Mechanical Blossom Thinning of Peaches

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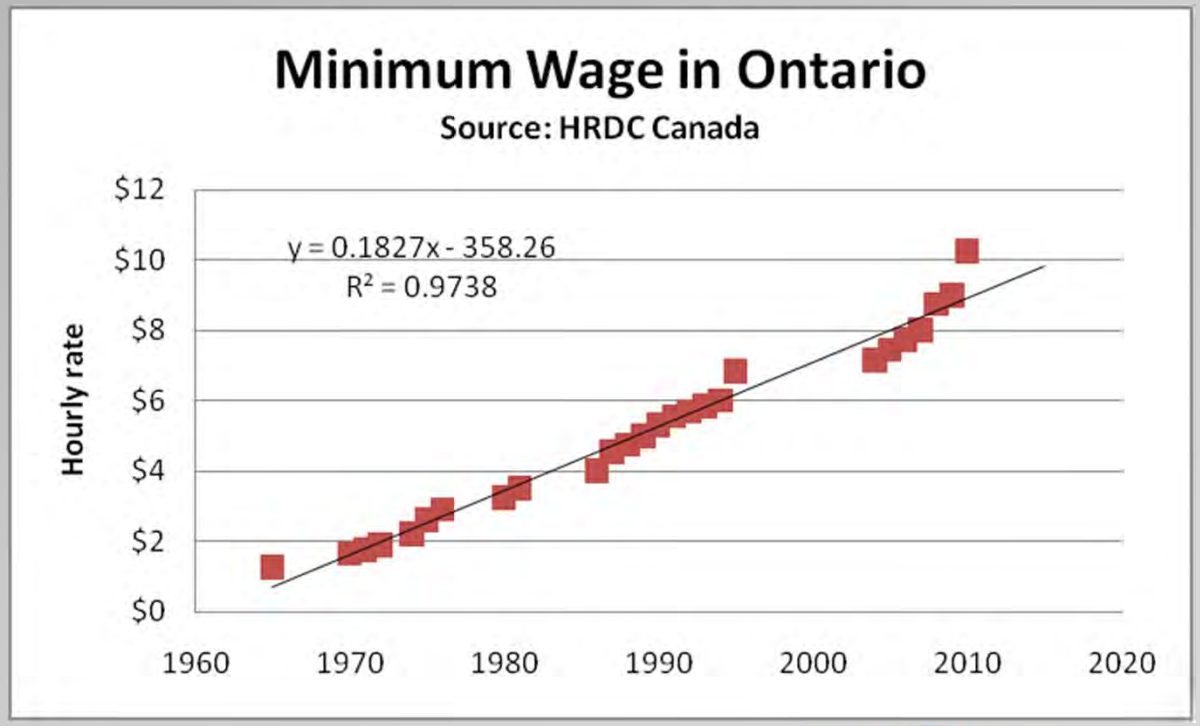
Outline of Presentation

- Horticultural basis for thinning peaches
- Various strategies – past and present
- 2009 experiments
- 2010 experiments
- Future Research, Challenges and Opportunities

What is the impetus for developing better thinning methods for peaches

- Thinning is labour intensive ~ $500/acre
- Hand thinning is done ~45 DAFB, resulting in an enormous ‘waste’ in photosynthate
- Harvest efficiency – proportional to number of fruit per tree



Horticultural Basis for thinning Peaches

- Trees fruits produce an excessive number of flowers
- Only 5-10% flower set required to produce a commercial crop
- maximize crop value
- maintain tree growth and structure



Various Strategies of Thinning Peaches

A. Pruning (Marini, 2002. HortScience 37:642)

B. Fruitlet Thinning

- Elgetol (Dinitro-ortho-cresol)
- Ethrel (Cline, Taheri, Coneva and others)
- Tree shaking (Leuty & Miller)
- Rope Thinning (Byers)

C. Flower Inhibition

- Gibberellic Acid (Coneva & Cline, 2006 HortScience 41:1596)

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Factsheet

THINNING TREE FRUITS

(Reprinted July 1983)

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S. R. Miller, Agriculture Canada, Smithfield

APPLES

Thinning of apples is often required to improve fruit size and to control the alternate bearing habit of some cultivars (varieties). Thinning needs must be based on grower experience, taking into account the cultivars involved, the amount of bloom, bee activity, weather conditions during pollination, and previous thinning history of the orchard (Figure 1).

Chemicals available for thinning include naphthaleneacetamide (NAD), naphthaleneacetic acid (NAA), carbaryl (Sevin) and ethephon (Ethrel). The latter material should be used only experimentally at the present time.

NAD is a relatively safe material that is applied at petal fall at concentrations of 50 to 100 ppm depending upon cultivar and growing conditions. It may be concentrated but should be applied in at least 180 to 275 litres of water per hectare (40 to 60 gal per acre).

NAA can be a most effective thinning agent but amount applied, concentration, cultivars, timing, and weather conditions are all important factors affecting the response. NAA must be applied as a dilute spray, usually 7 to 10 days after petal fall.

"Days after petal fall" does not always provide a sufficiently accurate index for timing fruit-thinning sprays. Sensitivity to NAA depends on fruit development which, in turn, depends on environmental conditions. Average fruit diameter reflects these yearly variations in growing conditions. The following fruit sizes resulted in improved thinning of three apple cultivars in Eastern Ontario.

Cultivar	Average Diameter at NAA-sensitive Stage
McIntosh	8.0-9.5 mm (approx 3/8 inch)
Delicious	6.5-8.0 mm (approx 5/16 inch)
Spy	10.0-11.0 mm (approx 7/16 inch)

During a backward spring, fruits may require 12 to 13 days after petal fall to reach the NAA-sensitive stage, whereas during a warm spring, this stage may be reached within six days.

