FINAL PROJECT REPORT

Project Title: Mechanical pruning in apple, pear and sweet cherry

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Percentage time per crop: Apple: 60% Pear:10% Cherry: 30% Stone Fruit:0

Other funding sources: None

Total Project Funding: 167,705

Budget History:

Item	Year 1: 2013	Year 2: 2014	Year 3: 2015
Salaries	26,295	26,307	27,359
Benefits	2,183	2,271	3,135
Wages	10,214	10,503	10,803
Benefits	844	878	913
Equipment	25,000		
Supplies	5,000	2,000	2,000
Travel	8,000	6,000	6,000
Plot Fees			
Miscellaneous			
Total	73,536	43,959	46,210

OBJECTIVES

The primary goal of this project is to establish best management practices for pruning PNW apple, pear and sweet cherry orchards mechanically.

(1) Understand equipment and orchard requirements for successful operation of both a circular saw and sickle bar mechanical pruning system
(2) Compare pruning technologies for their effects on fruit yield and quality
(3) Conduct a preliminary economic assessment of mechanical pruning systems
(4) Train an M.S. student in horticulture with extensive exposure to tree fruit horticulture, agricultural engineering and applied economics
(5) Conduct demonstration trials and associated outreach activities

APPLE: *Fuji – September Wonder/Nic29, Spindle. Planted 2009*

SIGNIFICANT FINDINGS

- Machine dormant pruning is faster than hand pruning.
- The least amount of wood was removed in the dormant hand/summer mechanical (T3) plots, with an average of 0.42 lb wood/tree and 0.20 lb wood removed/tree, respectively. The greatest amount of wood was removed from dormant hand (T1) and dormant mechanical (T2).
- The number fruit/tree from dormant mechanical (T2) was 31% higher than number fruit/tree from dormant hand /summer mechanical (T3), with an average of 70.2 apples/tree. (Tab. 1)
- Apples from dormant hand treatment (T1) had 10% lower °Brix than those from dormant hand/summer mechanical (T3), with an average of 12.4 °Brix.
- Apples from dormant mechanical/summer mechanical (T4) had 46% more sunburn than the apples from dormant mechanical (T2), with an average of 7.6 apples with some degree of sunburn per tree.

METHODS

Trial block: Fuji/Nic 29 block trained to Slender Spindle at McDougalls & Sons (Mattawa) as a Complete Randomized Block Design. Pruning treatments are coded as follows:

Tmt code	2014		2015	
	Dormant pruning	**Summer pruning**	**Dormant pruning**	**Summer pruning**
T1	Hand	-	Hand (hedging and topping)	-
T2	Mechanical	-	Mechanical + hand cleanup (hedging and topping)	-
T3	Hand	Mech. 12-15 leaves	Hand cleanup (hedging and topping)	Mech. 12-15 leaves
T4	Mechanical	Mech. 12-15 leaves	Hand cleanup (hedging and topping)	Mech. 12-15 leaves

Dormant pruning performed on 3/10/2015 with the LaGasse hedger. All rows were topped manually with use of a platform. Data collection included time to prune each plot and weight of wood pruned per plot. Total time/tree includes hedging and topping (s/tree/person). Summer pruning at 12 leaves was done on 5/29/2015. Data collection included time to prune and weight of wood. Wood that was pruned was taken to the lab to record fresh and dry weights.

RESULTS AND DISCUSSION

Times recorded for mechanical pruning were 68%, 62% and 40% faster than times recorded for hand pruning. The average speed for hand pruning was 34.6 s/tree while the average time for mechanical was 12.3 s/tree and 20.6 s/tree. The average time to prune a tree by hand at dormant timing was 34.6 s/tree. This was 40% slower than dormant mechanical (T2) and 60%, and 54% slower than dormant hand/summer mechanical (T3), and dormant mechanical/summer mechanical (T4), respectively. T3 and T4 were the fastest pruning treatments, and did not differ among themselves

Yield

- Number fruit/tree from dormant mechanical (T2) was 31% higher than dormant hand/summer mechanical (T3).
- The lowest yield (lb/tree) was observed in the plots from dormant hand/summer mechanical (T3)
- Yield (lb/tree) from T3 was 29% and 25% lower than yield from T2 and T1, respectively.
- Yield and yield efficiency from T1 and T2 did not differ from each other.
- Yield efficiency from T1 did not differ from T3, as it did in lb/tree.
- Yield efficiency from T3 was 25% lower than yield efficiency in T2.
- The highest lb/fruit was observed from T1, which was 15% higher than T2, T3 and T4.

