FINAL PROJECT REPORT
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Project Title: Sweet cherry source-sink relations
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Budget History:

Item	**Year 1:** 2004	**Year 2:** 2005	**Year 3:** 2006
Salaries	6199	6301	6553
Benefits	1736	1953	2031
Wages	13000	13000	9000
Benefits	2080	2080	1440
Equipment			
Supplies	3000	3000	3000
Travel	3000	3000	3500
Miscellaneous			
Total	29015	29334	25524

OBJECTIVES:

1. To develop and evaluate practical strategies for manipulating sweet cherry crop load and maximizing fruit quality.

2. To investigate whole-tree source-sink relations.

3. Investigate the effects of postharvest defoliation on whole-tree physiology and fruit yield and quality.

SIGNIFICANT FINDINGS:

- high quality fruit can be grown on dwarfing, precocious rootstocks with prudent crop load management
- chemical blossom thinners fish oil + lime sulphur (FOLS) and ammonium thiosulphate (ATS) show greatest potential as bloom thinning agents
- chemical blossom thinners vary in their mode of action and efficacy
- ATS and FOLS are most effective applied to flowers whereas tergitol was more effective applied to leaves
- VOE is not an effective bloom thinning agent
- fruit set assessments should not be conducted before late May
- there is a need to develop an effective post-bloom thinning program for sweet cherry
- the optimum timing of post-bloom thinning appears to be between 2 and 4 weeks after full bloom
- FOLS shows efficacy as a post-bloom thinning agent at 14 days past full bloom
- tergitol is not recommended for post-bloom thinning
- Applied to 'Bing', GA_3 is more inhibiting to flower bud induction than GA_{4+7}
- 'Bing' yield in the season subsequent to GA_3 application was related negatively and closely to $[GA_3]$
- GA_3 and GA_7 between 25 and 100 ppm had no impact on 'Rainier' fruit weight or soluble solids in the season of application
- On 'Rainier', GA_3 increased firmness, proportional to rate, whereas GA_7 did not affect firmness
- Both GA_3 and GA_7 reduced 'Rainier' red coloration and delayed fruit maturation compared to untreated
- gibberellic acid may be an effective crop load management tool for productive orchard systems
- Compared to unpruned trees, summer pruning reduced, by half, whole-canopy NCER
- Summer pruning improved intra-canopy light distribution but had no effect on fruit yield or quality

METHODS:

Objective 1

Chemical blossom thinning. The efficacy of several blossom thinning agents will be evaluated in multiple locations throughout the PNW. Treatments will be applied in the Yakima valley and Wenatchee region as well as in Hood River/The Dalles. Ammonium thiosulphate (ATS), fish oil + lime sulphur (FO+LS), vegetable oil emulsion (VOE), and tergitol will be applied to entire trees at different rates and timings. Treatments will be applied to heavily cropping Bing and Lapins trees on Gisela 5 at the Roza experimental farm as well as other heavily-cropped trees in grower cooperator

orchards. Treatments will be compared for their effect upon floral bud induction (both number of reproductive buds per spur/shoot and floral meristems per bud), fruit set, spur and branch F:LA, and fruit yield and quality. In addition, the tree's physiological response to thinners will be documented by measuring spur leaf gas exchange prior to, and following application, and leaf and shoot expansion rates.
Thinner phytotoxicity will also be evaluated during the winter on trees grown in a greenhouse. Entire potted trees will be sprayed with a wide range of concentrations (0, 1, 2, 4, 8%) of each thinner. Individual leaves will be monitored for rate of expansion, gas exchange, and chlorophyll content (prior to and following treatment).

GA to inhibit floral bud induction. Trees will be treated with GA at various concentrations (0, 30, 50, and 100 mg a.i./liter) and two stages of flower bud initiation (roughly equivalent to beginning of stage II and III of existing crop). Treatments will be compared for their effect upon fruit quality during the season of application, floral bud induction (both number of reproductive buds per spur/shoot and floral meristems per bud), return bloom density, spur and branch F:LA, and fruit yield and quality. Initial treatments were applied during summer 2003 and consisted of: 1) Control (no treatment), 2) GA_3 30 mg a.i./liter (standard program), 3) GA_3 50 mg a.i./liter, and 4) GA_3 100 mg a.i./liter. Treatments 3 and 4 were applied as single applications at either the beginning of stage II or stage II, or a double application receiving treatment on both dates.

