2018 Thinning Experiments with Metamitron

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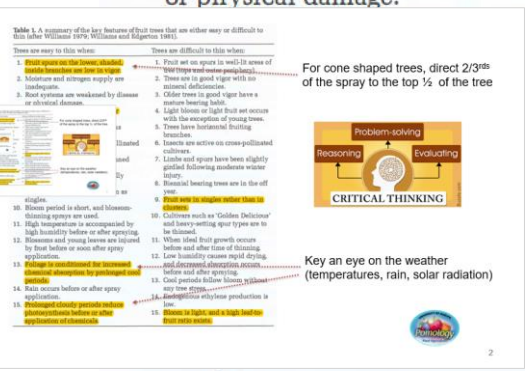
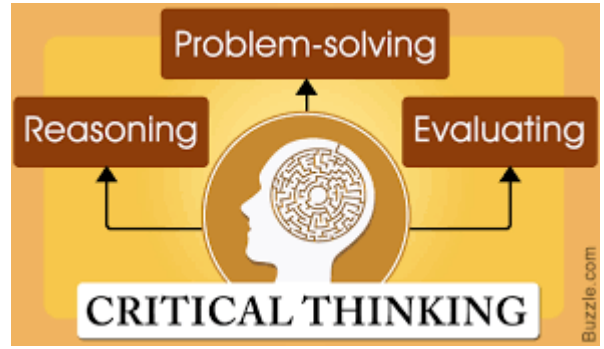
Table 1. A summary of the key features of fruit trees that are either easy or difficult to thin (after Williams 1979; Williams and Edgerton 1981).

Trees are easy to thin when:	Trees are difficult to thin when:
1. Fruit spurs on the lower, shaded, inside branches are low in vigor.	1. Fruit set on spurs in well-lit areas of tree (tops and outer periphery).
2. Moisture and nitrogen supply are inadequate.	2. Trees are in good vigor with no mineral deficiencies.
3. Root systems are weakened by disease or physical damage.	3. Older trees in good vigor have a mature bearing habit.
	4. Light bloom or light fruit set occurs with the exception of young trees.
	5. Trees have horizontal fruiting branches.
	6. Insects are active on cross-pollinated cultivars.
	7. Limbs and spurs have been slightly girdled following moderate winter injury.
	8. Biennial bearing trees are in the off year.
singles.	9. Fruit sets in singles rather than in clusters.
10. Bloom period is short, and blossom-thinning sprays are used.	10. Cultivars such as 'Golden Delicious' and heavy-setting spur types are to be thinned.
11. High temperature is accompanied by high humidity before or after spraying.	11. When ideal fruit growth occurs before and after time of thinning.
12. Blossoms and young leaves are injured by frost before or soon after spray application.	12. Low humidity causes rapid drying, and decreased absorption occurs before and after spraying.
13. Foliage is conditioned for increased chemical absorption by prolonged cool periods.	13. Cool periods follow bloom without any tree stress.
14. Rain occurs before or after spray application.	14. Endogenous ethylene production is low.
15. Prolonged cloudy periods reduce photosynthesis before or after application of chemicals.	15. Bloom is light, and a high leaf-to-fruit ratio exists.



For cone shaped trees, direct 2/3rds of the spray to the top ½ of the tree



Key an eye on the weather (temperatures, rain, solar radiation)

Optimizing crop value

The number of fruit that remain on the tree directly affects:

- yield
- fruit size
- Fruit quality
- Return bloom

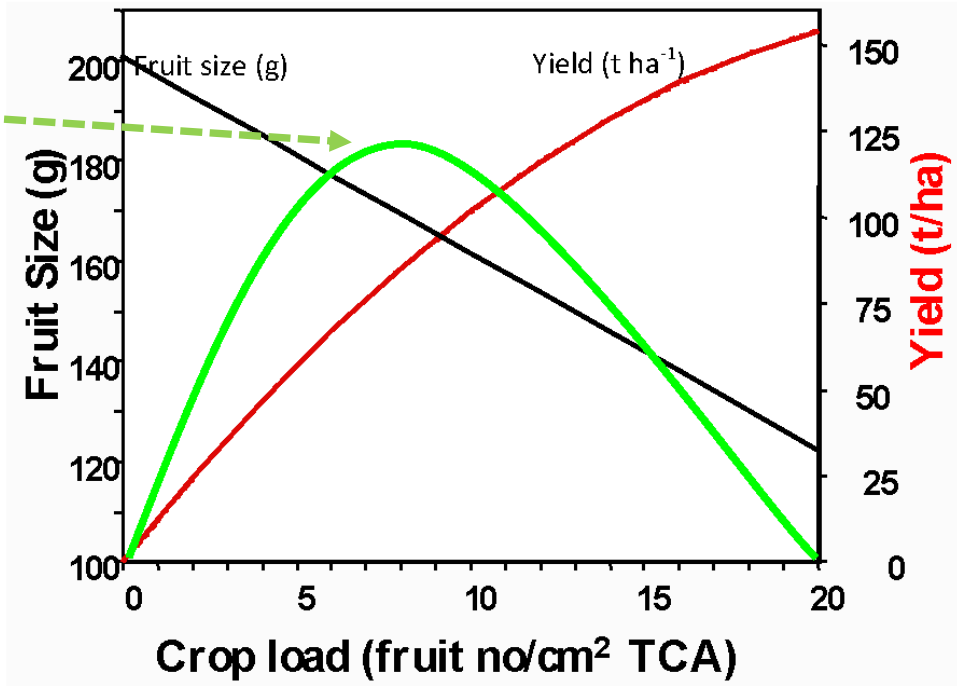
Crop Value

Calculations of crop value at various crop load levels have shown that at very high crop loads, yield is very high but fruit size and crop value are low (Robinson, 2013)

When crop load is reduced to more moderate levels through thinning, then crop value rises dramatically even though yield is lower because fruit size is larger and has greater value.