Sampling Method. A total of 50 to 60 fruits of each cultivar should provide a good estimate of fruit development in a reasonably uniform orchard block. Select the **two** largest developing fruits from each of 25 to 30 randomly selected clusters, measure the greatest width of each and determine the sample average. Vernier calipers or fruit-sizing rings provide a simple means for taking measurements rapidly and accurately.

NAA can reduce fruit size without removing any fruit, if not applied correctly.

Carbaryl can be applied over a wider time interval following petal fall than either of the above materials. Maximum response is obtained when carbaryl is applied at the most sensitive size outlined above; however, some thinning usually results from later applications up to four weeks after full bloom.

Treatments applied after the most sensitive time do not reduce fruit size. Carbaryl is used at rates of 840 to 3370 g active material per hectare (.75 to 3 pounds active material per acre) depending upon cultivar and timing. It can be applied as a concentrate spray although the response is not always satisfactory.

Carbaryl is extremely toxic to bees and certain beneficial predators.

Ethephon is being used experimentally to thin certain apple cultivars. Sprays are applied approximately 25 days after petal fall after the set has been assessed, but prior to normal June drop. Rates of 150 to 300 ppm are effective on Red Melba and McIntosh. Low-volume spraying has not been assessed.

Carbaryl plus NAA has been used on hard-to-thin cultivars such as Early McIntosh and Wealthy with considerable success. In general, a constant rate of carbaryl (340 g active ingredient per 455 litres of water) should be used with varying amounts (3 to 15 ppm) of NAA.

Factors Influencing Response to Thinning Agents

1. *Cultivar Sensitivity*

(a) Easy-to-thin cultivars include Delicious, Idared, and Spy.

(b) Hard-to-thin cultivars include Lodi, Duchess, Golden Delicious, Early McIntosh and Wealthy.

thinning such cultivars until many of the split-pit fruits can be identified and selectively removed.

Late-maturing cultivars are thinned according to their individual requirements. Heavy-setting, hard-to-size cultivars such as Redhaven and Madison require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, however, late-maturing cultivars with a good, uniform set are usually thinned 10 to 13 cm apart. Distance between fruits is not too critical as long as clusters are broken up and fruits separated (Figure 2). If the set is spotty on the tree, more fruits may be left on heavy-set branches.

for example, may be used at 0.5 to 1.7 litres per 455 litres of water (1 to 3 pints per 100 gal) depending on cultivar. Trees under 5 years of age should not be chemically thinned.

Mechanical The trunk-shaker method supplemented by touch-up hand thinning is being employed by a few growers (Figure 3). Major drawbacks of this method are erratic thinning and the very real danger of overthinning. Stiff branches are easily overthinned, while willowy or hanging branches are generally underthinned. Recent experiments at Vineland clearly demonstrated that while a mechanical trunk shaker reduced thinning costs, the savings were often more than obliterated by losses in yield due to overthinning.

Figure 3. Mechanical thinning of peaches. Care must be taken to avoid overthinning.

If mechanical thinning must be practised, it is strongly recommended that an observer accompany the machine operator to help avoid overthinning. It will be necessary to leave more fruit than normal on some of the underthinned branches to compensate for excessive thinning on others.

PLUMS

The dinitros will thin plums more easily than peaches. Where biennial bearing is occurring or where size is difficult to obtain, bloom thinning can be helpful. Elegtol at 0.5 litres per 455 litres of water is a suggested strength to try.

Metric to Imperial Conversions

Sevin	113 g = ¼ lb
	340 g = ¾ lb
	454 g = 1 lb
Water	455 litres = 100 Imperial gallons
Elgetol	0.5 litres = 1 pint (approximately)
	1.7 litres = 3 pints (approximately)

This Factsheet has been reviewed and is endorsed by the Ontario Pesticides Advisory Committee.