Objective 2
Potential periods of limiting carbohydrate supply will be investigated by establishing a range of F:LA by thinning fruit buds within Bing trees on Gisela 5, Gisela 6, and Mazzard rootstocks. For each scion/rootstock combination, fruit and shoot growth rates will be monitored weekly and canopy and spur F:LA will be determined at harvest.

Newly released cultivars (*e.g*., Chelan, Tieton, Benton, Selah) and advanced selections (*e.g*., PC 8011-3, PC 7903-2, PC 7147-9) from the WSU sweet cherry breeding program planted in 1998 will be subjected to one of two crop load treatments: (1) unthinned control, and (2) 50% removal of blossoms by hand. Tree growth, fruit yield and quality (weight, row-size distribution, soluble solids, and firmness) will be evaluated for each scion grown on Gisela 6, Gisela 5, Gisela 195/20, and Edabriz, where possible.
Objective 3
Summer pruning. The impact of summer pruning on canopy gas exchange, light distribution, growth, and fruit yield and quality in the subsequent season will be studied. Comparisons will be made between trees subjected to summer pruning (not dormant pruned) and dormant pruned control trees. Prior to pruning, canopy LA and light distribution will be measured for each tree. The LA removed from pruning will be collected and measured. In addition, for both treatments, pruned wood will be dried to a constant weight and weighed. Light distribution throughout pruned canopies will be assessed by ceptometer following pruning. In addition, rates of single leaf and whole-canopy gas exchange will be assessed prior to, and following summer pruning. In the dormant season, wood samples will be collected and analyzed for tissue carbon and nitrogen. In the subsequent spring, rates of vegetative growth (*e.g*., leaves and shoots) growth will be monitored weekly. Tree yield and fruit quality will be determined.

RESULTS AND DISCUSSION:
Blossom thinning
Prosser Roza Trials (11-yr-old 'Bing'/'Gisela6'; 4-yr-old 'Skeena'/'Gisela5')
In 2006, at the WSU-Roza research orchard, we conducted two separate thinning experiments. FOLS, ATS, and tergitol were tested as bloom thinning agents when applied at ca. 20% and 80% full bloom to 'Skeena'/'Gisela5' trees and 'Bing'/'Gisela6' trees. On 'Bing', FOLS and ATS were

effective thinners, reducing fruit set to ca. 59% vs. 76% from untreated trees (Table 1). Tergitol however did not reduce fruit set statistically. Fruit set was high overall at about 65% of available flowers. Fruit quality (i.e., weight, firmness, soluble solids, row-size) was not improved by tergitol or ATS, despite numerical reductions in fruit set. Indeed, quality of unthinned control was good (7.7 g, 268 g/mm, 65% 10.5-row and larger) even at a high yield of 29.5 kg/tree (66 lbs), or approximately 10 tons/acre. Only FOLS improved fruit quality. Average fruit weight was ca. 1.1 g higher and FOLS-treated trees yielded about 24% more 10.5-row and larger, on a percentage basis, than control trees (data not shown). However, yield was reduced by FOLS by 10.8 kg/tree and therefore unthinned control trees yielded the most high-quality fruit. Therefore, even a 20% reduction in fruit set can be excessive and have a negative impact on crop value.

Table 1. Effect of chemical blossom thinners applied to 11-year-old 'Bing'/'Gisela 6' trees at ca. 20% and 80% of full bloom on fruit set, yield, and quality. Means within column followed by same letter are not statistically different ($P < 0.05$).

Treatment	Fruit set (%)	Fruit weight (g)	Yield (kg)	Yield ≥10.5-row (kg)
Control	76.3 a	7.7 ab	29.5 a	20.1 a
FOLS	58.9 b	8.8 a	18.7 b	15.6 ab
Tergitol	64.1 ab	7.5 b	22.0 ab	14.0 ab
ATS	59.1 b	7.4 b	21.6 b	11.0 b