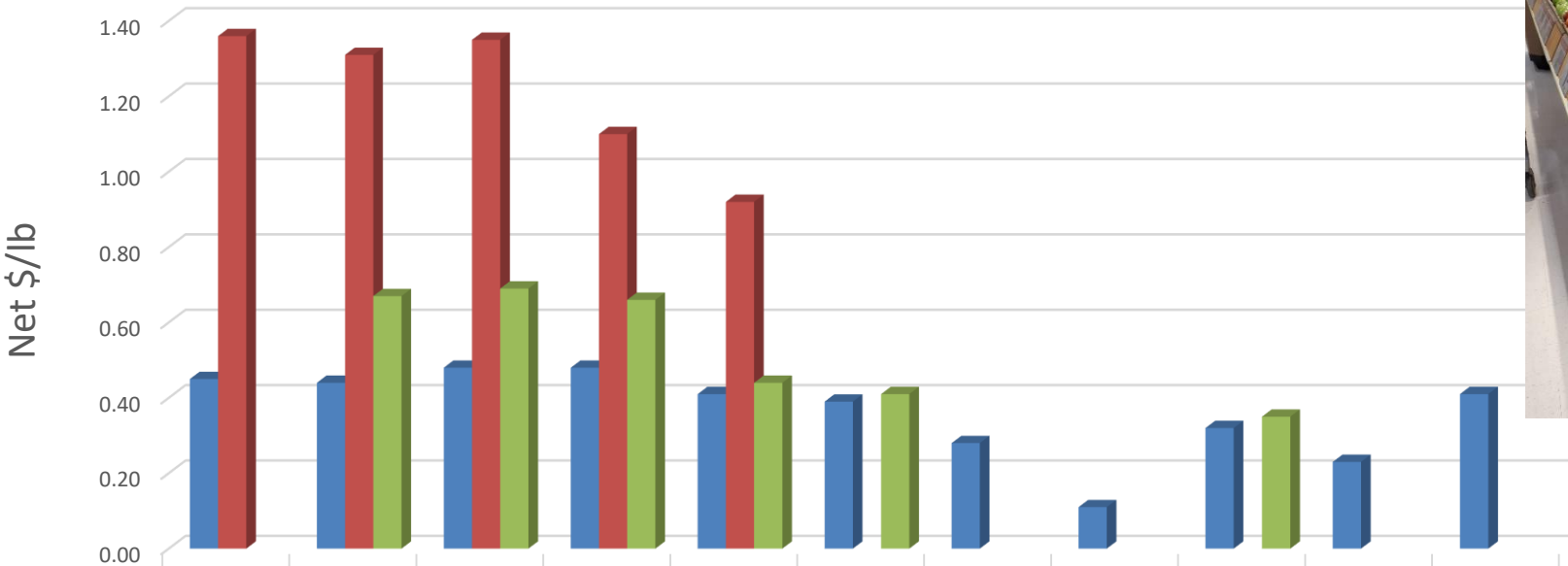
At some point crop value peaks when yield and fruit size are balanced and then with further reductions in crop load, crop value declines due to the lower yield not being fully compensated by larger fruit size

Managing crop load is a balancing act between reducing crop load (yield) sufficiently to achieve optimum fruit size and adequate return bloom without reducing yield excessively (Robinson et al., 2014).



Robinson et al. 2016

Net returns are required to determine target fruit size



	64 Box	72 Box	80 Box	88 Box	100 Box	113 Box	163 Box	198 Count	12 x 3lb Bags	8 lb bag	10 lb bag
Gala	0.45	0.44	0.48	0.48	0.41	0.39	0.28	0.11	0.32	0.23	0.41
Honeycrisp	1.36	1.31	1.35	1.1	0.92						
Ambrosia		0.67	0.69	0.66	0.44	0.41			0.35		

Example of $/lb in relation to fruit size

Target fruit size calculator

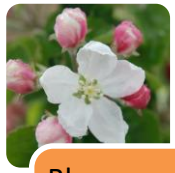
	Imperial		Metric	
Target Yield	1000	bu/acre	51.8	t/ha
Bins	50	bins/acre	124	bins/ha
Row Spacing	13.13	ft	4.00	m
Tree Spacing	4.1	ft	1.25	m

Density	809	trees/acre	2000	trees/ha
Yield	1.24	bu/tree	1.24	bu/tree
Yield	52	lbs/tree	23.6	kg/tree

	Minimum Diameter		**Target**	
Count Size	**(in)**	**(mm)**	**Fruit per Tree**	
196	2¼	57.0	242	Cee grade
175	2⅜	60.0	216	Cee grade
163	2½	64.0	201	
150	2⅝	67.0	185	
138	2¾	70.0	170	
125	2⅞	73.0	154	
113	3	76.0	140	
100	3⅛	79.0	124	
88	3¼	83.0	109	
80	3⅜	84.5	99	
72	3½	89.0	89	
64	3⅝	92.0	79	
56	3¾	95.0	69	
48	3⅞	98.0	59	

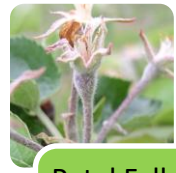
Precision thinning

Pruning



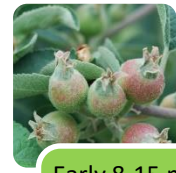
Blossom thinning

- Lime sulphur
- ATS
- String thinner



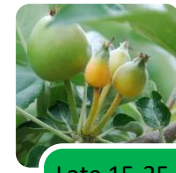
Petal Fall (5 mm ø

- NAA



Early 8-15 mm ø diameter

- 6-BA
- Carbaryl
- NAA
- (1-ACC)
- (Metamitron)



Late 15-25 mm fruitlet diameter

- (1-ACC)
- (Metamitron)
- (Ethephon)

Last Resort - Hand thinning

Target Fruit size

Metamitron (Brevis®)

- Brevis® contain 15% metamitron (w/w) and is formulated as a soluble granule
- Metamitron is a herbicide used on sugar beets
- first registered in Europe for thinning apples.
- metamitron is photosynthetic inhibitor (PSII) that temporarily (7-10d) reduces carbohydrate supply to developing fruitlets, trigging earlier and enhanced fruit abscission.
- Thinning levels are concentration-dependent and can be enhanced under specific conditions.
- Research has been conducted for two years the University of Guelph, Simcoe to evaluate its efficacy under our growing conditions and cultivars.

