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Precision Pruning to Partially Control Crop Load in Apples

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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 frut number at harvest.
 - Identify a goal for fruit size and yield based on the potential of the orchard and the climate.
 - Example 1: (1500 bu/ac * 88 count / 1,320 trees/acre = 100 fruits /tree
 - •Example 2: (1500 bu/ac * 100 count / 1,320 trees/acre = 114 fruits /tree
 - Example 3: (1500 bu/ac * 113 count / 1,320 trees/acre = 128 fruits /tree



Precision Pruning

How many flowering spurs to leave?

<u>88 ct 100ct 113ct</u>

- 1 bud per final fruit number. (100) (113) (128)
- 1.5 buds per final fruit number.(150) (170) (192)
- 2 buds per final fruit number. (200) (226) (256)
- 3 buds per final fruit number. (300) (339) (384)
- 4 buds per final fruit number. (400) (452) (512)



Studied natural abscission and chemically induced abscission from 2000-2017.

Used Vertical Axis trees of Gala/M.9, McIntosh/M.9 and Delicious/M.26 at Geneva, NY

Analyzed the effect of climate on natural fruit abscission and thinning response from chemicals using data for all years through multiple regression



The number of initial flower clusters varied

With Delicious from 983 to 222

With Gala from 1063 to 362

With McIntosh from 1417-318

Fruit set also varied and was negatively related to initial flower numbers.

		Number of flower	r	Fruit number
Cultivar	Year	clusters per tree	Fruit set	per tree
Delicious	2000	230	0.7	161
	2001	222	1.1	235
	2002	526	0.3	132
	2003	538	0.5	269
	2004	589	0.8	366
	2005	334	0.4	132
	2006	306	1.3	333
	2007	428	1.0	385
	2008	983	0.5	505
	2009	500	1.1	551
	2010	513	0.6	305
	2011	869	0.4	325
Gala	2000	668	0.7	433
	2001	525	1.1	586
	2002	577	1.2	663
	2003	362	1.7	616
	2004	998	0.7	633
	2005	754	0.5	391
	2006	1063	0.8	827
	2007	890	1.2	989
	2008	806	1.0	804
	2009	756	1.0	782
	2010	930	0.5	432
	2011	854	0.8	719
	2013	982	0.7	701
	2014	457	1.4	562
	2015	699	0.9	594
	2016	1049	0.9	950
	2017	829	1.0	796
McIntosh	2000	318	0.7	210
	2001	338	0.6	196
	2002	632	0.3	173
	2003	504	0.6	279
	2004	816	0.6	513
	2005	384	0.5	196
	2006	450	1.3	563
	2007	530	1.1	566
	2009	1027	0.5	544
	2010	444	0.4	150
	2011	1417	0.3	503
	2013	915	0.4	324

Results 2.0



Results - Delicious Model r²=60 and 90%



Results – Gala Model r²=81 and 63%



Results – McIntosh Model r²=74 and 75%



Conclusions

- Fruit set (%) over 17 years was negatively related to initial flower clusters per tree. This means that with more flower clusters on the tree the percentage of those flowers that will set is less. This is likely due to reduced fraction of resources (root supplied nitrogen and hormones and stored carbon reserves) available to each flower. With fewer flower clusters per tree the percentage set is greater. This is likely due to a greater fraction of resources available to each flower.
- The Final number of fruits per tree over 17 years was positively related to initial flower clusters per tree. 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>

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Location: Variety/age:	Experimental orchard at Cornell Station in Geneva, NY, USA Brookfield Gala/M. 9T337 planted in 2009
Tree density:	2857 trees \cdot ha ⁻¹
<u>Crop load Target:</u>	130 fruit per tree
<u>Years:</u>	2014, 2015, 2016 and 2017
<u>Bud load:</u>	1 bud : 1 final desired fruit per tree 1.5 : 1 2.0 : 1 2.5 : 1 3.0 : 1 3.5 : 1

Flower bud counting and pruning

After pruning, trees were chemically thinned with one of two treatments

1. Chemical Thinning:
Bloom stage – NAA
Petal fall stage – NAA + Carbaryl
12mm fruit size stage – 6-BA + Carbaryl
18 mm fruit size stage – 6-BA + Carbaryl

2. Hand Thinning: One fruit per cluster at full bloom

Table 1. Significance of *P* values from the ANOVA of the main effects of years, thinning treatments (hand or chemical thinning) and bud load ratios, and their interactions on yield and crop return of Brookfield Gala apples over 4 years at Geneva NY, USA.