Rope Blossom Thinner

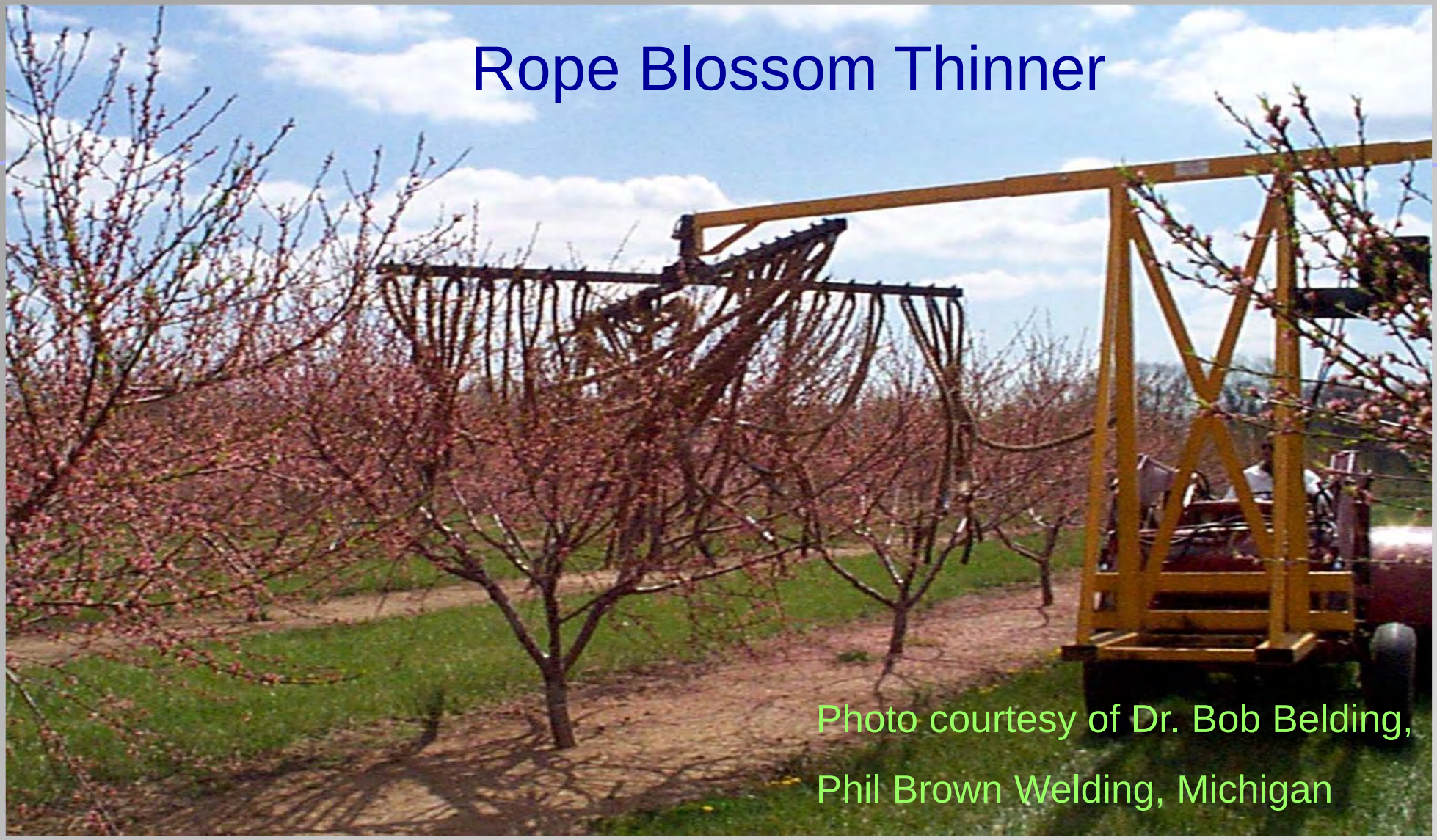

Photo courtesy of Dr. Bob Belding,

Phil Brown Welding, Michigan

Basis for Mechanical String Thinning

- Method to thin earlier (bloom)
- Non chemical approach
- For stone fruits there are few commercially accepted methods
- No registered blossom or fruitlet chemical thinners (unlike apple)

2009 Research Objectives

To assess the effectiveness of mechanical blossom thinning on:

- Reduction in hand thinning and cost savings
- Improvement in fruit size
- Effect on yield

Mechanical String Thinner

- Designed by Fruit-Tec, Germany
- Sold in North America by N.M. Bartlett Inc.
- Has front mount 3PH, fixed, or fork-lift mounts
- Model evaluated Darwin 300

Source: Pen State University

Mechanical String Arrangements

9 Strings

Variety	Timing	Rotations Per Minute	Miles Per Hour
Autumn Glow (heavy)	Pink	150 & 180	1
Red Haven	Pink	160	1
PF17	Pink	180	2
Saturn	Pink	150	2
Fantasia	Shucks On	150	2

18 Strings

Variety	Timing	Rotations Per Minute	Miles Per Hour
Autumn Glow	Pink	150	1

2 On, 2 Off

Variety	Timing	Rotations Per Minute	Miles Per Hour
Red Haven	Pink	160	1

2 On, 2 Off

Opposing

Variety	Timing	Rotations Per Minute	Miles Per Hour
White Lady	Pink	150 & 180	2
PF 17	Pink	180	2

Two On, Every Third Off

Variety	Timing	Rotations Per Minute	Miles Per Hour
PF 17	Pink	180	2

2 On, 4 Off

Variety	Timing	Rotations Per Minute	Miles Per Hour
PF17	Pink	200 & 220	1
White Lady	Pink	180	2

Four On, Four Off

Variety	Rotations Per Minute	Miles Per Hour
Red Haven	200	1


JOHN DEERE
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2009 Experiments

Catherina

- 8-yr old “Catherina”
- 1.8 x 6.6 m (841 t/ha)
- central leader
- Goal was to evaluate: speed of rotation (RPM), string configuration and to compare with hand thinning

Allstar

5-yr old “Allstar” peach

1.8 x 4.8 m (1121 t/ha)

Tall spindle

Goal was to evaluate: speed of rotation (RPM), string configuration and to compare with hand thinning