Photosynthetic Inhibition by Shading and Herbicides ~ 30+ year-old idea

J. Amer. Soc. Hort. Sci. 115(1):14-19. 1990.

Apple Thinning by Photosynthetic Inhibition

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Additional index words. terbacil, *Malus domestics*, herbicides, shading, photosynthesis

Abstract. **Shading (92%) of 'Redchief Delicious' apple (*Malus domestics* Borkh.) trees for 10-day periods from 10 to 20, 15 to 25, 20 to 30, and 25 to 35 days after full bloom (DAFB) caused greater fruit abscission than shading from 5 to 15, 30 to 40, 35 to 45, or 47 to 57 DAFB. Fruit 8 to 33 mm in diameter (10 to 30 DAFB) were very sensitive to 10 days of shade, even though fruit sizes of 6 to 12 mm are considered the most sensitive to chemical thinners. In a second test, shading for 3 days caused fruit thinning; 5 days of shade in the periods 18 to 23, 23 to 28, and 28 to 33 DAFB caused greater thinning than 11 to 16 or 33 to 38 DAFB. Shading reduced photosynthesis (Pn) to about one-third that of noncovered trees. Terbacil (50 mg·liter^{-1}) + X-77 surfactant (1250 mg·liter^{-1}) applied with a hand-pump sprayer 5, 10, or 15 DAFB greatly reduced fruit set and caused some leaf yellowing, particularly in the earliest treatments. Terbacil reduced Pn by more than 90% at 72 hours after application. Shoot growth of trees defruited by shade or terbacil was equivalent to defruited or deblossomed trees; ethephon (1500 mg·liter^{-1}) inhibited tree growth and defruited trees. No terbacil residues were dectected in fruit at harvest from applications made 5, 15, 20, 25, or 30 DAFB. Eleven of 12 photosynthesis-inhibiting herbicides were also found to thin 'Redchief Delicious' apple trees. Shading caused more thinning than terbacil at the later applications, which may reflect poorer absorption and/or lesser photosynthetic inhibition than when terbacil was applied to older leaves.**

Research Objectives

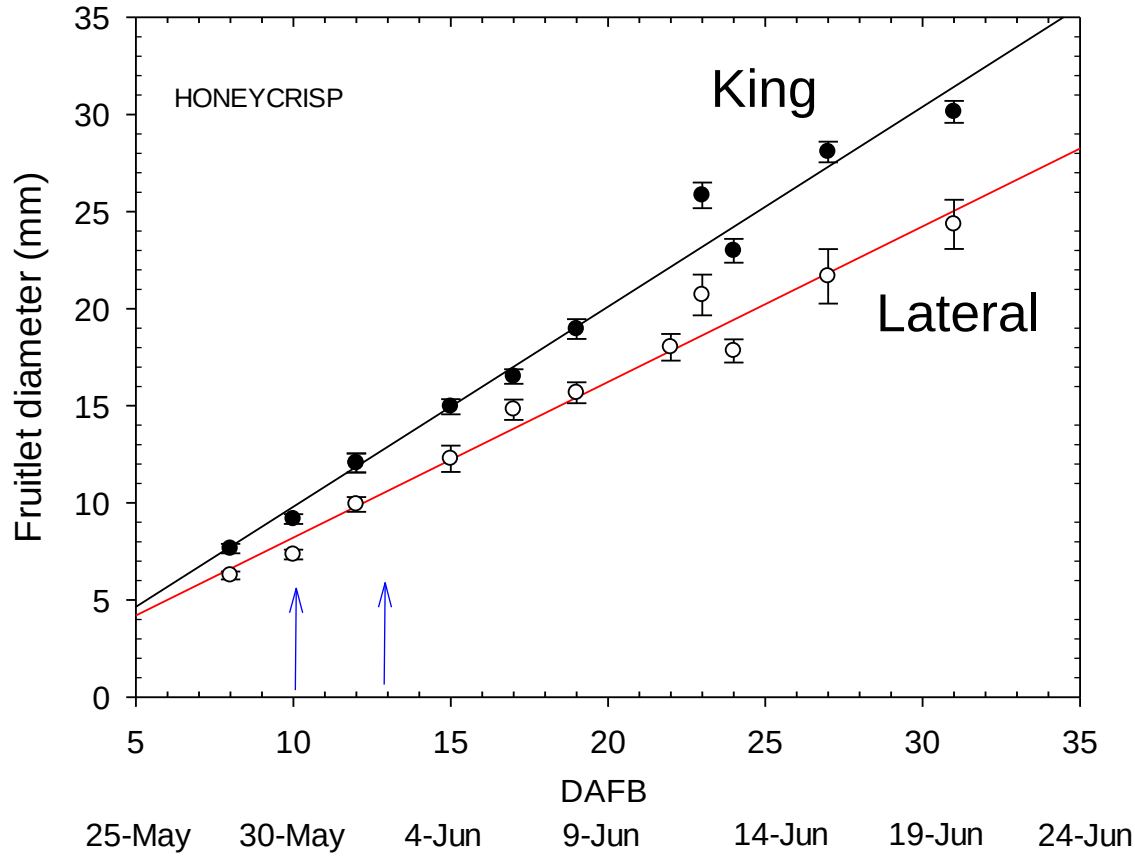
The purpose of this study was to determine the efficacy of metamitron applied at different rates and timings on the fruitlet thinning of ‘Gala’ and ‘Honeycrisp” apples

Honeycrisp treatments

- A random complete block (RCBD) , 7 replications
- Nine treatments, single tree plots
- 11-yr-old 'Honeycrisp'/M.26 EMLA rootstock spacing of 1.25 m x 4.0 m (2,083 trees ha^{-1}) was used
- Treatments 3 -5 were applied on the morning of 30-May (9 mm King fruitlet)
- Treatments 6-9 were applied on the morning of 2-Jun (13 mm King fruitlet)
- Full bloom: 20 May 2018

1) untreated control
2) hand-thinned control (single cluster, space ~10 cm apart)
3) 1500 mg/L Carbaryl (Sevin XLR+)
4) 10 mg/L 1-naphthaleneacetic (NAA) acid (Fruitone L)
5) 1500 mg/L carbaryl tanked mixed with 10 mg/L NAA
6) 165 mg/L (1.1 L/ha) metamitron (Brevis 46701, Adama Canada)
7) 247.5 mg/L (1.65 L/ha) metamitron
8) 330 mg/L (2.2 L/ha) metamitron
9) 412.5 mg/L (2.75 L/ha) metamitron.