Tab. 1 Effect of four pruning treatments on averaged harvest metrics for 'Fuji'

TMT	**TMT**	**Number fruit/tree**	Kg/Tree	**lb/tree**	**Yield Efficiency (kg/cm^2)**	**Yield Efficiency (lb/cm^2)**	**Total kg/tree**	**Total lb/tree**
T1	Dormant Hand	**54.47**	14.09	**31.06**	1.14	**2.51**	0.26	**.57**
T2	Dormant Mechanical	**70.27**	15.01	**33.09**	1.27	**2.80**	0.22	**.48**
T3	Dormant Hand + Summer Mechanical	**48.47**	10.63	**23.43**	0.95	**2.09**	0.22	**.48**
T4	Dormant mechanical + Summer Mechanical	**58.67**	12.90	**28.44**	1.25	**2.75**	0.22	**.48**

APPLE: *Cripps Pink - Masilin /M9-337, Spindle. Planted 2012*

SIGNIFICANT FINDINGS

- Trees mechanically pruned in summer and winter + summer showed the same pruning weight.
- Trees that were mechanically pruned in summer only had higher yields than trees pruned in winter only by hand or machine and those that were mechanically pruned in winter and summer.
- At harvest, the number of fruit per tree, net weight of fruit, and yield efficiency was significantly lower in the control than the other treatments. However, the weight of the fruit in the control was significantly higher than other treatments

METHODS

Four treatments: dormant mechanical pruning, summer mechanical pruning, dormant and summer

mechanical pruning, and control (hand dormant pruning). All treatments trees were thinned to remove damaged and undersized fruit. Fruit was harvested on 9/28 for all the treatments; fruit from 9 representative trees per treatment were sized to assess the fruit size distribution at harvest. Some fruit in all treatments dropped a few days prior to harvest and fruit from 3 trees per winter and control treatments were sized. Weight, background and over-color, DA index, starch, firmness, and SSC (brix) were recorded.

RESULTS AND DISCUSSION

Hand pruning in the winter (control) removed more material than mechanical and hand pruning (Fig 1). Trees mechanically pruned in summer and winter + summer showed the same pruning weight, however significantly more fruits were removed when the trees were mechanically pruned in summer alone than in both seasons (Fig 2). Thinning in June, both total weight of fruit removed and weight of individual fruits per control tree were significantly heavier than other pruning treatments.

At harvest, the number of fruit per tree, net weight of fruit, and yield efficiency was significantly lower in the control than the other treatments. However, the weight of the fruit in the control was significantly higher than other treatments (Tab 1).

Tab. 1 - The effect of four pruning treatments on averaged harvest metrics for Cripps Pink

Treatment	**Count of fruit/tree**	Net weight fruit kg/tree	**Net weight fruit lb/tree**	**Fruit weight g**	**TCSA cm^2**	Yield eff kg/cm^2	**Yield eff lb/cm^2**	Metric ton/A	**US ton/A**
winter pruning	111.67 a	22.04 ab	48.59 ab	197.62 b	15.09	1.48 a	3.26	32.00 ab	35.27 ab
summer pruning	115.89 a	23.64 a	52.11 a	205.64 b	15.61	1.40 a	3.09	34.32 a	37.83 a
mechanical winter+summer	97.44 a	19.28 b	42.51 b	199.39 b	14.45	1.36 a	2.99	28.00 b	30.87 b
Control hand only	62.33 b	14.10 c	31.09 c	226.31 a	14.32	1.01 b	2.22	20.47 c	22.57 c
Significance	***	***	***	***	NS	**		***	***

p<0.05, *; p<0.01, **; p<0.001, *; ns, not significant for Type III sums of squares model significance.**

Arithmetic means are presented; post hoc tests were done with LSMEANS option and the Bonferonni adjustment provided letter.