Treatments

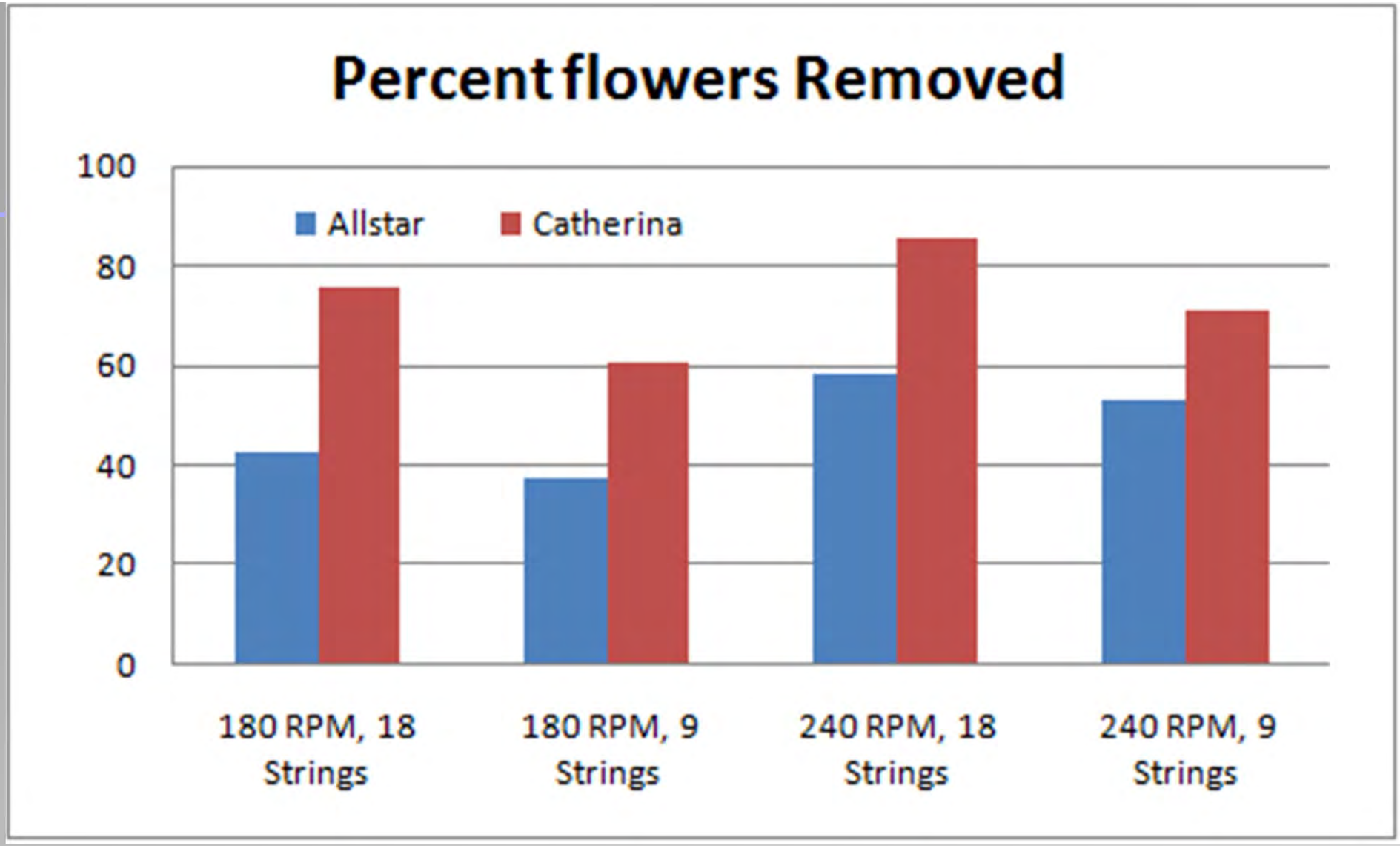
- Hand thinned control
- 180 RPM, 18 strings
- 180 RPM, 9 strings
- 240 RPM, 18 strings
- 240 RPM, 9 strings