Timing of Honeycrisp treatments

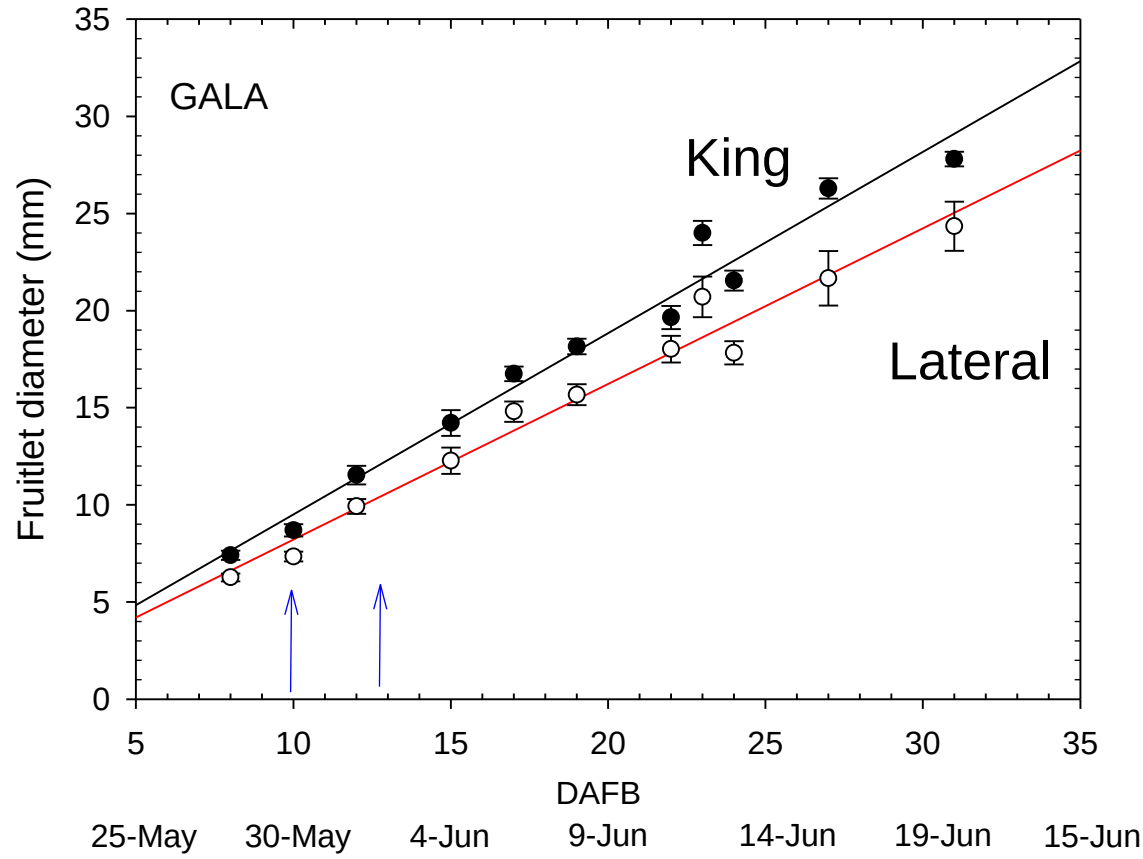


Gala treatments

- A random complete block (RCBD) , 7 replications
- Eight treatments, single tree plots
- 17-yr-old 'Gala'/Bud.9 spacing of 2.5 m x 4.5 m (889 trees ha^{-1})
- Treatments 3-5 were applied on the morning of 30-May (8.7 mm King fruitlet)
- Treatments 6-9 were applied on the morning of 2-Jun (~12 mm King fruitlet)
- Full bloom: 20 May 2018

1) untreated control
2) hand-thinned control (single cluster, space ~10 cm apart)
3) 1500 mg/L Carbaryl tank mixed with 75 mg/L 6-BA
4) 165 mg/L (1.1 L/ha) metamitron (Brevis 46701, Adama Canada)
5) 247.5 mg/L (1.65 L/ha)metamitron
6) 330 mg/L (2.2 L/ha) metamitron
7) 412.5 mg/L (2.75 L/ha) metamitron
8) 480 mg/L (3.2 L/ha) metamitron