Applying the same program to 'Skeena' did not produce similar results. No product effectively reduced fruit set (Table 2). Similar to the 'Bing' trial, fruit set overall was high (ca. 75% of available flowers). Interestingly, we recorded average fruit weight from FOLS and tergitol-treated trees that was lower than the control. In addition, FOLS and tergitol treatments yielded about 30% less fruit that was 10.5-row and larger than the control trees. It appears that FOLS and tergitol delayed fruit maturity – our red color rating and soluble solids were lower in FOLS- and tergitol-treated trees compared to the control (data not shown). It is possible that fruit had not reached a maturity (i.e., size) similar to that of the control at the time of harvest. This is the first evidence of FOLS and tergitol having any negative impact on fruit maturity or quality, and our first trial on 'Skeena'. It is not known whether varieties respond differently to caustic chemical blossom thinners. We intend to repeat this trial in 2007 to further investigate this possibility. In contrast, and consistent with our previous research on 'Bing', ATS was effective at improving 'Skeena' fruit quality without reducing yield significantly. Fruit from ATS-treated trees were 15% heavier (ca. + 1 g/fruit) than control fruit. In addition, ATS-treated trees yielded 93% 10.5-row and larger vs. only 67% from control trees. At the density of the research orchard (580 trees/ac), this improvement in fruit quality translates into an additional 2 tons of 10.5-row and larger fruit per acre from ATS-treated trees vs. untreated.

Table 2. Effect of chemical blossom thinners applied to 4-year-old 'Skeena'/'Gisela 5' trees at ca. 20% and 80% of full bloom on fruit set, yield, and quality. Means within column followed by same letter are not statistically different ($P < 0.05$).

Treatment	Fruit set (%)	Fruit weight (g)	Yield (kg)	Yield ≥10.5-row (kg)
Control	81.1 a	7.5 ab	15.7 a	10.0 ab
FOLS	72.8 a	6.8 b	15.0 a	7.6 b
Tergitol	73.0 a	6.8 b	13.3 a	7.0 b
ATS	72.7 a	8.6 a	14.7 a	13.8 a

Regional thinning trials

In a 'Lapins'/'Gisela 5' thinning trial in Moxee, we found no thinning efficacy from any thinning treatment (FOLS, ATS, or tergitol). Fruit set in this orchard was particularly high at slightly less than 80% across treatments (data not shown). Fruit yield was high, mean across treatments was ca. 90

kg/tree. Quality also was good and unaffected by thinner. Approximately two-thirds of fruit were 10.5-row or larger, and less than 4% was smaller than 12-row. The poor thinning efficacy of the caustic blossom thinners ATS, FOLS, and tergitol on self-fertile varieties such as 'Lapins' and 'Skeena' suggests that these varieties may require more aggressive (i.e., more frequent applications or higher rates) thinning strategies.

In 2006 we also conducted a thinning trial in 'Rainier'. Fruit set was reduced significantly and similarly by each blossom thinner (Table 3). This result supports a previous 'Rainier' thinning trial in which our most promising results were achieved with FOLS, ATS, and tergitol – each reduced fruit set similarly (ca. 33%) and significantly vs. untreated control. At Doornink's orchard, overall, fruit set was about 39% lower in thinned trees. Yield was reduced to a similar extent, 45% lower in thinned trees. Fruit quality was not improved significantly, despite reductions in fruit set. Reductions in fruit set and yield per tree without any improvement in fruit quality is indicative of non-source limiting conditions in unthinned trees. Indeed, it appears that fruit in unthinned trees were not limited in their development by the supply of photoassimilates (96% 10.5-row or larger, 10.6 g). These results again underscore the need for a reliable post-bloom thinning program. Fruit set in untreated trees was low (< 28%) and thinning was not necessary (though this was not apparent during bloom).

Table 3. Effect of chemical blossom thinners applied to 'Rainier' trees at ca. 20% and 80% of full bloom on fruit set, yield, and quality. Means within column followed by same letter are not statistically different ($P < 0.05$).

Treatment	Fruit set (%)	Fruit weight (g)	Yield (kg)	Yield ≥10.5-row (kg)
Control	23.9 a	10.6 a	33.1 a	31.8 a
FOLS	14.0 b	10.3 a	20.0 b	19.3 b
Tergitol	13.3 b	10.1 a	13.4 b	13.2 b
ATS	16.1 b	11.0 a	21.8 b	21.6 b

In another 'Bing' trial we recorded significant reductions in fruit set with FOLS, ATS, and tergitol (data not shown). Similar to the 2006 'Rainier' trial, thinners were similarly effective at reducing set (24% lower than unthinned). Fruit set was high overall however, still greater than 60% in thinned trees. Therefore, due to heavily over-cropped trees, fruit quality was poor across treatments. Thinning did improve mean fruit weight, however, only ATS improved fruit quality significantly (ca. + 1g/fruit, + 1 % soluble solids).