PEAR: *Bartlett/ OHF87, Spindle. Planted 2012*

2015 SIGNIFICANT FINDINGS

- Hand pruning (control) Bartlett trees resulted in the removal of less total wood per tree than mechanical + hand pruning. (0.88 lb/tree and 1.34 lb/tree respectively)
- No statistical difference in vigor, as determined by trunk cross sectional area (TCSA), was found between the two pruning treatments.
- Hand pruning resulted in a greater yield than mechanical + hand (8.8 lb fruit/tree and 6.6 lb fruit/tree), but this difference was not found to be statistically significant.
- Mechanical + hand pruning produced a greater proportion of large fruit (>70mm diameter) than the control treatment (11.9% and 5.7%, respectively). (Fig. 1)
- Colorimetric readings indicated significant differences between fruit harvested from each pruning treatment; fruit from hand pruned trees were lighter in color, less green, and more yellow than fruit harvested from mechanical + hand pruned trees.

- No statistical differences between pruning treatments were found in fresh weight, dry weight, and percent over color, or SSC (Brix).

2016 SIGNIFICANT FINDINGS

- Mechanical winter pruning required 12 hours/acre, hand pruning took significantly longer at 19 hours/acre
- Hand pruning treatment resulted in twice the yield than mechanical + hand treatment (Table 1)
- Hand pruning treatment resulted in greater number of fruit per tree and higher average fruit weight than mechanical + hand treatment (Table 1)
- Mechanical + hand pruning produced less fruit in the larger category (≥70mm diameter) than the hand pruned control (40% and 49%, respectively) and higher incidence of fruit in the 55mm diameter group (Fig. 2)
- Fruit harvested from hand pruned trees (I_{AD} = 1.86) were riper than fruit harvested from mechanical + hand pruned trees (I_{AD} = 1.96)
- Fruit harvested from hand pruned trees showed higher soluble solid content (SSC, Brix), titratable acidity and lower pH than fruit from mechanical + hand trees
- Fruit from hand pruned trees had a higher DM% than fruit from mechanical + hand trees (15.00% and 13.85% respectively)

METHODS

The mechanized pruning trial on Bartlett trees was conducted in Monitor, WA. The orchard was planted in 2012 at 5‘x 12 ‘ and trained to a spindle (726 trees/Acre). The trees were separated into two treatments: 1) hand pruning (4 plots), and 2) mechanical pruning (4 plots) with additional hand pruning (mechanical + hand). Pruning was carried out in March (hand pruning) and in April (6.9 sec/tree). All pruning wood was collected and weighed.

All fruit was harvested from each tree in the trial and fruit was counted and weighed. Fruit were sized by diameter and separated into the following classes: <55mm, 55-60mm, 60-65mm, 65-70mm, and >70mm. Twenty-five fruit from each plot (4 plots per treatment = 100 fruit/treatment) and belonging to the 65-70mm size class were selected for fruit quality analysis and storage. After harvest all fruit were weighed and sorted into three I_{AD} classes (by DA meter readings): A, B and C (<1.9, 1.9-1.99, and >2.0, respectively), and split into two normal air (33^{o}F) storage pull-out groups (T0=1 month, T1=4 months). The quality data reported here represent those only derived from the T0 group. Quality parameters investigated include fresh weight and weight loss after storage, I_{AD} values before and after storage, flesh color (L*a*b*, Minolta), percent red blushed overcolor, firmness (FTA, measured in kg), SSC (Brix), dry matter, pH and titratable acid (% malic acid).

RESULTS AND DISCUSSION - 2015

Pruning and vigor

In 2015, we found hand pruning Bartlett trees resulted in the removal of less total wood per tree than mechanical+hand pruning (0.88 lb/tree and 1.34 lb/tree respectively), but the difference was not statistically significant. No statistical difference in vigor, as determined by trunk cross sectional area (TCSA), was found between the two pruning treatments (18.9 cm^2 hand and 19.2 cm^2 mechanical+hand).