Timing of Gala treatments



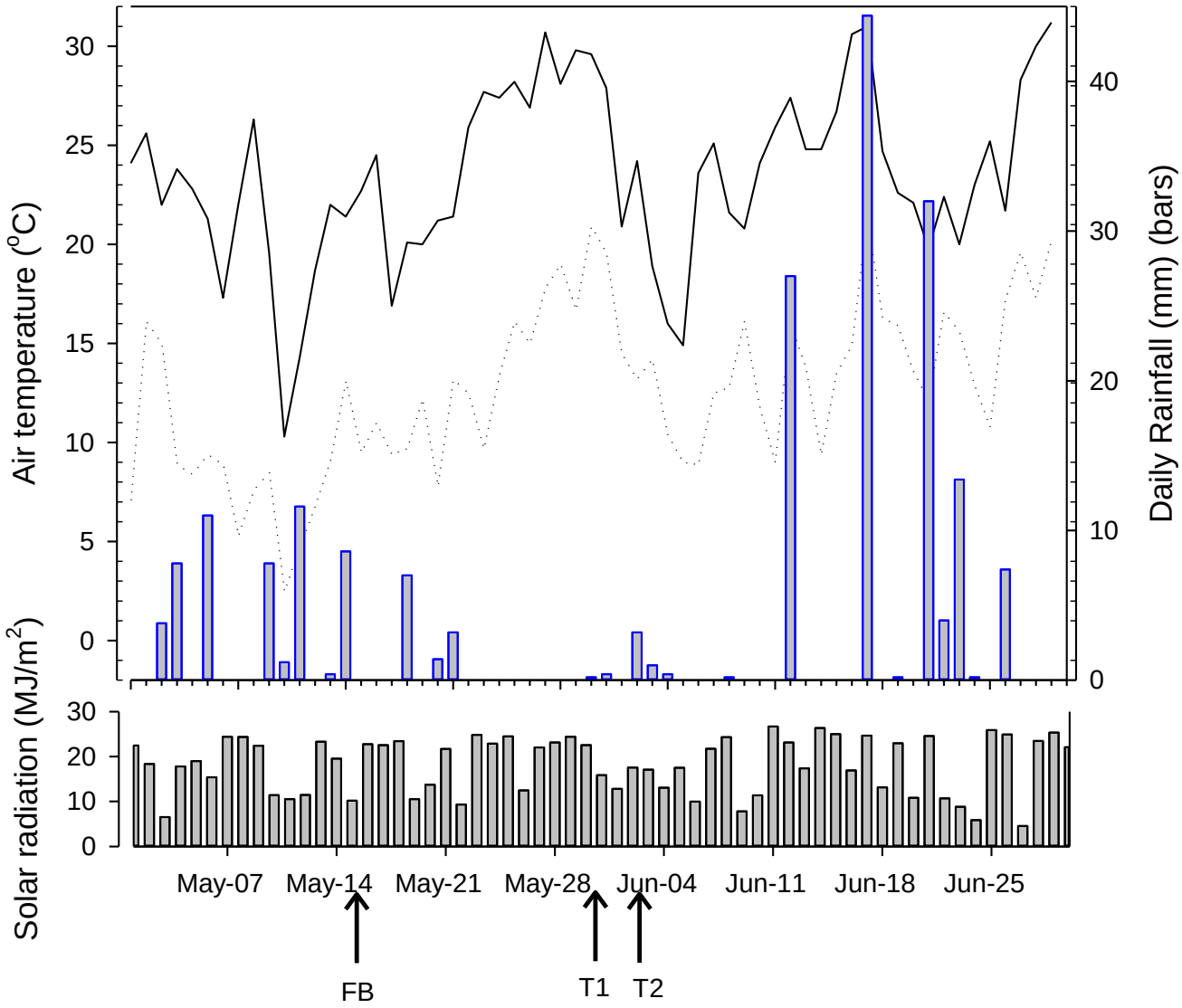
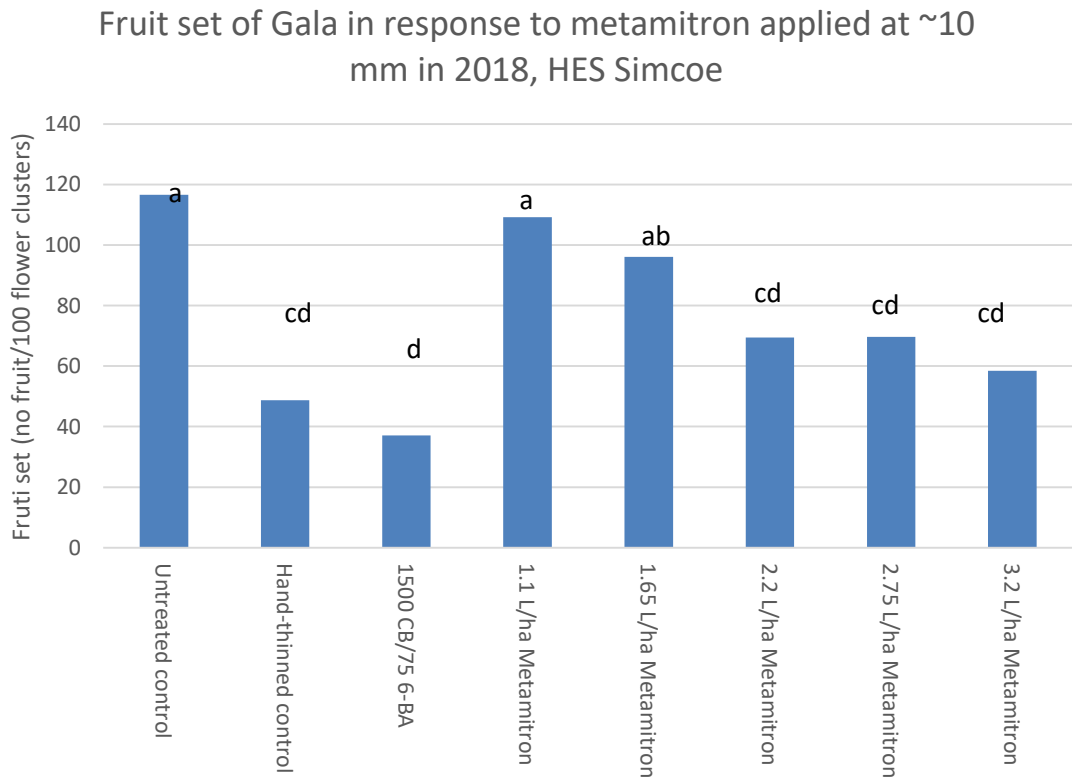


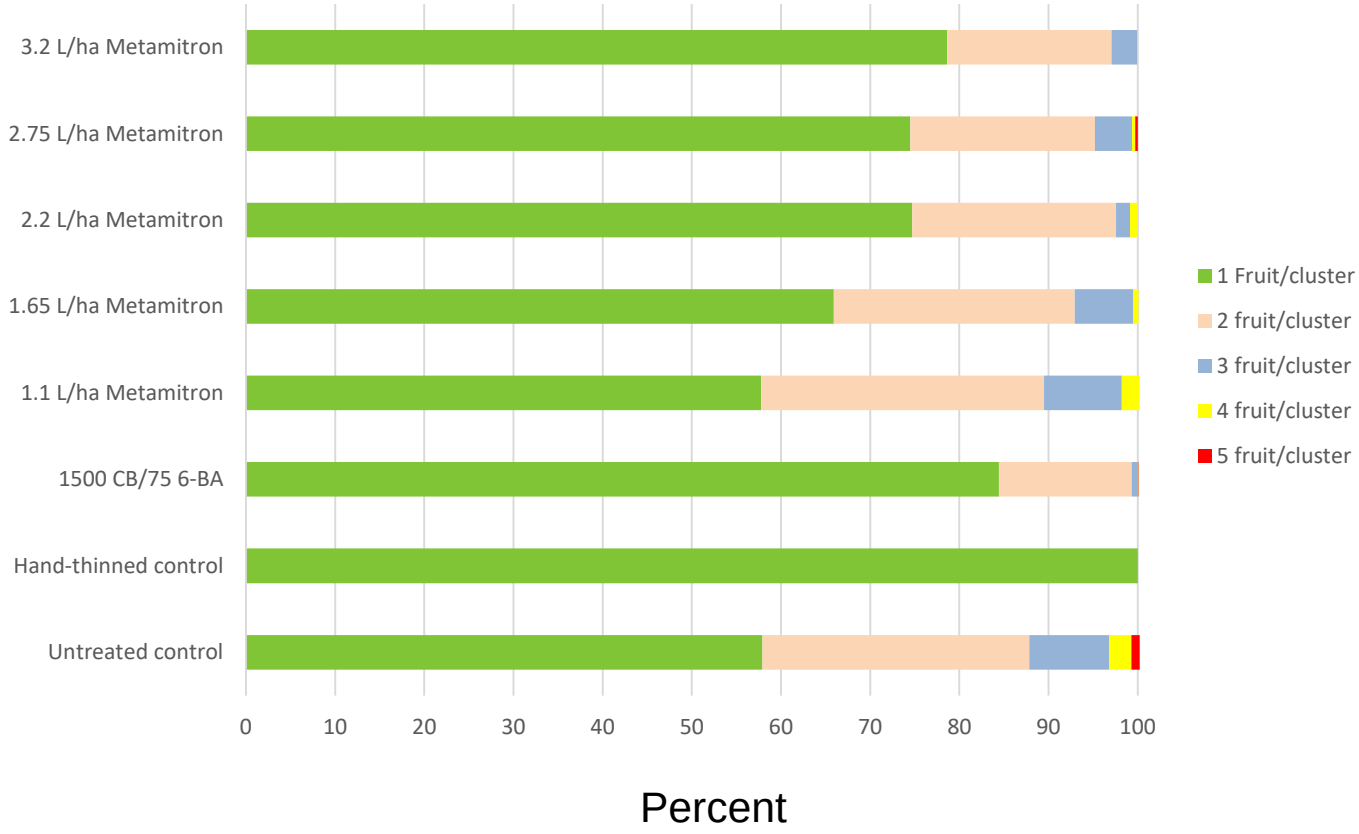
Figure 1. 2018 minimum and maximum air temperature, precipitation and solar radiation at the University of Guelph, Simcoe (1 May - 30 June). Arrows indicate the dates of full bloom (FB) and application of treatments (T1, T2).