The inconsistent response among thinners and years, and between varieties, underscores our poor understanding of the mode of action of blossom thinners and the factors limiting to fruit set and pollination. Future research should investigate more precisely thinner mode of action on self-sterile and self-fertile varieties. Too often we have elicited thinning at bloom to discover at harvest that over-thinning had occurred. This occurs when improvements in fruit quality of remaining fruit are not sufficient to overcome the reduction in yield. Our data support the need for the development of a reliable post-bloom thinning program for sweet cherry. Having the opportunity to assess fruit set, and therefore the need for thinning would be beneficial for optimizing crop load.

In the 2006 'Bing'/'Gisela6' trial at the Roza experimental farm, we attempted to better understand the thinning response by recording, on 4 spurs per tree, the percent of potential fruit (i.e., number of flowers per spur) actively growing (i.e., exhibiting increase in equatorial diameter measured weekly), the percent attached to the spur but not growing (i.e., no change in fruit diameter), and the percent dropped fruit. These spur characteristics were assessed approximately every 7 days from early May until early June (Table 4). The percent of fruit that were actively growing increased throughout the measurement period. This was due to both an increase in fruit drop and fruit that stopped growing.

In early June, nearly all fruit were either actively growing or had dropped. Most fruit dropped in early May, though treatment affected the timing of the most significant fruit drop. FOLS-treated spurs for example, still exhibited significant drop between 22 May and 31 May – they had significantly more fruit attached and not growing on all but the last two sample dates, compared to control and tergitol treatments. Between 11 May and 7 June, very few fruit dropped from tergitol-treated trees (an additional 7.3%) and untreated control trees (an additional 7.5%). This suggests that fruit from these trees dropped prior to 11 May. In contrast, there was significant fruit drop from FOLS- and ATS-treated trees over the same period, ca 29% and 20.1%, respectively. Expeditious fruit drop would be advantageous, giving the grower an early indication of thinning efficacy and time to plan subsequent thinning, if necessary. In this regard, FOLS is the least favorable thinner because on 11 May, ca. one month after full bloom, 35% of the fruit had not yet dropped. For continued research of blossom thinning, our data also suggest that fruit set determinations should not be collected until the end of May.

Table 4. Effect of chemical blossom thinners applied to 11-year-old 'Bing'/'Gisela 6' trees at ca. 20% (17 April) and 80% (21 April) of full bloom on fruit set. Means within column and category followed by same letter are not statistically different ($P < 0.05$).

Fruit per category (%)						
Actively growing		11 May	18 May	22 May	31 May	7 June
	Control	67.6 a	71.8 a	72.5 a	75.7 a	76.3 a
	FOLS	53.1 b	59.8 ab	61.2 ab	59.4 b	58.9 b
	Tergitol	47.4 b	62.1 ab	56.5 b	63.6 ab	64.1 ab
	ATS	46.2 b	55.7 b	53.4 b	57.2 b	59.1 b
Not growing (attached)						
	Control	16.9 c	13.5 c	6.1 b	2.2 a	0.7 a
	FOLS	35.1 a	30.5 a	12.4 a	2.3 a	0.5 a
	Tergitol	24.3 bc	20.9 bc	5.2 b	1.8 a	0.3 a
	ATS	33.2 ab	23.6 ab	8.5 ab	2.3 a	0.2 a
Dropped						
	Control	15.5	14.7	21.4	22.1	23.0
	FOLS	11.8	9.8	26.4	38.3	40.6
	Tergitol	28.3	17.0	38.2	34.7	35.6
	ATS	20.6	20.8	38.1	40.5	40.7