Ground speed: 2.1 miles per hr

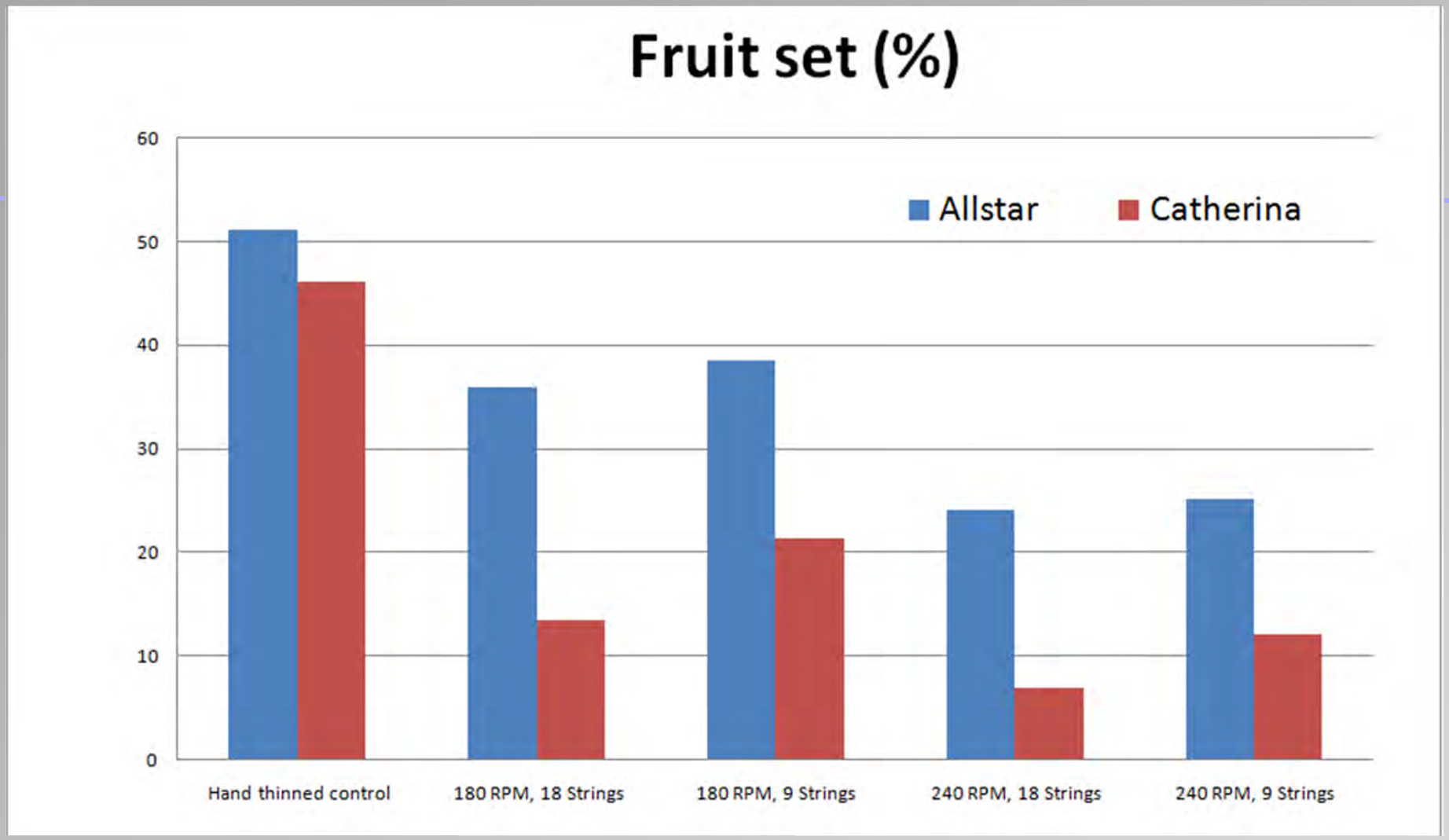
Timing: Full Bloom

Peach Measurements

- Percent blossoms removed
- Fruit set (on selected branches)
- Number of fruit thinned per branch
- Time required to hand thin
- Harvest: Number of fruit per tree, yield, fruit size, split pits,



Allstar: 37-58% Catherina: 60-85%



- Mechanical thinning reduced fruit
- RPM greater effect than String configuration

Labour Savings

Hand thinning per Acre

77 hrs (Allstar)

20 hrs (Catherina)

Reduction

- 21-50% (Allstar)
- 10-50% (Catherina)

Savings (at $10 per hr)

- $160-290 (Allstar)
- $20-100 (Catherina)

Treatment	Time required to thin (hr/ acre)	# hrs	%
Allstar			
Hand thinned control	76.8		
180 RPM, 18 Strings	61.0	16	21
180 RPM, 9 Strings	60.0	17	22
240 RPM, 18 Strings	39.3	37	49
240 RPM, 9 Strings	47.9	29	38
Significance [x]	**		
P value	0.0044		
Contrasts (P value)			
Effect of Hand vs Mechanical Thinning	0.0018		
Effect of 18 vs 9 strings	0.5422		
Effect of 180 vs 240 RPM	0.0118		
Catherina			
Hand thinned control	20.3		
180 RPM, 18 Strings	13.0	7	35.9
180 RPM, 9 Strings	18.2	2	10.7
240 RPM, 18 Strings	10.2	10	49.8
240 RPM, 9 Strings	11.9	8	41.7
Significance [x]	***		
P value	<0.0001		
Contrasts (P value)			
Effect of Hand vs Mechanical Thinning	0.0029		
Effect of 18 vs 9 strings	0.0001		
Effect of 180 vs 240 RPM	<0.0001		

Yield and Fruit Size

Total Weight per Tree

No effect (Allstar)

Mechanical thinning reduced yields 9 to 45% (Catherina)

Fruit size

- Mechanical thinning increased fruit size 8 – 15%

Treatment	Total fruit weight (kg/tree)		Fruit weight (adjusted for crop load) (g)	
Allstar				
Hand thinned control	24.4		147	c
180 RPM, 18 Strings	24.1		158	b
180 RPM, 9 Strings	21.9		155	b
240 RPM, 18 Strings	20.0		173	a
240 RPM, 9 Strings	20.9		167	a
Significance [x]	ns		**	
P value	0.1624		0.0015	
Contrasts (P value)				
Effect of Hand vs Mechanical Thinning	0.1103		0.0005	
Effect of 18 vs 9 strings	0.6302		0.1926	
Effect of 180 vs 240 RPM	0.0926		0.0011	
Catherina				
Hand thinned control	29.7	ab	198	c
180 RPM, 18 Strings	27.1	ab	218	ab
180 RPM, 9 Strings	34.6	a	219	bc
240 RPM, 18 Strings	16.1	c	231	a
240 RPM, 9 Strings	23.1	bc	212	bc
Significance [x]	**		*	
P value	0.0061		0.015	
Contrasts (P value)				
Effect of Hand vs Mechanical Thinning	0.0237		0.1085	
Effect of 18 vs 9 strings	0.0017		0.4446	
Effect of 180 vs 240 RPM	0.1803		0.8209	

