Proposal Title: OPTIMIZATION OF HONEYDEW WASHING SYSTEMS IN PEAR ORCHARDS

Report Type: Final Report

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Item	2023	2024	
Salaries	$19,267.00	$20,038.00	
Benefits	$5,836.00	$6,069.00	
Wages	$24,273.00	$25,244.00	
Benefits	$2,477.00	$2,576.00	
RCA Room Rental			
Shipping			
Supplies	$1,110.00	$1,005.00	
Travel	$250.00	$250.00	
Plot Fees	$787.00	$818.00	
Miscellaneous			
Total	$54,000.00	$56,000.00	$0.00

Footnotes: Salaries: RT Curtiss (@ 0.1 FTE), RJ Orpet (@ 0.1 FTE), L Nottingham (@ 0.02 FTE). Benefits: RT Curtiss (32.9%), RJ Orpet (32.9%), L Nottingham (28.6%). Wages (Time-slip @ $20/hr, 40hr/wk, 30 wk/year). Supplies: Misc. field and lab supplies ($1110 in year 1, $1005 in year 2). Plot Fees: $787 in year 1, $818 in year 2. Travel: Fuel and vehicle costs to reach field sites in WA $250/yr.

ORIGINAL PROJECT OBJECTIVES

1) Monitor seasonal honeydew deposition to understand when washing should be applied
2) Compare honeydew washing efficacy with overhead, air blast, and handgun sprayers, and at seasonal (phenology-based) wash timings
3) Evaluate the impact of surfactants and/or soaps on honeydew removal
4) Provide Extension

SIGNIFICANT FINDINGS

Objective 1 – 2022-2023 key findings

- Honeydew levels and psylla populations were highest in conventional orchards by the end of the season
- Most fruit damage occurs in conventional orchards within 2-3 weeks of harvest
- Natural enemies were highest in IPM and Organic orchards

2023-2034 key findings

- As in the first year, honeydew and psylla populations were higher in conventional orchards at the end of the season
- 2024 was a poor fruit set year, so fruit evaluations were difficult in some locations. However, the same fruit damage patterns were observed in both years of this project.
- Natural enemies also followed similar patterns in year two

Objective 2 – 2022-2023 key findings

- Honeydew levels were highest in plots not receiving washing treatments (controls)
- Plots washed every two weeks had lower honeydew levels than plots treated based on psylla phenology or other treatment timings
- It was difficult to apply enough water to wash trees with the air blast sprayer
- Psylla adults, nymphs, and eggs were not impacted by washing treatments

2023-2034 key findings

- Although 2024 was an extremely poor fruit-set year in our washing plots, and we were not able to evaluate honeydew and damage on fruit, we were still able to measure honeydew on leaves.
- Plots receiving washing treatments had lower honeydew levels
- In 2024 we increased overhead wash times from 8 hours to 24 hours, and more effectively removed honeydew.
- Other than removal of honeydew, pear psylla were not impacted by washing

Objective 3 – 2022-2023 key findings

- The surfactant tested did not improve washing efficacy

2023-2034 key findings

- After two tests with surfactant, washing efficiency was not improved over water alone. This treatment is not currently legal and would be an off-label use of these products. We do not recommend adding surfactant to wash water.

Objective 4 – 2022-2023 key findings

- Information generated from these studies was shared with farmers at 6 events in 2023

2023-2034 key findings

- Information from this study was presented at 4 events in 2024 and will be presented in at least two in 2025 after project conclusion.

METHODS

Objective 1: Monitor seasonal honeydew deposition to understand when washing should be applied

Weekly through both years, at least nine commercial study sites located in the Wenatchee River Valley had pear psylla and natural enemy populations, and honeydew levels monitored. Study sites had one of three management systems: organic-, conventional- and IPM-based pest management. Plots were monitored for natural enemies from March to October using beat trays, rolled cardboard traps, and yellow sticky cards with volatile lures. Pear psylla populations were monitored by beat tray and leaf sampling. Honeydew was monitored on leaves with a method to measure BRIX, and on fruit with visual inspection. Natural enemies that were monitored included adult *Trechnites insidiosus*, adult and immature stages of Aranae (spiders), Anthocoridae (minute pirate bugs), *Campylomma verbasci* (common mullein bugs), Chrysopidae (green lacewings), Coccinellidae (ladybird beetles), *Deraeocoris brevis*, *Forficula auricularia* (Dermaptera, European earwigs), Geocoridae (big-eyed bugs), Hemerobiidae (brown lacewings), and Nabidae (damsel bugs). Pear psylla counted from leaves samples included eggs, young psylla nymphs (instars 1-3), old psylla nymphs (instars 4-5), and mummified (parasitized) psylla nymphs. Mealybugs, European red mites, spider mites, and rust mites were also be counted on glass plates from leaf samples.