In 2006 we also initiated research designed to elucidate the relationship between time of thinning and the benefit of the thinning. We conducted a preliminary trial in which 5 'Sweetheart'/'Gisela5' trees were subjected to a 50% removal of fruit every week, beginning 1 week after full bloom. We observed the greatest improvements in fruit quality from thinning 2 to 4 weeks after full bloom (Table 5). Interestingly, the earliest thinning, at 1 week after full bloom was not as effective as the later thinning timings at improving fruit quality. Thinning after about 7 weeks had no benefit on fruit quality. At 7 weeks and later, fruit weight, soluble solids, % 10.5-row and larger were not different from the control. Week 2 thinning caused the greatest improvements in fruit quality – weight was 14% higher, soluble solids were 9% higher, and there were ca. 18% more fruit in the 10.5-row and larger categories. However, unfortunately, yield of unthinned control trees was significantly lower than that of the thinned trees (6.0 kg vs. 13.3 kg). We hypothesize that thinning treatments would have been more beneficial if compared to unthinned trees yielding a similar mass of fruit per tree. We intend to repeat this experiment with greater replication in 2007. These data should be useful as we develop post-bloom thinning programs. From these trials we can comment about appropriate timings of post-bloom thinning. Our preliminary data suggest that fruit quality can be improved significantly with crop removal as late as 7 weeks after full bloom. This supports the conclusion that

final fruit size within a genotype is largely determined by the size of cells in the fruit, rather than the number of cells in each fruit.

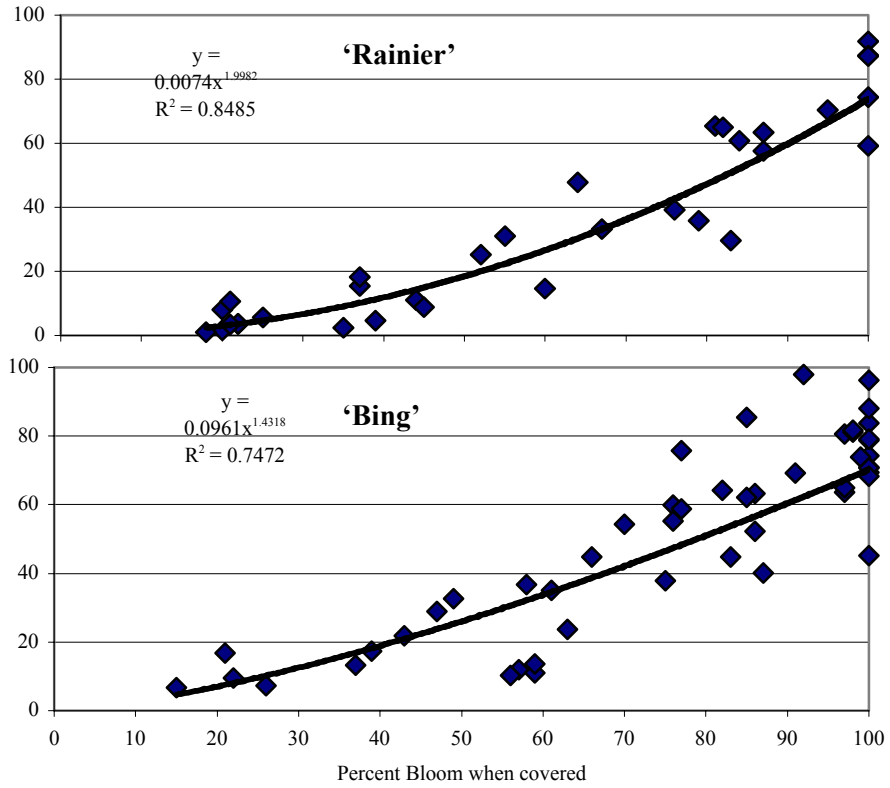
Table 5. Effect of timing of thinning (weeks after full bloom) 4-year-old 'Sweetheart'/'Gisela5' trees to 50% crop load on fruit quality and yield. Means within column and category followed by same letter are not statistically different ($P < 0.05$).

