FINAL PROJECT REPORT

Project Title: **Investigating post-bloom thinning**

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Total Project Request: **Year 1:** $48,483 **Year 2:** $50,144

Other funding sources; None

Budget 1
Organization Name: WSU **Contract Administrator: Mary Lou Bricker**
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Item	**2012**	**2013**	
Salaries	28,732	29,954	
Benefits	5,420	5,653	
Wages	9,198	9,386	
Benefits	883	901	
Equipment			
Supplies			
Travel	2,000	2,000	
Miscellaneous[1]	2,250	2,250	
Total	48,483	50,144	

Footnotes: Salaries are for ¼ time technician, Allyson Leonhard and for Ph.D. student Lu Zhang. Wages are for temporary timeslip assistance at $10/hour. Travel is for transport to field plots with collaborators. [1]For orchard maintenance at WSU-Roza farm ($4,500/acre @ 0.5 acre).

OBJECTIVE: To develop pragmatic, cost-effective post-bloom thinning strategies

SIGNIFICANT FINDINGS:

- Ethephon applications are effective at reducing fruit set in sweet cherry post-bloom (as great as 90% reduction)
- Thinning efficacy is largely rate-dependent
- Timing of application is important – greater thinning efficacy was observed with earlier applications
- Fruit quality improvements were inconsistent, irrespective of quality parameter
- Fruit soluble solids were improved consistently from thinning – size was not always improved, despite significant reductions in crop load
- There was no relationship between fruit set and fruit quality parameters

METHODS

The need for post-bloom thinning tools is clear – one cannot assess fruit set until well after flowering. Currently, the only reliable means of post-bloom thinning in sweet cherry is manual fruit removal, an expensive operation. We propose to develop a post-bloom thinning strategy focusing on Ethephon because it showed promise in our previous work on 'Sweetheart', and 'Rainier'. Ethephon will be compared to hand thinning. There are two key elements that need to be determined – the best time for application and the rate-response.

I – TIMING OF APPLICATION

Treatments:

- unthinned control (water sprayed)
- hand thinning to about 30 fruit per foot
- Ethephon at 200 ppm

Timing of application:

- shuck fall
- shuck fall + 1 week
- shuck fall + 2 weeks
- shuck fall + 3 weeks

Methods:

Applications will be made using a pressurized spray gun or commercial airblast sprayer to 'Sweetheart', 'Rainier', and 'Skeena' trees that exhibit heavy fruit set. Two experiments will be conducted for each cultivar – one in a commercial orchard and one at the WSU-Roza experimental orchards. In addition, we will work opportunistically with additional growers interested in evaluating post-bloom thinning strategies by providing suggestions for protocols and helping with data collection on efficacy. On each application date, treatments will be made to entire trees, with 6 whole-tree replications. Hand thinning will be accomplished by manually removing fruit from throughout entire trees with a goal of leaving ca. 30 fruit per foot (preliminary work shows this is a reasonable target to balance fruit number with quality). Depending on the orchard, we will use either a completely randomized design or a randomized complete block design, with at least 2 border trees between adjacent treatments. We will require 96 trees in each orchard (4 treatments x 4 timings x 6 reps). Key environmental conditions (e.g., wind speed, temperature, humidity) during and following application will be monitored using AgWeatherNet stations in the vicinity.

Within a day of application, we will flag two limbs in every tree and count fruitlet density (fruitlets/limb cross-sectional area and length), measuring limb caliper as well. In addition, we will measure fruit diameter on 30 fruit per limb to record fruitlet size at the time of treatment – this will facilitate comparisons among cultivars with respect to timing). We will record the time required to hand thin and 'rake' thin each replicate tree. In addition, we will collect thinned fruit and measure fruit size and weight to see whether the population of thinned fruitlets differs significantly from the remaining unthinned fruitlets. A photo journal will be collected as well to visually document application timings and crop densities. At commercial fruit maturity we will make fruit counts to the same limbs and assess thinning efficacy as % fruitlet removal. Fruit subsamples (minimum 100 fruit per replication) will be collected and analyzed for quality attributes including color, weight, diameter, firmness, and surface damage.