Yield and quality

Hand pruning resulted in a greater yield than mechanical+hand (8.8 lb fruit/tree and 6.6 lb fruit/tree), but this difference was not found to be statistically significant, while yield efficiency (yield per tree/average TCSA), differed significantly between the two pruning groups; hand pruning resulted in greater yield efficiency than mechanical+hand pruning (data not shown). In the comparison of

secondary fruit harvested from each pruning treatment, the mechanical+hand treatment averaged 33% fewer secondary fruit than the hand pruning treatment, but the difference was not statistically significant.

Mechanical+hand pruning produced a greater proportion of large fruit (>70mm diameter) than the control treatment (11.9% and 5.7%, respectively) and lower incidence of fruit categorized in the 55mm diameter group (20.2% compared to 25.5, Fig. 1).

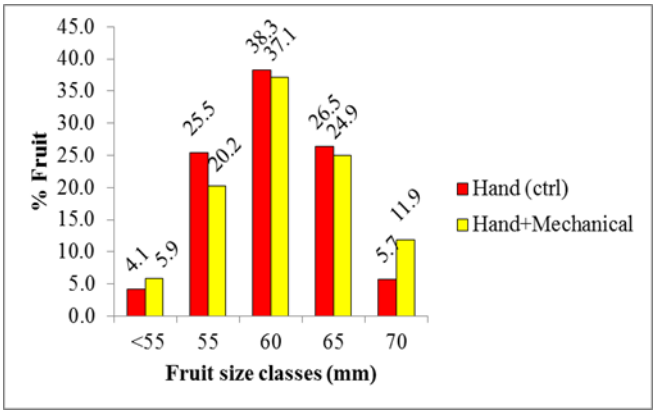


Figure 1: The effect of two pruning treatments on Bartlett fruit size distribution in 2015.

Fruit quality analysis revealed significant differences in measured I_{AD} values immediately after harvest, indicating fruit harvested from hand pruned trees (I_{AD} = 1.96) were more ripe than fruit harvested from mechanical+hand pruned trees (I_{AD} = 1.99). Differences in rate of I_{AD} change during ripening were statistically significant, suggesting fruit from hand pruned trees ripened quicker than fruit from mechanical+hand (data not shown). Comparison of firmness showed significant differences between fruit harvested from both pruning treatments (data not shown). Colorimetric readings indicated significant differences between fruit harvested from each pruning treatment; fruit from hand pruned trees were lighter in color, less green, and more yellow than fruit harvested from mechanical+hand pruned trees (Table 2). No statistical differences between pruning treatments were found in fresh weight, dry weight, percent over color, or SSC (Brix) (data not shown).

RESULTS AND DISCUSSION – 2016

Pruning and vigor

In 2016, hand pruning Bartlett trees resulted in less total wood removed per tree than mechanical+hand pruning (1.7 kg/tree and 2.8 kg/tree, respectively), but the difference was not statistically significant like the previous year (Fig. 1). No statistical differences in vigor, as determined by trunk cross sectional area (TCSA) and annual growth, were found between the two pruning treatments (27.45 cm^2 hand and 27.37 cm^2 mechanical+hand).

The mechanical pruning confirmed to save labor time: winter pruning was mechanically done in 12 hours/acre, while only hand pruning took significantly longer (19 hours/acre).

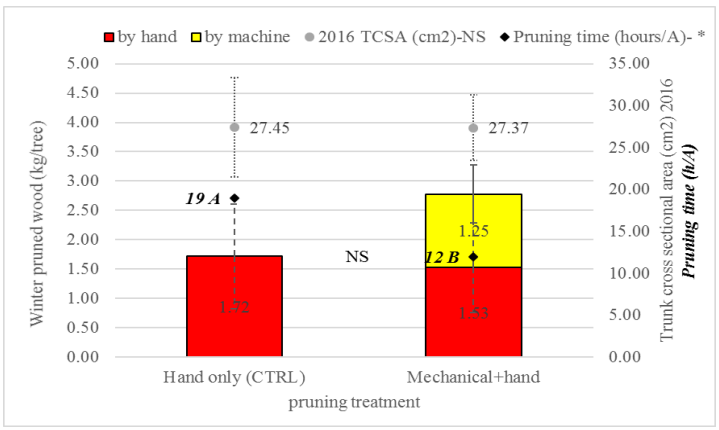


Figure 1: Weight of wood pruned by two pruning methods on Bartlett trees in March 2016, trunk cross sectional area (TCSA cm^2) 2016 and pruning time.