Thinning timing	Fruit weight		Soluble solids (%)		% 11- or 12-row		%10.5-row & larger		Yield (kg)	
control	7.7	abcd	20.5	ab	33.4	ab	65.0	ab	6.0	d
week1	7.2	bcd	18.5	b	47.7	ab	49.2	ab	14.8	ab
week2	8.8	a	22.2	ab	16.9	b	82.8	a	12.2	bcd
week3	8.2	abc	21.2	ab	22.6	b	77.8	a	14.5	abc
week4	8.3	ab	22.8	a	23.0	b	76.8	a	12.9	abc
week7	7.9	abcd	22.2	ab	27.5	ab	73.5	ab	11.2	bcd
week8	7.1	cd	19.8	ab	56.8	a	40.2	b	9.9	bcd
week10	7.0	d	19.3	b	52.7	a	42.5	b	17.4	a

In 2006, we also initiated a trial in which we bagged flowering limbs of 'Bing' and 'Rainier' trees on 'Gisela 6' rootstocks with bee exclusion bags at various stages throughout the bloom period. The bags were removed well after bloom. Immediately before covering a limb, each was assessed for percent flowers that were open (i.e., could be accessed by bees). Before harvest, fruit set was assessed as the number of fruit per total flowers on each limb at the time of bagging. Not surprisingly, percent fruit set increased as bloom progressed (i.e., more flowers were open). For both 'Bing' and 'Rainier', the relationship between percent fruit set and percent open bloom at the time of bagging was positive and curvilinear (Fig. 1). Therefore, fruit set is proportional to the amount of open flowers, or percentage of full bloom. These data may be important in designing thinning strategies. For example, between 20% full bloom and 80% full bloom, there exists the potential to set 60% of available flowers (if conditions are good). Unfortunately, we know little of the effect of blossom thinners on the various components of fruit set. We intend to repeat this experiment in 2007 with the addition of a caustic blossom thinner treatment. In addition, these data also suggest the possibility for manipulating pollinator activity to affect fruit set. These data suggest that, in 2006, if one targeted 40% fruit set for their orchard, the removal of bees at 40% full bloom may have achieved this. Alternatively, aggressive thinning strategies imposed immediately after 40% full bloom may accomplish the goal (though again, it is not known how thinners affect previously fertilized fruit vs. interfering with future pollination).

Post-bloom thinning A post-bloom application of 2% FOLS was made in 2005 to investigate the potential for thinning via photosynthetic inhibition. Applications were made at 14 days after full bloom (DAFB) to roughly coincide with the switching from growth supplied by stored resources to being supplied by current season assimilates. In addition, this is a period of high fruit growth rates in early stage I, and therefore, high sink demand (see High density orchard management report). We hypothesize that by reducing assimilate supply at this stage, we may be able to induce resource

Figure 1. Relationships between percent fruit set and percent open flowers for 'Bing' and 'Rainier' sweet cherry trees.



limitations and fruit drop. Indeed, fruit set (# fruit/100 flowers) in 2005 was reduced significantly by FOLS applied 14 DAFB (data not shown). This response is likely a result of photosynthetic inhibition from FOLS because pollination/fruit set had already taken place. However, the post-bloom FOLS application was less effective at reducing fruit set than the applications made during bloom. This is likely because post-bloom applications were less phytotoxic compared to applications during bloom and there was no interference with pollination and fruit set – a clear thinning mechanism of bloom applications of FOLS. Despite reductions in fruit set, post-bloom FOLS did not affect fruit yield or quality.

In 2006, we conducted post-bloom thinning timing trials with FOLS and rate trials with both FOLS and tergitol. These were products our previous research showed had phytotoxic effects and reduced photosynthesis. In the timing trial, 2% fish oil mixed with 3% lime sulphur was applied at 14 or 21 days after full bloom or on both dates to 'Bing'/'Gisela 6' trees. No treatment reduced significantly fruit set. This contrasts our previous results with 2% fish oil + 2% lime sulphur applied 14 days after full bloom in 2005. In 2006, fruit set overall was high at 68%. Fruit quality was not affected by any treatment. In the rate trial, 2% fish oil was mixed with either 2%, 3%, or 4% lime sulphur, and tergitol was applied at 1%, 1.5%, and 2% at two weeks after full bloom to 'Bing'/'Gisela 6' trees. Again, no thinning treatment significantly affected fruit set, compared to the control (data not shown). It is not clear why FOLS was ineffective in 2006 and effective in the previous year. In 2005, trials were on 'Bing'/ 'Gisela5' and treatments in 2006 were applied to 'Gisela 6'-rooted trees. The apparent thinning mechanism is via reductions in carbohydrate supply to developing fruit. Larger, 'Gisela 6'-rooted trees may have had greater carbohydrate reserves to supplement the transient reduction from thinner applications. We intend to continue to investigate potential post-bloom thinning programs in 2007, focusing on mode of action.