Significance (p)	Fruit set (fruit cluster-1)	Fruit No. per tree	Yield (kg tree ⁻¹)	Yield (t ha ⁻¹)	Fruit Size (g)	Crop Value (\$/ha)
Year (Y)	**1	**	**	**	**	**
Thinning treatment (T)	**	**	ns	ns	**	*
Bud load treatment (BL)	**	**	**	**	**	**
Y * T	ns	ns	ns	ns	ns	ns
Y * BL	**	ns	**	**	*	**
T * BL	ns	ns	ns	ns	ns	ns
Y * T * BL	ns	ns	ns	ns	ns	ns

^{1*}, ^{**} or NS indicate treatment had a significant effect at P≤0.05 or P≤0.01 levels, or had a non-significant effect, respectively.

Final fruit number per tree and fruit set of Brookfield Gala after trees had been pruned to 6 different bud load and hand or chemically thinned over 4 years at Geneva, NY, USA.



Fruit Set

Ratio of Flower Buds to Final Fruit Number

Fruit size and crop value responses of Gala apples to initial flower bud over 4 years



The combined data shows that crop value was maximized when the optimum level of pruning severity for Gala was about 2.0 :1. This resulted in an optimum of 250 buds per tree (200 fruits/tree) which is double the target bud number we had assumed before the experiment.

Crop value response after trees had been pruned to 6 different bud loads in each of the four years studied. Geneva, NY, USA.



Under dry weather conditions, severe pruning would be favorable.

Other Results

Return bloom and fruit quality

- There was no significant effect of pruning level or bud load ratio on return bloom.
- In some years, fruit color and sugar content were increased when crop load was reduced and weather conditions were favorable.
- The effect of year on fruit quality was related to the weather conditions.
- Severe pruned trees, with lower bud load ratios and consequently carried less fruit, had firmer fruit at harvest.

Conclusions

- Our results indicate that maximum crop value for a 'Gala' Tall Spindle orchard in New York State was achieved when fruit size was about 160 g (113 size) and fruit number per tree was 200 fruits/tree which is higher than the target fruit number we had assumed before the experiment.
- When growers attempt to get large size they are sacrificing some dollars as large Gala's are accompanied with significantly lower yield.
- However, fruit marketers in NY State indicate that if all the Gala's in the state were medium sized then the prices we used for medium sized Gala's would be lower. Given that market reality, perhaps the best strategy for NY Gala growers is to prune slightly more aggressively than this study indicated. Perhaps 1.5-1.8 flower buds per final fruit number.

What is the optimum size of each variety?

- 88 count (200 gram) Gala, Empire, Macoun, P. Lady, NY1
- 80 count (230 gram) Fuji, McIntosh, Gingergold, Evercrisp, NY2
- 72 count (260 gram) Honeycrisp, Cortland, Jonagold, Rome, Cameo, Pazazz

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
- Disect each spur bud and determine if it is floral or vegetative.
- From the buds dissected on the 6 branches (2 from each of 3 trees) calculate the percentage of spurs that are floral.
- Multiply the target fruit number by an insurance factor (1.5) and then divide by the fraction of buds that are floral to determine the number of spurs to leave on the tree after pruning Example 1 target final fruit number is 100 per tree X 1.5=150 spurs however only 90% are floral thus divide 150 by 0.9=167 is the target number of spurs per tree after pruning. Example 2 target final fruit number is 100 per tree X 1.5=150 spurs however only 50% are floral thus divide 150 by 0.5=300 is the target number of spurs per tree after pruning.

Range of Pruning Severities for Gala in 2013

Orchard	Ratio of F. Buds : Final Fruit Number	Orchard	Ratio
1	1.13	16	3.48
2	1.31	17	4.38
3	1.47	18	5.80
4	1.64	Average	2.39
5	1.74		
6	1.82		
7	1.83		
8	1.85		
9	1.94		
10	2.05		
11	2.11		
12	2.64		
13	2.70		
14	2.88		
15	3.26		

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

How to do precision pruning

- Require pruners to count the spurs remaining after pruning on 1 tree every 100 trees
- Adjust the severity of pruning to achieve the target number of spurs.

Conclusions

- 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.