Yield 2016

Hand pruning resulted in double yield than mechanical+hand (18 kg fruit/tree and 9 kg fruit/tree respectively), with higher number of fruit per tree and higher average fruit weight than mechanical+hand (188 g vs 162 g respectively). Hand pruning confirmed a greater yield efficiency than mechanical+hand pruning (Table 1). There was no significant difference in the number and weight of secondary fruit harvested from each pruning treatment. Mechanical+hand pruning produced less fruit in the larger category (≥70mm diameter) than the hand pruned control (40% and 49%, respectively) and higher incidence of fruit in the 55mm diameter group (Fig. 2).

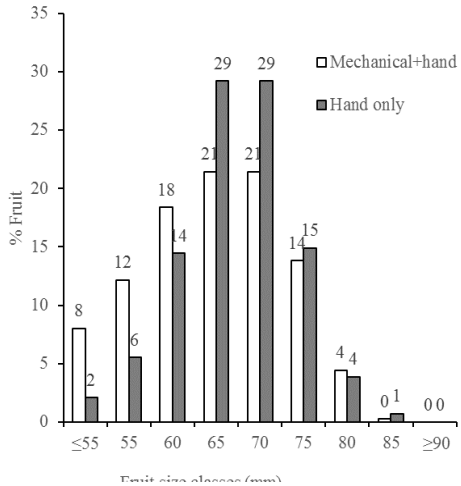


Figure 2: Comparison of Bartlett size at harvest 2016 between two pruning treatments.

Table 1: Bartlett yield in Monitor, WA August 2016

Treatment	Number fruit /tree		Net yield (lb /tree)		Avr. fruit weight (g)		Yield efficiency (lb /TCSA cm2)		Crop load (num. fruit /TCSA cm2)	
Pruning										
Mechanical+hand	53	**B**	18.9	**B**	162	**B**	0.69	**B**	1.93	**B**
Hand only	92	**A**	38.9	**A**	188	**A**	1.41	**A**	3.41	**A**
Significance	***		***		*		***		***	
Significance: * p<0.05, ** p<0.01, *** p<0.001. SNK as *post-hoc* test for means discrimination.										

Fruit quality 2016

Quality analysis revealed significant differences in measured I_{AD} values after harvest (T0=1month after harvest), indicating fruit harvested from hand pruned trees (I_{AD} = 1.86) were riper than fruit harvested from mechanical+hand pruned trees (I_{AD} = 1.96). Differences in rate of I_{AD} change during ripening were statistically significant, suggesting fruit from hand pruned trees ripened quicker than fruit from mechanical+hand (Table 2). Colorimetric parameters (hue and chroma) were not different between treatments, while % red overcolor seemed to be higher in mechanical+hand fruit (difference not statistically significant). Fruit harvested from both pruning treatments reported similar firmness values (Table 2). "Hand pruned" fruit showed higher soluble solid content (SSC, Brix), titratable

acidity and lower pH than "Mechanical+hand" fruit. The traditional destructive dry matter (DM) assessment showed significant differences between the two treatments revealing a higher DM% in "hand" fruit than "Mechanical+hand" fruit (15.00% and 13.85% respectively). I_{AD} classes (A, B, C) showed significant difference mainly in SSC: the ripest class had the highest SSC value (within "hand pruned" fruit I_{AD} <1.9 had 14.13 Brix, while I_{AD}>2.0 reported 12.99 Brix, similar difference for "Mechanical+hand" fruit) and lower titratable acidity only in the "Mechanical+hand" fruit, while not significant differences among the other parameters (data not shown). Fruit quality at T1 (4 months after harvest) is not presented in this report, all fruit after ripening at room temperature reported internal browning and several superficial scald.

Table 2: Bartlett fruit quality at T0 (harvest 2016).