Gala – fruit set



- The untreated control had the greatest fruit set while trees treated with the tank mix of 1500 mg/L carbaryl and 75 mg/L 6-BA and 3.2 L/ha Metamitron had the lowest fruit set.
- Trees that were left un-thinned and treated with 1.1 and 1.65 L/ha metamitron had fruit set values less than the hand-thinned control
- Trees treated with 2.2 L/ha metramitron or greater, had fruit set values similar to the hand thinned controls.
- Fruit set decreased in an inverse linear relationship ($P<0.001$) with metamitron concentration.

Gala - fruit clustering



Gala - yield parameters

Table 2. Influence of various rates and combinations of metamitron, carbaryl (CB), and naphthaleneacetic acid (NAA) on harvest parameters in 2018 of 'Gala'/M.26 apple trees planted in 2002.

Treatment	Total fruit yield (kg/tree)		Field graded marketable yield (kg/tree)		Total number of fruit (no/tree)		Mean weight of marketable fruit (g)		Adjusted mean weight of marketable fruit (g)		Crop load fall 2018 (no/TCSA[x])[y]	
Untreated control	57.0	a	32.0	a	394	a	152.5	c	154	bc	2.8	ab
Hand-thinned control	33.6	cd	23.8	b	200	de	174.5	a	174	a	1.3	d
1500 CB/75 6-BA	23.3	d	15.0	c	140	e	171.5	ab	170	ab	1.3	d
1.1 L/ha Metamitron	49.7	ab	25.8	ab	332	ab	159.0	bc	160	abc	2.9	a
1.65 L/ha Metamitron	42.2	bc	20.5	bc	302	bc	149.8	c	150	c	2.4	abc
2.2 L/ha Metamitron	42.5	bc	26.6	ab	282	bcd	154.4	c	155	bc	2.1	abcd
2.75 L/ha Metamitron	33.5	cd	19.8	bc	210	de	162.5	abc	162	abc	1.8	cd
3.2 L/ha Metamitron	34.3	cd	25.5	ab	219	cde	161.8	abc	161	abc	1.9	bcd
P value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Rate of Metamitron[z]	L***		L**Q**		L***		L***		L*		L***	

[w] Mean values with the same letter within a given column are not significantly different according to Tukey's HSD test at *P* =0.05.

[x] Trunk cross-sectional area.

[y] Determined by dividing the total number of fruit harvested with the TCSA measured in fall.

[z] ns, *, **, ***, indicates not significant, and significant differences at *P* =0.05, *P* =0.01, and *P* =0.001 respectively. L, Q, C refer to linear, quadratic, and cubic relationships

Thinning resulted in lower yield per tree

Metamitron:

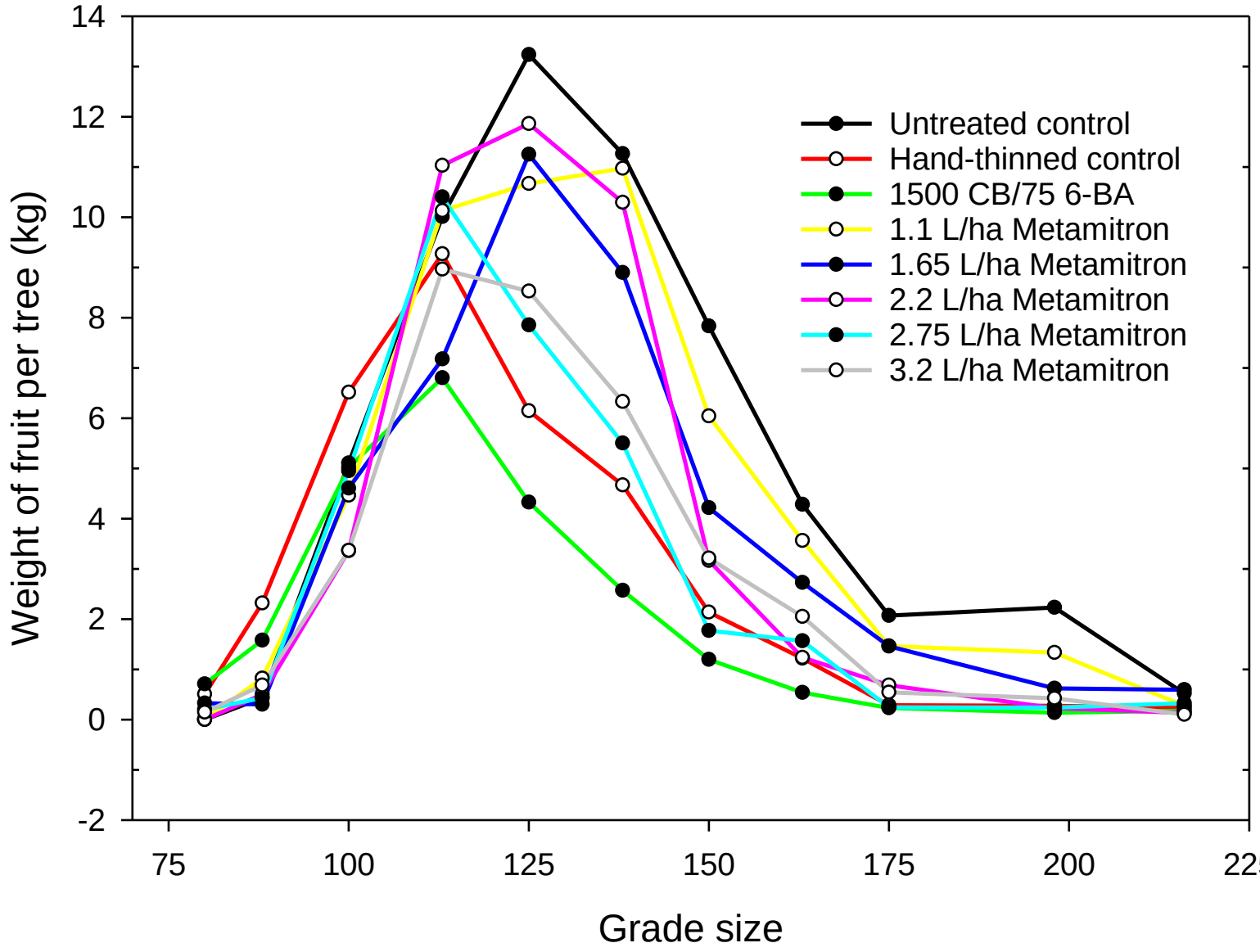
-reduced the number of fruit per tree

-increased fruit weight

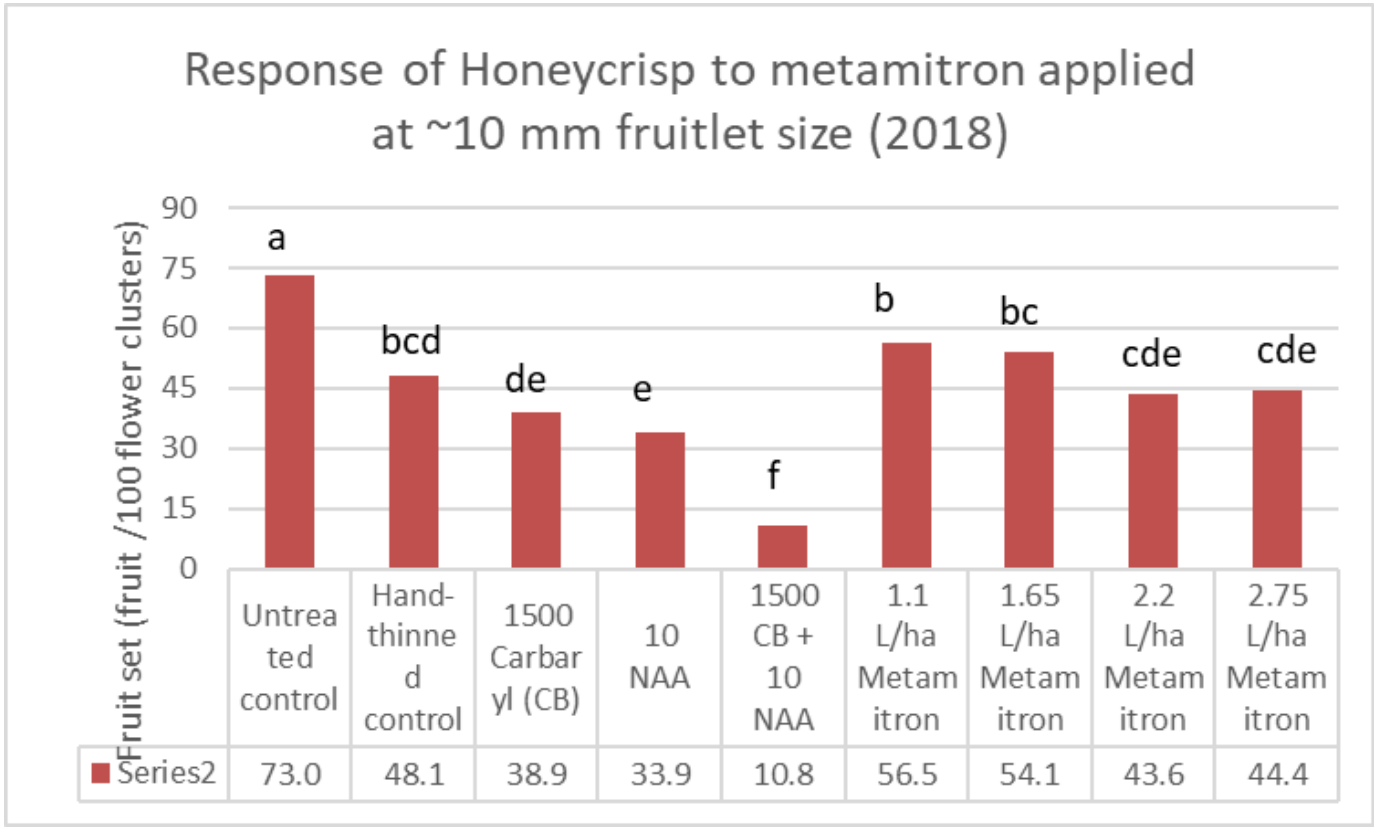
-reduced crop load

Metamitron responses were linear with increasing rates of metamitron

Gala – Grade Distribution



Honeycrisp – Fruit Set



The untreated control had the greatest fruit set while trees treated with the tank mix of 1500 mg/L carbaryl and10 mg/L NAA and 10 mg/L NAA alone had the lowest fruit set.

There were no thinning treatments that had fruit set values less than the hand-thinned control.

Trees treated with 1500 mg/l carbaryl, 1.1 to 2.75 L/ha metamitron, had fruit set values similar to the hand thinned controls.

Treatment effect on yield parameters

Table 6. Influence of various rates and combinations of metamitron, carbaryl (CB), and naphthaleneacetic acid (NAA) on harvest parameters in 2018 of 'Honeycrisp' M.26 apple trees planted in 2008.

Treatment (mg/L)	Total fruit yield (kg/tree)		Field graded marketable yield (kg/tree)		Total number of fruit (no/tree)		Mean weight of marketable fruit (g)		Adjusted mean weight of marketable fruit (g)		Crop load fall 2018 (no/TCSA)[b]	
Untreated control	26.4	a[a]	14.0	abc	130	a	212	d	227	bc	4.8	a
Hand-thinned control	18.7	c	11.2	d	86	de	227	d	225	c	3.1	de
1500 CB	18.3	c	10.9	d	69	e	285	ab	278	a	2.8	de
10 NAA	19.0	c	13.0	abcd	76	e	268	bc	263	ab	2.5	e
1500 CB + 10 NAA	7.6	d	4.8	e	25	f	305	a	281	a	0.8	f
1.1 L/ha Metamitron	24.1	ab	11.9	cd	116	ab	214	d	223	c	4.5	ab
1.65 L/ha Metamitron	24.9	ab	14.6	ab	114	ab	236	d	244	abc	4.1	abc
2.2 L/ha Metamitron	21.3	bc	12.8	bcd	94	cd	240	cd	242	bc	3.3	cde
2.75 L/ha Metamitron	24.6	ab	15.3	a	108	bc	241	cd	247	abc	3.6	bcd
P value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
Rate of Metamitron[c]	L**		Q*		L***,Q*		L***		L*		L***,Q*	