2010 Experiments

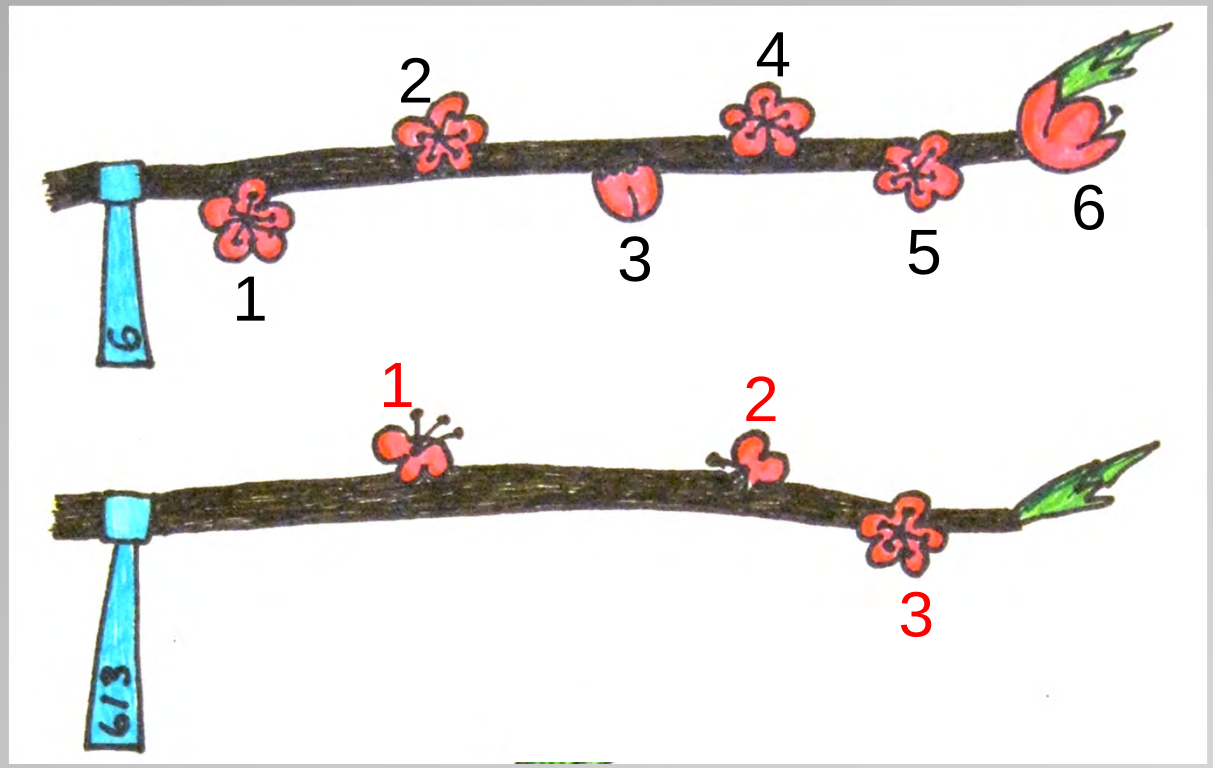
2010 Peach Trial Overview

- Grower trial: Lepp Farms Inc., Virgil Ontario
- 6 year-old ‘Allstar’/Bailey rootstock
- Goal: compare mechanical thinning to hand thinning *at the same rate at the same time*

2010 Peach Trial - Materials & Methods

Step 1: Count blossoms before treatment

Step 2: Count blossoms after mechanical thinning



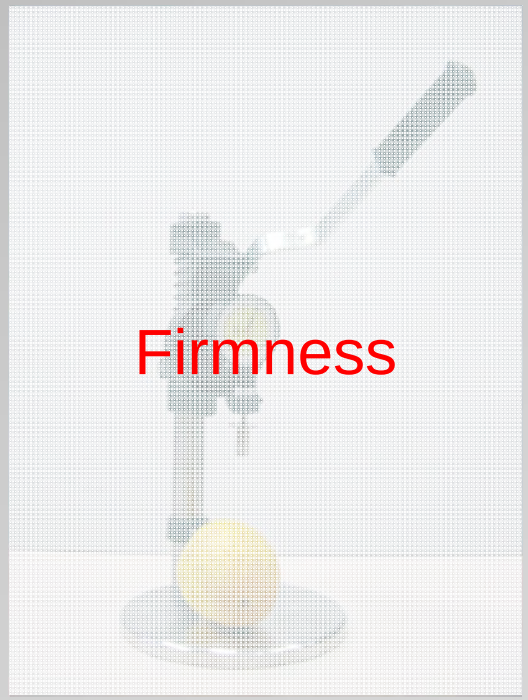
Step 3: Thin hand treatments to 50%

2010 Peach Trial - Materials & Methods

Colorimeter

Vernier caliper

Refractometer



Penetrometer

Peach Results - 2010 Field Season

% Blossoms Removed & % Fruit Set

Table 1. The effect of thinning treatment on percentage of blossoms removed, and subsequent percentage of fruit set for Allstar peaches on Bailey rootstock in Virgil, Ontario, Canada before June Drop 2010.

Treatment	% of blossoms removed	% fruit set
180RPM	44 bc[x]	51 ab
210RPM	58 b	35 c
240RPM	74 a	22 d
Hand1	37 c	58 a
Hand2	57 b	41 bc
Hand3	74 a	23 d
Trt effect	***	***
Estimates		
Mechanical vs. Hand	NS	NS

[x]Means with the same letter are not significantly different at $P = 0.05$. Non-significant effects or comparisons are indicated by NS.

Follow-up Hand Thinning

Table 2. The effect of thinning treatment of follow-up hand thinning at 'June Drop' for 'Allstar' peaches on Bailey rootstock in Virgil, Ontario, Canada 2010.

Treatment	No. fruit removed	Wt. of fruit removed, g	Avg. wt. of ind. fruit, g	Time spent thinning, sec	Time spent thinning, hours/acre
180RPM	283 a[x]	4470 a	15.9 b	465 ab	59
210RPM	302 a	4639 a	15.4 b	510 ab	64
240RPM	236 ab	4007 a	17.3 ab	450 ab	57
Hand1	323 a	5314 a	16.7 ab	608 a	77
Hand2	223 ab	3959 a	18.2 ab	437 ab	55
Hand3	111 b	2128 b	19.4 a	285 b	36
Trt effect	***	***	**	*	
Estimates					
Mechanical vs. Hand	*	NS	**	NS	

[x]Means with the same letter are not significantly different at $P = 0.05$ (Tukey's). Non-significant effects or comparisons are indicated by NS.