BARTLETT 2016	weight (g) T0 day0		I_{AD} at T0 day0		Color parameter: Hue (T0 day7)	Color parameter: Chroma (T0 day7)	I_{AD} drop in 7days @RT		weight (g) drop in 7days @RT	% red overcolor	avr firmness (kg)	SSC (Brix)		destructive DM %		pH		titratable acidity (% malic acid)	
hand only (ctrl)	211	A	1.86	B	95.04	52.37	1.56	A	8.53	9.98	0.85	13.74	A	15.00	A	3.69	B	0.38	A
mech+hand	196	B	1.96	A	96.11	52.56	1.48	B	8.76	12.10	0.79	12.67	B	13.85	B	3.79	A	0.33	B
Significance trt	**		NS		NS	NS	**		NS	NS	NS	***		*		**		**	
Significance class	NS		***		NS	NS	*		NS	NS	NS	***		NS		NS		*	
Significance trt*class	NS		NS		NS	NS	NS		NS	NS	NS	NS		NS		NS		NS	

CHERRY*:* *Tieton / Gisela 5, UFO. Planted 2008*

SIGNIFICANT FINDINGS

Sweet Cherry (Mechanical pruning vs/+ hand pruning)

- Mechanical pruning was 29 times faster than hand pruning alone at a tractor speed of 1.3 m/h, and 17 times faster than the combination of both approaches.
- Hand pruning removed 2.6 times more wood/tree than mechanical pruning, and 1.2 times more wood/tree than the combination of mechanical and hand pruning.
- Mechanical pruning was 11 times more efficient than hand pruning, the combination of mechanical and hand pruning was 1.4 times more efficient than hand pruning alone.
- Mechanical pruning had no effect on yield or yield efficiency. There was no difference between treatments regarding yield efficiency and kg fruit/tree.

Sweet Cherry (Preharvest and postharvest topping)

- Total current season shoot length per upright was significantly greater from uprights pruned during the dormant season and full bloom compared to those topped 2 and 3 months after full bloom. Pruning performed 2 and 3 months after full bloom removed 73% more wood than full bloom pruning and 48% more than DP.
- Timing of pruning affected yield per upright but not yield efficiency in 2015.
- Yield was 35% higher on unpruned uprights compared to uprights pruned in the dormant season, and no different from the other treatments.
- Fruit quality traits were not affected by timing of topping, except for soluble solids content.

METHODS

Mechanical pruning vs/+ hand pruning: The experiment was designed to assess the effect of pruning over two years. The three treatments are as follows (2014/2015): 1) hand pruning/hand pruning, 2) mechanical pruning/mechanical pruning, and 3) mechanical pruning/mechanical pruning + hand pruning follow-up. Each treatment has 5 replications of 20-tree blocks (i.e., 100 trees/treatment).

Mechanical pruning was performed with the sickle bar (Gillison's Center Mount Topper and Hedger) with 3 passes of the machine (hedging on each side of the row and topping), topping was performed at 11 feet height. The motor of the sickle bar was positioned at the top to avoid hitting the lower branches of the trees, and the speed of the tractor was fixed at 1.2 m/h in 2014 and 1.3 m/h in 2015. Hand pruning was performed by the commercial crew (4 people) using ladders, and with the practices that they regularly perform at the orchard. The time to prune each plot and the weight of the wood pruned were recorded for each treatment. Additionally types of cuts and wood damage were observed, as well as the general performance of the machine. The block was picked at commercial harvest (6/4/2015), 3 trees/rep/treatment were randomly chosen for yield and fruit quality evaluation and samples of 25 cherries/tree. Fruit quality was evaluated in the laboratory with weight, firmness, soluble solids content, stem pull force and diameter measurements.

Preharvest and postharvest topping: this trial was also established at Olsen Brothers in Benton City with 'Tieton'/'Gisela®5'trained to the UFO system in a complete randomized design, consisting of 5 different timings of hand pruning (treatments) with 5 replications, and 3 trees/rep. Trials were initiated in 2014, the trees were topped by hand at 11-12' high at different timings: 1) dormant, 2) full bloom, 3) full bloom + 1 month, 4) full bloom + 2 months and 5) full bloom + 3 months. Fruit was picked at commercial harvest (6/11/2014) with samples of 25 cherries per upright. Data of the diameter at the cut site and the length of the removed branches were recorded. Fruit quality was evaluated in the laboratory with firmness, total soluble solids, titratable acidity, weight, and diameter measurements. Regrowth was measured during the winter 2015. The experiment was replicated in 2015 on 4 different rows, fruit was picked at commercial harvest (6/4/2015) and fruit quality was evaluated in the laboratory. Regrowth is being measured during the winter 2016.