Table 6. Effect of thinning treatments applied to leaves (not flowers) and flowers (not leaves) on fruit set of 'Bing'. Letters indicate statistical differences by Duncan analysis of variance test within column ($p < 0.05$). Asterisks indicates significant differences within row.

Treatment	Leaves covered/flowers treated	Leaves treated/flowers covered
	Fruit set (% available flowers)	
Control	24.8 ab	34.1 ab
ATS	18.9 b*	42.9 a*
VOE	35.3 a	40.7 a
Tergitol	21.9 ab	19.1 b
FOLS	10.3 b*	21.3 b*

In 2005 and 2006 we attempted to better understand the mechanism by which thinners effect a response. Our previous research and printed reports in other species point to two possibilities – a reduction in tree/spur carbon balance via reductions in net photosynthesis and/or increase in dark respiration, and the interference with pollination and fruit set via causticity to floral structures. In 2005, just prior to the 80% full bloom thinner applications, we covered with plastic bags either the entire spur leaf area (flowers exposed) or all flowers (leaves exposed to thinner). We evaluated fruit set near harvest as a percent of available flowers on a spur basis. When only flowers were treated with thinners, fruit set varied by three-fold though no treatment was significantly different from the control. Both ATS and FOLS however were significantly lower fruit set than VOE (Table 6). FOLS reduced fruit set the most, to about 41% of the control. When only leaves were treated with thinning treatments (i.e., flowers were untreated) fruit set of tergitol- and FOLS-treated spurs showed the greatest reductions in fruit set (ca. 40%) and VOE- and ATS-treated spurs showed numerically greater fruit set than the control (Table 6). These contradict previous reports on the inhibition of pollination by VOE by sealing closed the unopened perianth. In addition, it appears that ATS, despite significantly reducing NCER (though it was the least phytotoxic thinning treatment) acts by interfering with pollination. Only for ATS and FOLS was fruit set significantly lower when flowers

were treated vs. when leaves were treated (indicated by asterisks in Table 6). This suggests that these thinners are most effective when applied to blossoms rather than leaf tissue. In contrast, tergitol was more effective when applied to leaves, rather than flowers only (44% vs. 12% reduction, respectively). In 2006 we covered leaves and flowers separately again but for both the 20% and the 80% full bloom applications. In contrast to the 2005 trial, fruit set was not significantly reduced by any thinner when applied only to the leaves (data not shown). In 2006, fruit set overall was much higher than in 2005. However, when applied to the flowers, each thinner reduced fruit set. FOLS, tergitol, and ATS reduced fruit set vs. the control by ca. 18%, 30%, and 15%, respectively.

Gibberellic acid to inhibit floral bud induction We have shown previously that applications of high rates of GA_3 to 7-year-old 'Bing'/'Gisela 1' trees can inhibit the formation of flower buds, reduce yield, and improve fruit quality significantly in the season after application. In 2004 we conducted an isomer trial on 'Bing'/'Gisela 1' trees to compare the efficacy of GA_3 vs. GA_{4+7} at reducing return bloom and balancing crop load in the season subsequent to application (i.e., 2005). Every application of GA_3 and GA_{4+7} in 2004 significantly reduced return bloom and yield in 2005 compared to the control. At 100 mg/L, GA_3 and GA_{4+7} reduced yield by ca. 71% and 34%. At 200 mg/L GA_3 treatment nearly eliminated all flowers with a 95% reduction in yield; GA_{4+7} was not as inhibiting, reducing yield by 37%. No treatment had a positive effect on crop value though GA_3 at 100 mg/L did improve soluble solid and firmness. Unfortunately, this orchard was not particularly productive – our untreated control trees yielded less than 9 kg (<20 lb). Therefore, fruit growth in untreated trees was not limited by the partitioning of assimilates. Our fruit weight data supports this contention – there was no difference in fruit weight between control trees and those which yielded less than 1 kg.