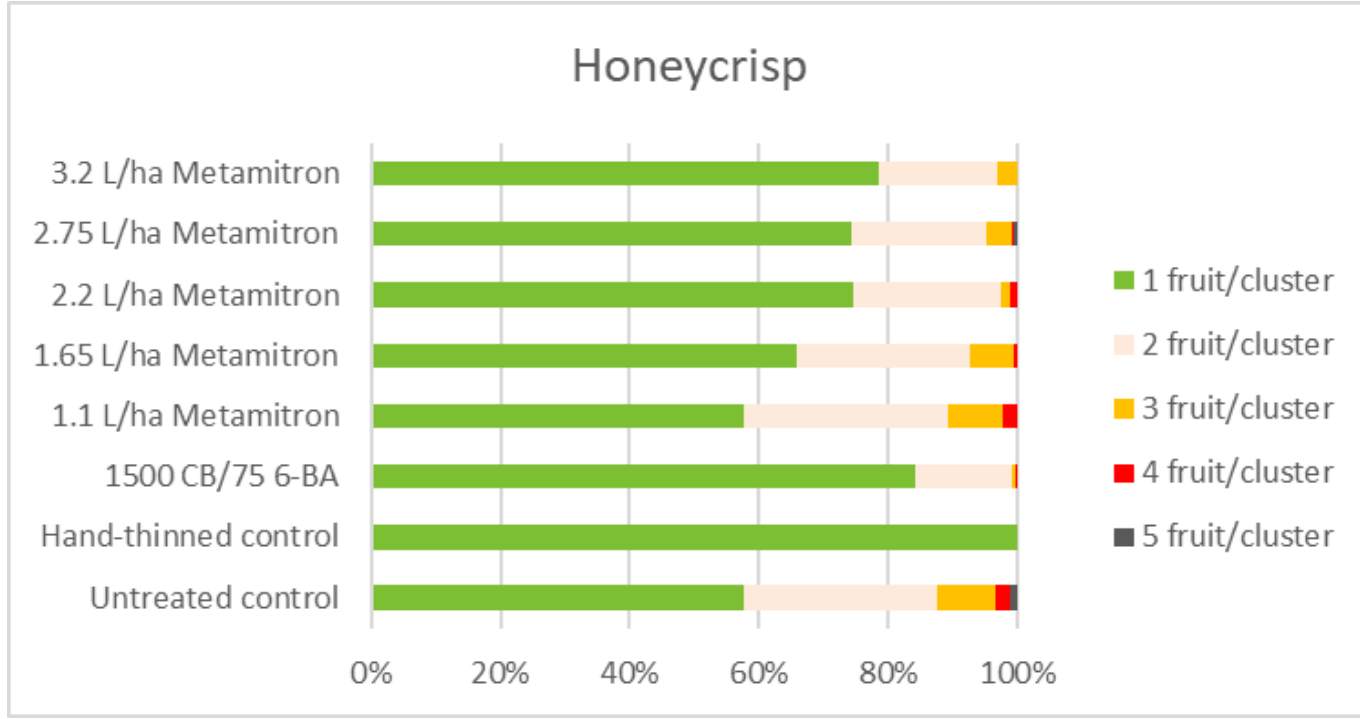
[a] Mean values with the same letter within a given column are not significantly different according to Tukey's HSD test at *P* =0.05.

[b] Trunk cross-sectional area. Crop load determined by dividing the total numbe rof fruit harvested by the TCSA measured

[y] Determined by dividing the total number of fruit harvested with the TCSA measured

[c] ns, *, **, ***, indicates not significant, and significant differences at *P* =0.05, *P* =0.01, and *P* =0.001 respectively.

Treatment effect on fruit clustering



Summary

- There was no marked leaf or fruit phytotoxicity or leaf drop detected from any of the metamitron spray treatments
- 2.75 L/ha metamitron (Brevis) was required to thin Gala to an equivalent level of hand thinning
- 2.2 to 2.75 L/ha metamitron (Brevis) was required to reduced fruit set of Honeycrisp to an adequate level
- The response to metamitron was generally linear with increasing rates
- Our data suggest the response may vary from year to year, as with other thinners currently on the market

Acknowledgements

Cathy Baker and Amanda Gunter, Research Technicians

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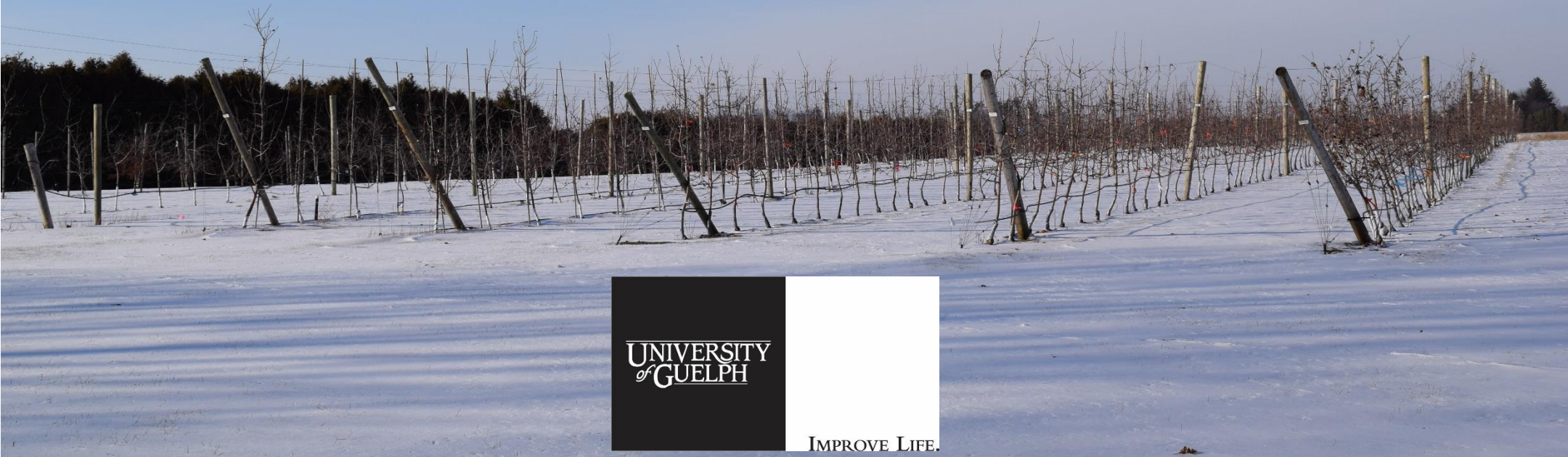
Adama Canada



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