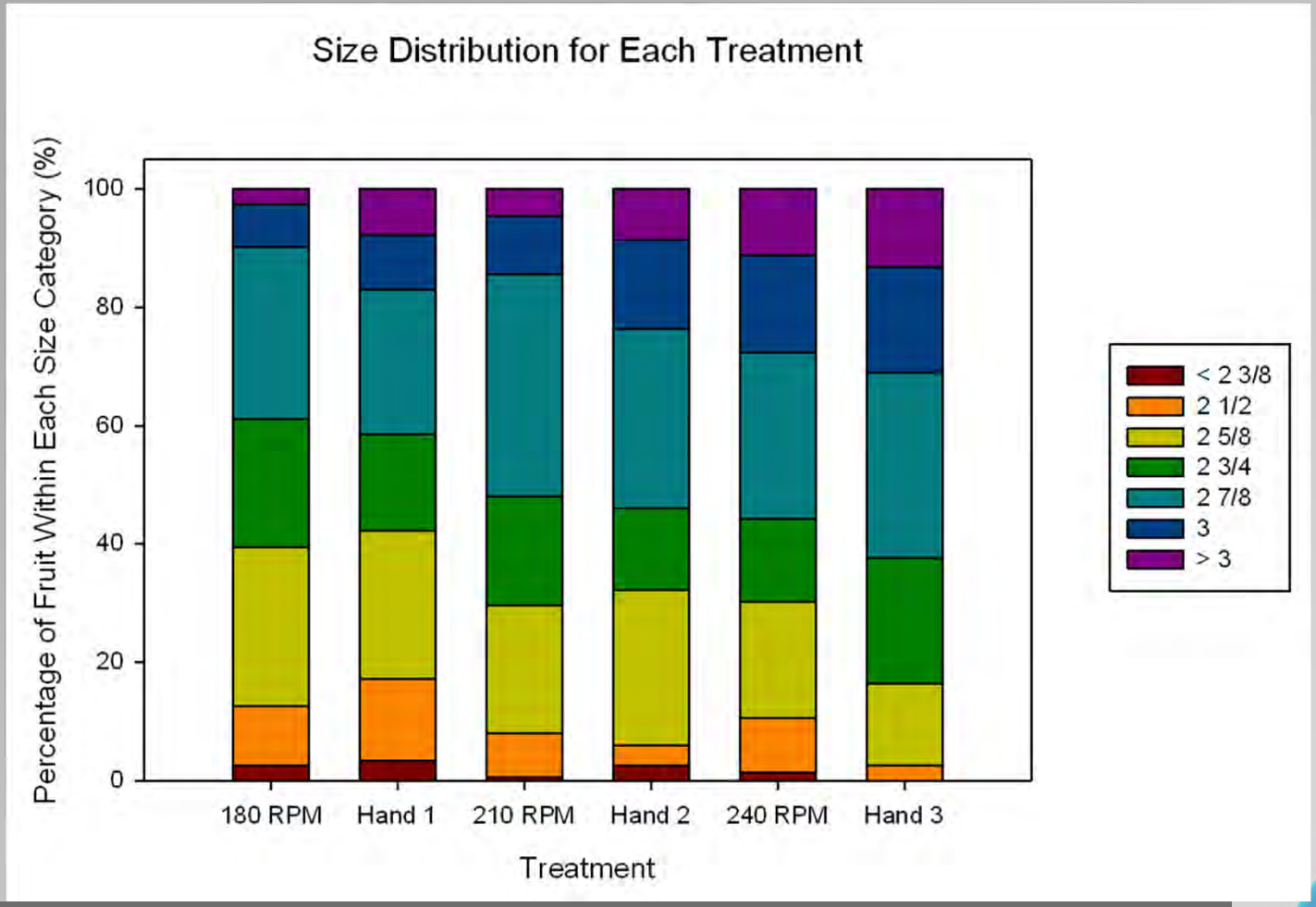
Harvest Yields

Table 3. The effect of thinning treatment on harvest yields of 'Allstar' peaches on Bailey rootstock in Virgil, Ontario, Canada 2010.