Scope of work:
3 cultivars (Rainier, Skeena, Sweetheart)
2 sites for each cultivar (1 commercial orchard + WSU Roza farm)
16 'treatments' (4 timings and 4 treatments)
6 replicates

II – RATE OF ETHEPHON

Treatments:
- unthinned control (water sprayed)
- Ethephon at 100 ppm
- Ethephon at 200 ppm
- Ethephon at 300 ppm

Methods:

These experiments will be conducted as described above with respect to applications, experimental design, data collection, and analyses. Again, we will make applications to Rainier, Skeena, and Sweetheart in 2 locations (a commercial orchard + the WSU Roza farm), identifying commercial orchards once fruit density can be determined. The treatments will be made at shuck fall + 1 week by pressurized spray gun or commercial airblast sprayer. We will require 24 trees for these experiments (4 treatments x 6 reps).

In the second year, we will repeat post-bloom thinning experiments and generate outreach material describing the results from our post-bloom thinning trials. These may include videos (describing benefits of post-bloom thinning), presentations at winter meetings, and written reports for the Good Fruit Grower.

RESULTS

Fruit set

In 2013 we conducted 5 distinct thinning trials, 4 with commercial growers and 1 at the WSU-Roza farm. In 2013 we included abscisic acid (ABA) in addition to the Ethephon treatments from 2012. The following will highlight the results from 3 of those trials – they are representative of the overall response.

In a 'Sweetheart' trial in the Yakima valley natural fruit set was about 80% of available flowers and fruit density was about 35 fruit/foot. Average fruit weight from untreated control limbs was 8.8 g (about 10.5 row). Ethephon treatment reduced fruit set proportional to rate, but only at the earliest application timing (FIG 1). Ethephon applied on the 6th of May (i.e., shortly after shuck fall, 11.9 mm mean fruit diameter) reduced fruit set by 4, 19, and 73% compared to the control at 100, 200, and 300 ppm, respectively. ABA was generally ineffective as a post-bloom thinner in this trial; in fact, later applications of ABA at 500 ppm improved fruit set by roughly 10-14%. Similarly, later applications of Ethephon were ineffective as thinners and, in some cases, increased fruit set by up to 17% (Ethephon at 300 ppm applied 20 May).

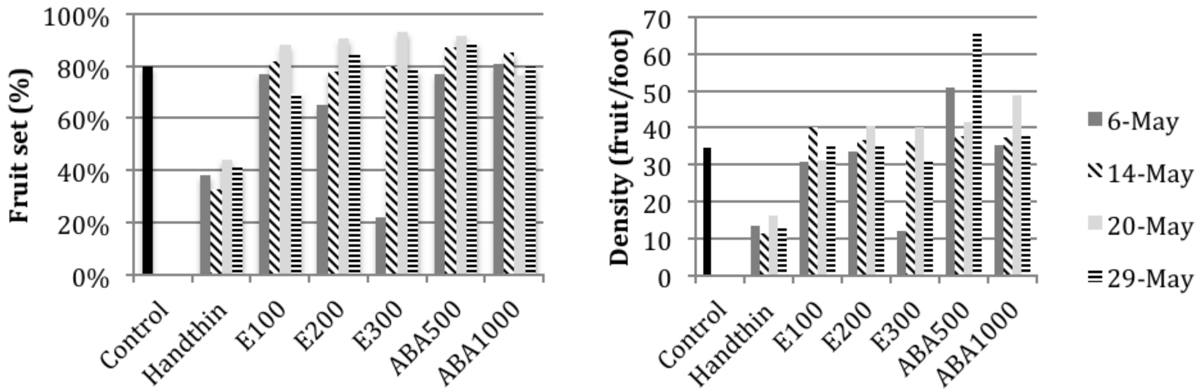

Figure 1. Thinning efficacy of Ethephon or ABA applied to 'Sweetheart'.

Hand-thinning treatments consistently reduced crop load, to about 12 fruit/foot. These thinning treatments did not improve fruit weight/size however (FIG). This suggests that fruit were not source-limited during growth and development; therefore, thinning was unnecessary. Fruit size from the first applications of Ethephon on 6 May (i.e., those treatments that did provide thinning) was improved 6% by 100 ppm, unaffected by 200 ppm, and reduced 25% by 300 ppm despite that treatment reducing fruit set 73%. Interestingly, similar to results in 2012 with different cultivars, several Ethephon treatments improved fruit quality without providing any thinning. The greatest improvements to fruit size/weight were from 100 ppm Ethephon at the first and second timings (+6 and 11%, respectively) and 300 ppm Ethephon on the second application date (+7%).