In 2006 we initiated another trial evaluating the effects of rate of different GA isomers (GA_3 and GA_7) on 'Rainier' fruit quality in the season of application, and, in the subsequent season, return bloom, yield, and fruit quality (to be conducted in 2007). In-season effects of GA isomer and concentration were significant (data not shown). GA_3 caused an increase in fruit firmness that was rate dependent. GA_7 in contrast, had no effect upon fruit firmness. Across 4 picks, irrespective of rate, neither isomer had any consistent impact on fruit soluble solids or weight, though in the first two picks, GA-treated fruit had higher soluble solids. Red coloration of fruit skin was inhibited by both GA isomers and GA_3 was more inhibiting to color development than GA_7. Overall, yield of fruit with greater than 50% surface colored red was reduced by 50%, 64%, and 73% by GA_3 at 25, 50, and 100 ppm, respectively and reduced by 35%, 32%, and 43% by GA_7 at 25, 50, and 100 ppm, respectively. Both GA isomers delayed fruit harvest compared to untreated trees. Approximately 90% of untreated fruit were harvested in the first two picks vs. only ca. 50%, 37%, and 28% for GA_3 at 25, 50, and 10ppm, and 72%, 63%, and 49% for GA_7 at 25, 50, and 100 ppm, respectively (Fig. 2). GA_3 delayed fruit maturation more than GA_7 did. We also recorded significant increase in shoot growth in GA-treated canopies. The greatest increase in vegetative extension growth was from 25 ppm of GA_3 (ca. 18% increase). We will assess treatment effects on floral bud induction by examining buds/spur and flowers/bud during the winter. In addition, return bloom will be assessed in 2007 along with fruit yield and quality.

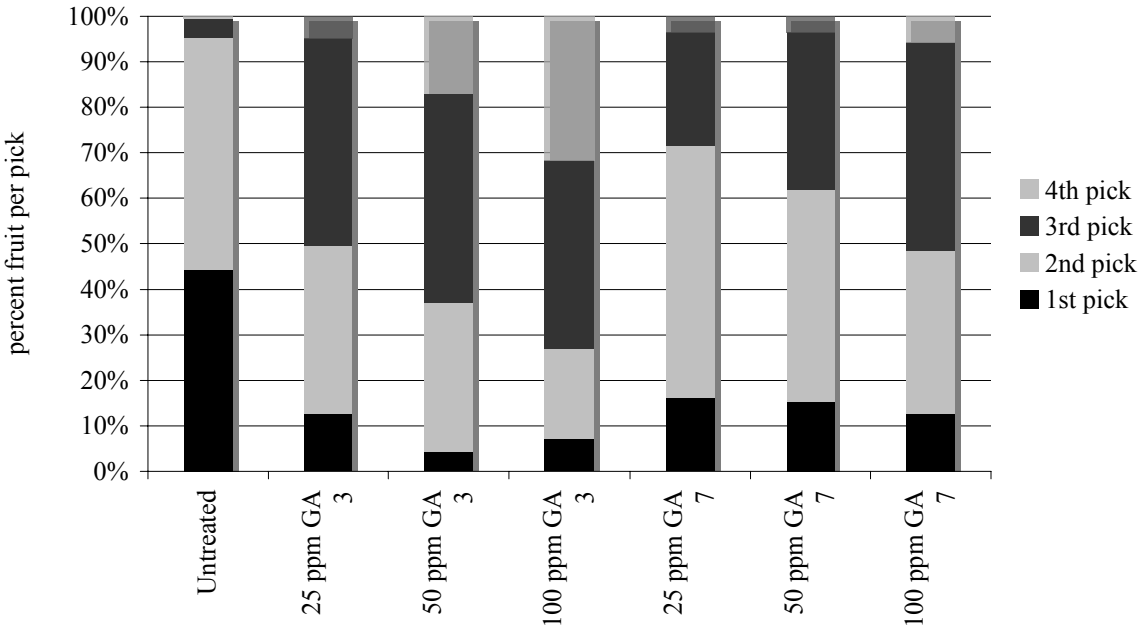


Figure 2. Effect of gibberellic acid isomer and concentration on the percentage of 'Rainier' fruit (of total yield per tree) harvested on 4 separate harvest dates. 1st pick – 23 June, 2nd pick – 1st July, 3rd pick – 10 July, 4th pick – 19 July.

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