350 potential fruitlets/block.
Select and Number Clusters and Fruitlets	
	Shortly after bloom but no later than the 6 mm stage select clusters and mark them with numbered file folder labels or snap clothespins painted with a florescent color and numbered.
	Use the same pattern to number fruit clusters on every tree. Start at the bottom to the top on one side clusters numbered 1-7 and other side clusters 8-14 (Fig 4).
	If you want to use the top and bottom set prediction for your block chose clusters as follows.
	Bottom tree clusters 1, 2, 3, 8, 9, & 10. Top tree clusters 4, 5, 6, 7, 11, 12, 13 & 14 (Fig 4).
Data Sheet (yellow areas are entry areas)	
	Enter your farm name and/or block name. (1)
	Enter the target number of fruit/tree. (2)
	Enter the spray dates. (3)
	Enter your measurement dates. (4)
	Are you doing a split tree (bottom and top)? Enter “yes” or “no”. (5)
	All of these entries will be automatically copied to the other appropriate cells and the Summary Sheet.
	Enter the cluster counts each sampling date. (6)
	The average of your sampling cluster counts are listed at the bottom of the Data Sheet (Top Half) (Fig 5). (7)
	Enter the measurement dates. (8)
	Take your 1st measurements, enter them into the Date and Fruitlet size (mm) area Data Sheet (Bottom Half) (Fig 6). (9)
	You can enter up to 7 sample measurments.
Enter Fruitlet Diameters	
	The Data Sheet will accept direct input of diameters or they can be pasted in from another spreadsheet.
	Do not mark the fruitlets. The spreadsheet will automatically sort the diameters from largest to smallest for each sampling calculations.
	The spreadsheet will correct errors (non-numeric characters) such as periods and spaces.
	The spreadsheet will **not correct** diameters (too large) because of a missing decimal point.
	The spreadsheet will fill-in missing diameters (halfway between the preceding and following diameters).
	The spreadsheet will correct shrinking diameters to the previous recorded diameter (e.g. 6, 8, 7.5 changes to 6, 8, 8).
Summary Sheet	
	Move to the summary sheet after entering your diameters.
	When you leave the Data sheet, the spreadsheet will automatically calculate and write the Summary Sheet.
	The spray dates and the measurement dates are automatically copied to the sheet from the Data Sheet.

Interpretation	
	The whole tree summary is on the top of the Summary Sheet.
	The Sampling Dates are listed in the left column, with the Days Between Samples listed in Column 2. (10)
	The Persisting Fruitlet Data is listed in the next 5 columns. These are all the averages of Overall Fruitlet Diameter, Largest 3 Fruitlets/Tree Diameter, Smallest 3 Fruitlets Diameters, Growth Rate of the 3 Fastest Fruitlets/Tree and the 50% Average Growth Rate. Fruitlets growing less than 50% of fastest growing fruit are predicted to drop. (11)
	Next is the Fruitlet Count summary. The number of fruitlets growing fast are predicted to set and used to calculate the percent setting. The number growing slow are predicted to drop. The measured **fruitlets for** each date and the 1st being the original number measured. (12)
	Cluster counts are the average of clusters per tree per sampling date. This is used to calculate the predicted number of set apples per tree. (13)
	The Predicted Set/Tree (last two right columns). The 1st column has the predicted % set. This is calculated by dividing the number of growing fruitlets by the Original Fruitlet Count. For the 2nd measurement this would be 184/303 = 60.7%. (14) Finally, the Average Number of Apple/Tree in the far-right column is the predicted set/tree. It is calculated by using the predicted setting fruitlets for the 5 trees divided by the number of trees multiplied by the number of clusters (e.g. 5*14) and multiplying by the current average cluster count. For the 2nd measurement this would be 184/70 * 136 = 357. Use this prediction to approximate how close to your target cropload you are. (15)
Fruitlets Dropping	
	The predicted largest diameter dropping fruitlets is below each table. It is the largest abscising diameter. (16)
Top and Bottom Tables	
	The top and bottom tables follow the same calculations. You must input "Yes" in the Data Sheet Split Tree question.
	Selecting "Yes" will require you to mark 8 clusters in the top of the tree and 6 in the bottom.
	Selecting "No" will clear the Top of tree and Bottom of tree Tables on the Summary Sheet, but not the whole tree summary.