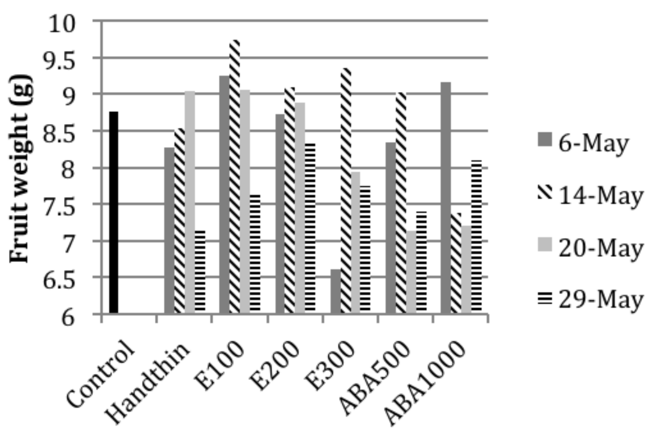

Figure 2. Fruit weight of 'Sweetheart' following application of thinners.

In a 'Lapins' trial in 2013 natural fruit set was high, about 90%, and fruit density was 46 per foot. Average fruit weight from untreated, control limbs was about 9.2 g (peaking on 10 row). Ethephon treatment at 100 ppm was ineffective as a thinner, average fruit set across all four application timings was about 91%. Ethephon at 200 ppm was effective for thinning but only on the first two application dates (5 and 14 May); later applications did not affect fruit set. Fruit set was reduced by Ethephon at 200 ppm to 45% on both the first two application dates. At 300 ppm Ethephon was an effective post-bloom thinner only on the first application timing when this treatment reduced fruit set to 20% (i.e., about 20% of control). Later applications of Ethephon at 300 ppm did not effectively thin fruit. ABA at 1000 ppm reduced fruit set by about 29% compared to unthinned control on the earliest timing, but was ineffective with later applications. ABA at 500 ppm was not an effective thinning agent at any timing. Ethephon applied at 100 ppm on the later two timings improved fruit set by 6%.

Fruit density was reduced by hand-thinning treatments consistently, to about 42% of the unthinned limbs (46 fruit/foot vs. 20 fruit/foot). The hand-thinning improved fruit size/weight by about 25%. Fruit weight was 11.5 g from all hand-thinned timings combined compared to 9.2 g in unthinned limbs (FIG). Interestingly fruit size/weight was improved by nearly every treatment,

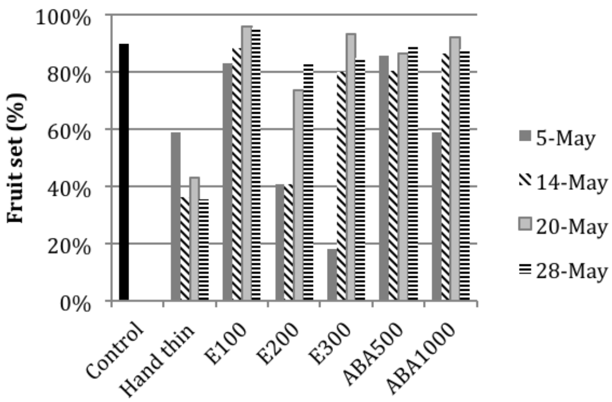

Figure 3. Thinning efficacy of Ethephon or ABA applied to 'Lapins'.

despite the inability of most treatments to thin the fruit. The greatest improvements in fruit weight were in response to Ethephon at 100 ppm applied on the first two dates – these treatments led to improvements in fruit weight of 30 and 33%, respectively. This is similar to previous results from 2012 in which improvements in fruit quality were not associated with reductions in fruit set. The lack of relationship between fruit density and fruit weight suggests across all treatments and timings suggests that the PGR treatments are altering limb/tree source-sink relationships.