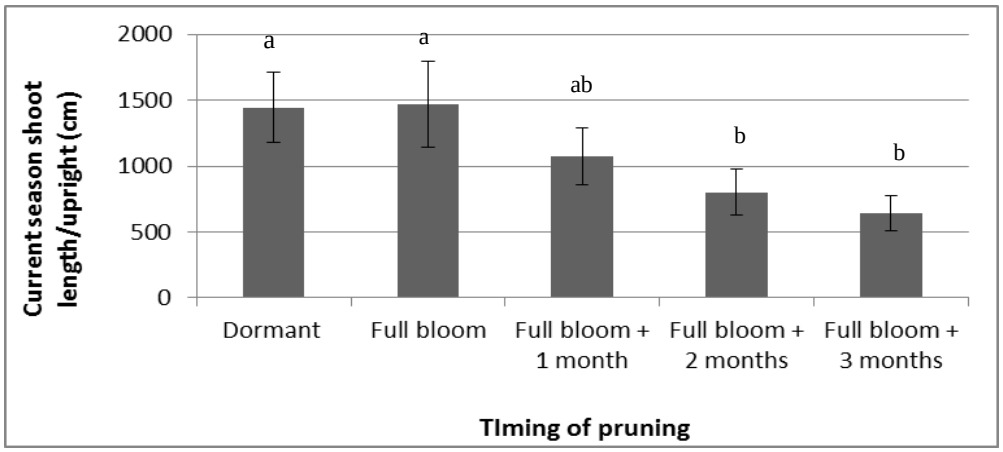
RESULTS AND DISCUSSION

Mechanical vs/+ hand pruning: Our 2015 results showed that mechanical pruning was 29 times faster than hand pruning alone and 17 times faster than the combination of both approaches, mechanical pruning followed by a hand cleanup was 1.6 times faster than hand pruning alone (Figure 1). Each tree was pruned approximately in 14 s with the sickle bar, 408 s per person by hand (6.8 min) and 245 s (4 min) with the sickle bar followed by a hand cleanup.

Hand pruning removed 2.6 times more wood/tree than mechanical pruning, and 1.2 times more wood/tree than the combination of mechanical and hand pruning, with 6.5 kg wood removed/tree approximately. With these results, we evaluated pruning efficiency as kg of wood removed/min/tree and mechanical pruning was 11 times more efficient than hand pruning, and 8.2 times more efficient than mechanical pruning followed by a hand cleanup. The combination of mechanical and hand pruning was 1.4 times more efficient than hand pruning alone. It is believed that hand pruning removed more wood than mechanical pruning because it is more selective. Mechanical pruning had no effect on yield or yield efficiency. Yield efficiency ranged from 0.05 to 0.06 kg/cm2 TCSA, which represents 7.6 tons/acre for hand pruning, 9.1 tons/acre for mechanical pruning and 7.5 tons/acre for mechanical pruning 2 (Figure 2). Mechanical pruning had an effect on fruit diameter and weight but in a very small percentage. Fruit diameter from mechanical pruning1 and mechanical pruning2 was 3% (0.9 mm) and 2% (0.7 mm) lower than fruit from trees that were hand pruned, but row size was the same (9) for all treatments. Fruit weight from mechanical pruning was 7% lower (0.8 g) than fruit from trees than were hand pruned. We believe that these results might be due to the fruit yield of our trial, even though the difference was not significant, yield from mechanical pruning was 10% higher than yield from hand pruning.