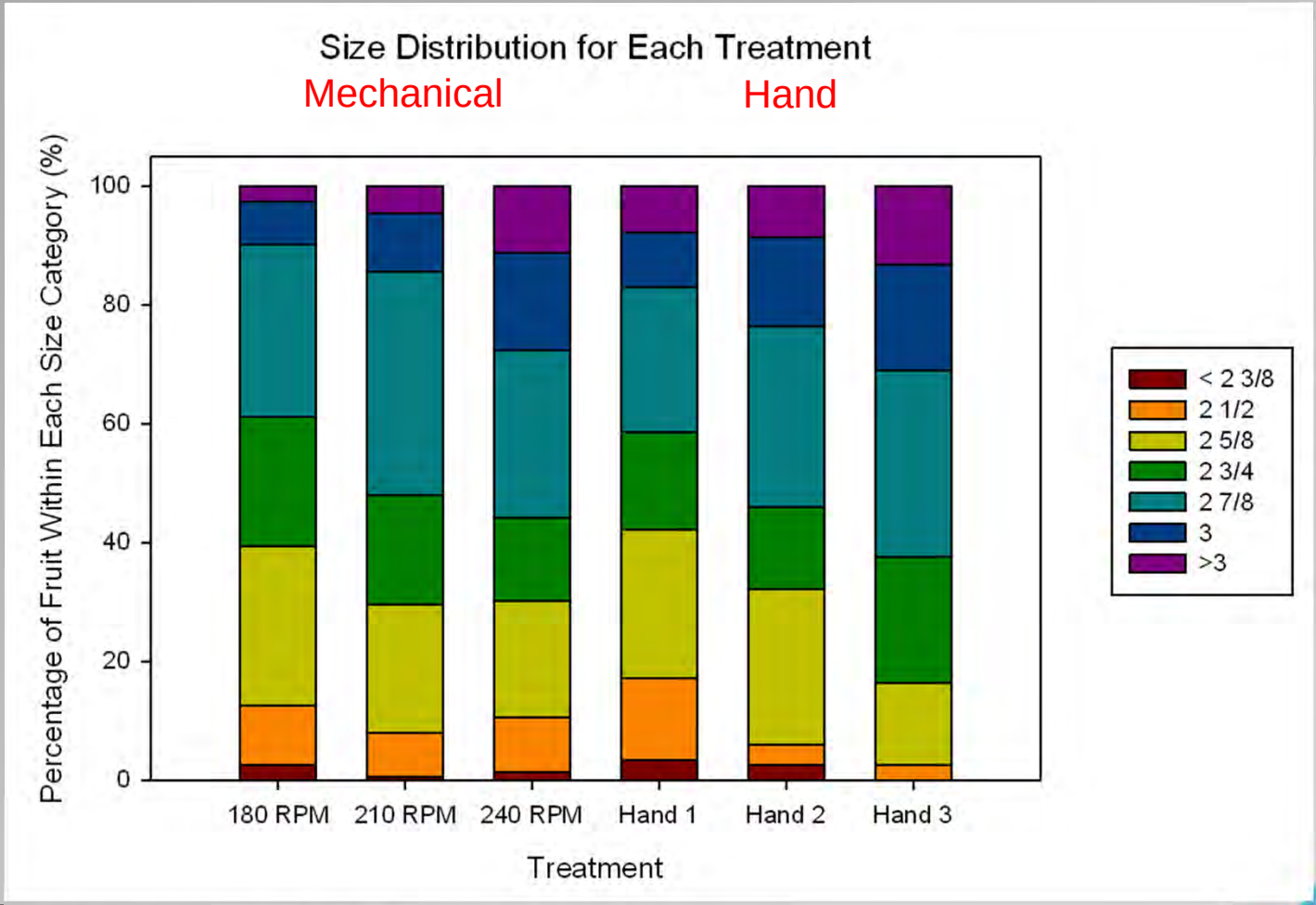
Treatment	No. of fruit per tree	Wt. of fruit per tree, kg	Avg. wt. of ind. fruit, g
180RPM	197 ab[x]	25.3 ab	128 b
210RPM	145 abc	20.3 abc	141 ab
240RPM	91 c	13.3 c	145 ab
Hand1	220 a	28.1 a	131 ab
Hand2	190 ab	24.9 ab	135 ab
Hand3	107 bc	16.1 bc	150 a
Trt effect	**	**	*
Estimates			
Mechanical vs. Hand	NS	NS	NS

[x]Means with the same letter are not significantly different at $P = 0.05$ (Tukey's). Non-significant effects or comparisons are indicated by NS.

Grading


Size Distribution for Each Treatment
Percentage of Fruit Within Each Size Category (%)
100
80
60
40
20
0
180 RPM
Hand 1
210 RPM
Hand 2
240 RPM
Hand 3
Treatment
< 2 3/8
2 1/2
2 5/8
2 3/4
2 7/8
3
> 3

Grading


Size Distribution for Each Treatment
Mechanical
Hand
Percentage of Fruit Within Each Size Category (%)
100
80
60
40
20
0
180 RPM
210 RPM
240 RPM
Hand 1
Hand 2
Hand 3
Treatment
< 2 3/8
2 1/2
2 5/8
2 3/4
2 7/8
3
>3

Harvest Quality

Table 4. The effect of thinning treatment on harvest quality parameters of Allstar peaches on Bailey rootstock in Virgil, Ontario, Canada 2010.

Treatment	Pressure, kg	Brix, %
180RPM	3.32 a[x]	10.0 a
210RPM	3.51 a	9.8 a
240RPM	3.04 a	9.7 a
Hand1	3.71 a	9.8 a
Hand2	3.48 a	9.4 a
Hand3	3.65 a	9.9 a
Trt effect	NS	NS
Estimates		
Mechanical vs. Hand	NS	NS

[x]Means with the same letter are not significantly different at *P* = 0.05 (Tukey's). Non-significant effects or comparisons are indicated by NS.

Peach 2010 Summary

- No significant difference between mechanical and hand treatments for blossom removal or fruit set
- Hand thinning decreased no. of fruit removed, decreased the weight of fruit removed, and decreased time spent thinning at ‘June Drop’
- For both mechanical and hand treatments, lower magnitudes had more fruit per tree at harvest. The same was seen for fruit weight per tree. Hand3 treatment produced largest fruit (150g)
- More large fruit observed with increasing magnitude of thinning (grading)
- Firmness and sugar content unaffected by treatment

Where to go from here…

- Repeat trial
- Areas of interest:
  - Return bloom
  - Look at quality for each picking date
  - Other cultivars?

Future Research and Challenges

- Tree architecture (tall spindles, hedge row systems) will need to be adjusted to make best use of this technology
- Negative effects of leaf injury not fully understood
  - Since leaves are not typically out at bloom, less of a concern on peach than other tree fruit
- MT requires earlier pruning
  - Start with earlier ripening cultivars
  - Prune on warm, dry days to avoid spread of peach canker (*Leucostoma cincta* and &. *L. persoonii)*
- MT is strategy to be used in conjunction with hand thinning
- Potential for use on other stone fruit

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