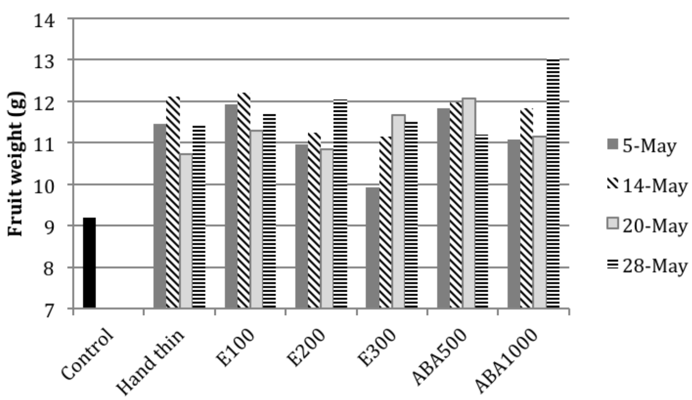

Figure 4. Fruit weight of 'Lapins' following application of thinners.

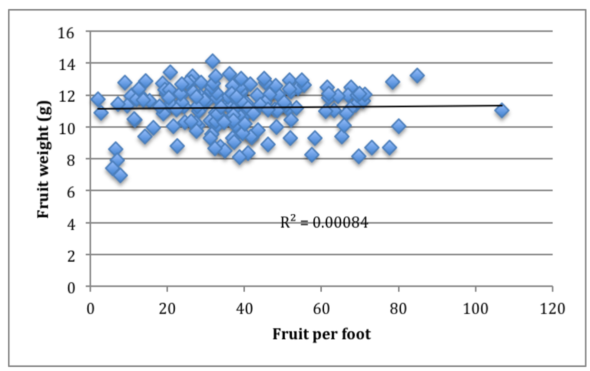

Figure 5. Relationship between fruit density (fruit/ft) and individual fruit weight in 'Lapins'.

Executive Summary

Ethephon showed potential to thin fruit after bloom. The thinning response was proportional to rate and earlier applications were more effective than late applications. ABA showed little potential as a post-bloom thinning agent for sweet cherry in the application timings we studied. We documented an interesting disconnect between thinning and fruit quality improvements – treatments that reduced fruit density did not always improve fruit quality, and, in many cases, Ethephon treatments of 100 or 200 ppm improved fruit quality without reducing fruit density. This is deserving of further study. It is recommended to conduct further trials with Ethephon at 100-200 ppm within 2 weeks after shuck fall.

Abbreviated summary of results from 2012:

Ethephon applications reduced fruit set significantly in every cultivar tested (data not shown). In Skeena, fruit set in untreated control was ca. 66%. Hand thinning treatments reduced final fruit by about half (fruit set = 31% overall), irrespective of timing of thinning (Figure 1). In comparison, mean fruit set across all timings was 68%, 50%, and 33% in response to treatment with 100 ppm, 200 ppm, and 300 ppm Ethephon, respectively. Therefore, 100 ppm was ineffective, and 300 ppm closely matched the hand thinning targets. Timing of Ethephon application was important – thinning efficacy was greatest on the first application and declined with each of the next two application dates (Figure 2). Expressed as a % of control fruit set, 300 ppm was effective at thinning on each application date, whereas 100 ppm was effective only on the first application date, and 200 ppm was effective only on the first two application dates (Fig. 2). These results suggest that there is a positive relationship between Ethephon rate and thinning efficacy, and that at higher rates, efficacy is greatest at early stages of fruit development.

In Sweetheart, fruit set of untreated limbs was similar to Skeena at about 66% (Figure 3). Hand thinning treatments reduced fruit set by about 65%, to 27% across all timings. In comparison, mean fruit set across all timings was 73%, 59%, and 34% in response to treatment with 100 ppm, 200 ppm, and 300 ppm Ethephon, respectively (each very similar to final fruit set in Skeena). Therefore, 100 ppm was ineffective, and 300 ppm most closely matched the hand thinning targets. Timing of Ethephon application was important – thinning efficacy was greatest on the first application and declined with each of the next two application dates (Figure 2). Expressed as a % of control fruit set, 300 ppm was effective at thinning on the first three application dates, whereas 100 ppm was effective only on the first application date, and 200 ppm was effective only on the first two application dates (Fig. 4). These results suggest support our conclusion with Skeena that there is a positive relationship between Ethephon rate and thinning efficacy, and that at higher rates, efficacy is greatest at early stages of fruit development. Interestingly, Ethephon applied at 100 ppm and 200 ppm on the later application dates led to subtle improvements in final fruit set, with both treatments yielding about 40% more fruit than untreated control when applied on 8-June.