Preharvest and postharvest topping: Our 2015 results showed that pruning performed full bloom + 2 months (FB2) and full bloom + 3 months (FB3) removed 73% more wood than full bloom (FB) pruning and 48% more than dormant pruning (DP). DP and FB were the treatments with the lowest amount of wood removed, but they were not different from each other. There was a positive correlation between length and caliper of wood removed at different timings of pruning, R2

coefficient was lower for 2015 than for 2014. Differently from our 2014 trial, timing of pruning affected yield per upright but not yield efficiency. Yield was 35% higher on unpruned uprights compared to uprights from DP, and no different from the other treatments. Yield efficiency ranged from 0.12 kg/cm^2 TCSA to 0.18 Kg fruit/cm^2 TCSA. Timing of pruning showed an effect on fruit SSC and stem pull force. Fruit SSC ranged from 14.1 °Brix to 15.5 °Brix. The lowest value was observed from full bloom + 1 month (FB1) , SSC from FB1 was 4%, 5% and 7% lower than fruit SSC from DP, FB and unpruned uprights, respectively. There was no difference between unpruned trees and DP and FB1. Fruit from all treatments were row size 9.



Executive Summary

The primary goal of this project is to establish best management practices for pruning PNW apple, pear and sweet cherry orchards mechanically. In all cases, trials included mechanical hedging and hand pruned treatments with hand pruned only being the control. In some cases, treatments included hand plus mechanical.

This project included replicated trials (two consecutive seasons) and demonstration trials in Apple, Pear and Sweet Cherry. Apple trials were conducted in 'Fuji' (planted 2009), 'Cripps Pink' (planted 2012) and 'Kanzi' (planted 2013). The one pear trial was conducted in 2015 and 2016 in a 'Bartlett' spindle block planted in 2012. Sweet Cherry replicated trials were conducted in a 2008 Tieton block trained to UFO architecture. Significant findings for each trial can be found in the full report.

The project included the purchase and operation of 2 commercial mechanical hedgers. The Gillison's hedger (Benzonia, MI) has the capacity to hedge on the horizontal and vertical. This hedger was used in year 1 in all species and was a good fit in cherries for topping and hedging. This implement is heavy, difficult to mount and has more bounce than we want. The second hedger is the Lagasse (Lyons, NY) and it can only vertically hedge (at various angles). This is a simple, relatively light weight, front loaded implement that is a good fit for narrow row spacing and tree heights and commonly used orchard tractors. Ground speed ranged from 1.2 to 1.5mph.

To use or not to use a hedger should be decided when development plans for a block are in the initial stage. If this is a tool you want to use, than you should establish blocks and pruning strategies accordingly. As an example, mechanical hedgers do not prune wood that is parallel to the row, so tree architecture and development would need to take this into consideration. All the blocks we used were established without the plan to use mechanical hedging resulting in more hand and structural pruning.

Mechanical hedging should not be considered for the sole purpose of saving money. Mechanical hedging should be considered for the following reasons: 1) filling in blind wood near the trunk, 2) restricting canopy depth and height for various reasons including to allow for additional mechanization and automation, 3) light management in late winter/early spring, summer and close to harvest. You need to know what response you after to determine when and how to use mechanical hedging. Our trials were designed to evaluate the response to time of hedging on tree vigor, yield and fruit quality and return bloom.

Project investigators agree that there is a place in the toolbox for mechanical hedgers in canopy management of modern apple, pear and cherry orchards. Results in the field are dependent on many factors including tree architecture (type of wood and placement), timing, cultivar, equipment type and operation, and follow up / clean up pruning.

It is important to assess blocks for fireblight before using a mechanical hedger. This tool like any other tool going from tree to tree can spread bacteria.

The hedger has been demonstrated to roughly 400 people. Trade articles:
http://www.goodfruit.com/be-careful-in-adopting-summer-hedging-to-build-those-fruiting-walls/
http://www.goodfruit.com/help-with-hedging/
https://youtu.be/Pm0ppPdt1M4?list=PLvq9oom2vWpc7icQdCKb0VDJuNb-pELod
www.goodfruit.com/keeping-limbs-in-line-with-**mechanical-pruning**-video/
www.goodfruit.com/**hedging**-to-improve-quality/

A Best Management Practice document will be prepared in the next few months and will include information learned in Europe and the Eastern US.