Pear psylla honeydew on leaves in commercial sites was measured weekly to understand the correlation with infestation and injury levels. Ten leaves were collected from each of 10 randomly selected trees distributed throughout each plot. Additionally, we monitored individual fruit at the unsprayed WSU-TFREC orchard through the entire season to understand the pattern of damage caused by honeydew. Fruit were evaluated in commercial orchard sites at mid- and end-of-season one week prior to harvest. Fruits were categorized based on USDA pear packing grades for pear psylla marking (USDA, 2007) by the U.S. #1, Washington Fancy, or Cull designation.

Objective 2: Compare honeydew washing efficacy

Honeydew washing methods were compared in small plots at the unsprayed WSU-TFREC and Sunrise pear orchards. In a randomized block designed experiment we compared efficacy of overhead washing systems, tractor with airblast sprayer, tractor with handgun, and unwashed control at managing honeydew. We used honeydew presence on fruit and leaves as a trigger for treatments other than the calendar treatment.

Table 1. Example experimental layout used in washing study.

	WSU-TFREC				**WSU-Sunrise**			
	Block 1		***Block 2***		***Block 3***		***Block 4***	
	Anjou	***Bartlett***	***Anjou***	***Bartlett***	***Anjou***	***Bartlett***	***Anjou***	***Bartlett***
Treatment in plot	Overtree wash	Airblast sprayer	Handgun sprayer	Control	Airblast sprayer	Control	Handgun sprayer	Overtree wash
	Airblast sprayer	Control	Overtree wash	Handgun sprayer	Control	Handgun sprayer	Overtree wash	Airblast sprayer
	Handgun sprayer	Overtree wash	Control	Airblast sprayer	Overtree wash	Airblast sprayer	Control	Handgun sprayer
	Control	Handgun sprayer	Airblast sprayer	Overtree wash	Handgun sprayer	Overtree wash	Airblast sprayer	Control

In 2024, fruit set in the TFREC orchards was particularly poor, and very few fruit were present in the orchard. Due to this unforeseen circumstance, we were unable to evaluate fruit damage as a measure of honeydew washing.

Objective 3: Evaluate surfactants' and/or soaps' impact on honeydew removal

We compared water alone with soaps' ability to remove honeydew from pear trees.

Objective 4: Provide Extension

Project findings will be submitted for peer reviewed publication after project end. In addition, we provided information directly to the industry. Our overall goal was to help farmers produce clean fruit through sustainable pest management programs with reduced inputs that conserve natural enemies.

RESULTS AND DISCUSSION

1) Monitor seasonal honeydew deposition to understand when washing should be applied

In 2023 and 2024 we monitored honeydew deposition in the 17 and 19 commercial pear orchards respectively, that were under focus in Dr. Orpet's project "Assessing and supporting effective areawide pear pest management."

In 2023, seven orchards were under conventional management programs, seven were under integrated management programs, and three were under organic management programs. Generally, across orchards, honeydew levels were higher in IPM orchards than conventional orchards early in the season, but by mid-season, conventional orchards' honeydew load typically increased and exceeded the levels measured in IPM and organic orchards (Fig. 1).

In 2023, fruit damage assessments were conducted at all sites, and we found that pre-harvest damage was lowest in IPM- and organic-managed orchards but was generally low across all sites. We found a correlation between higher leaf BRIX measurements and fruit downgrading (Fig. 3) in commercial orchards. Generally, the correlation between honeydew levels and fruit damage was clearest in conventionally managed orchards, where most damage occurred within two weeks of harvest due to lack of tools and natural enemies.

Natural enemy monitoring efforts followed typical trends observed in other years. Few natural enemies were found in conventionally managed orchards, while natural enemy populations increased through the season in IPM- and organic-managed orchards.

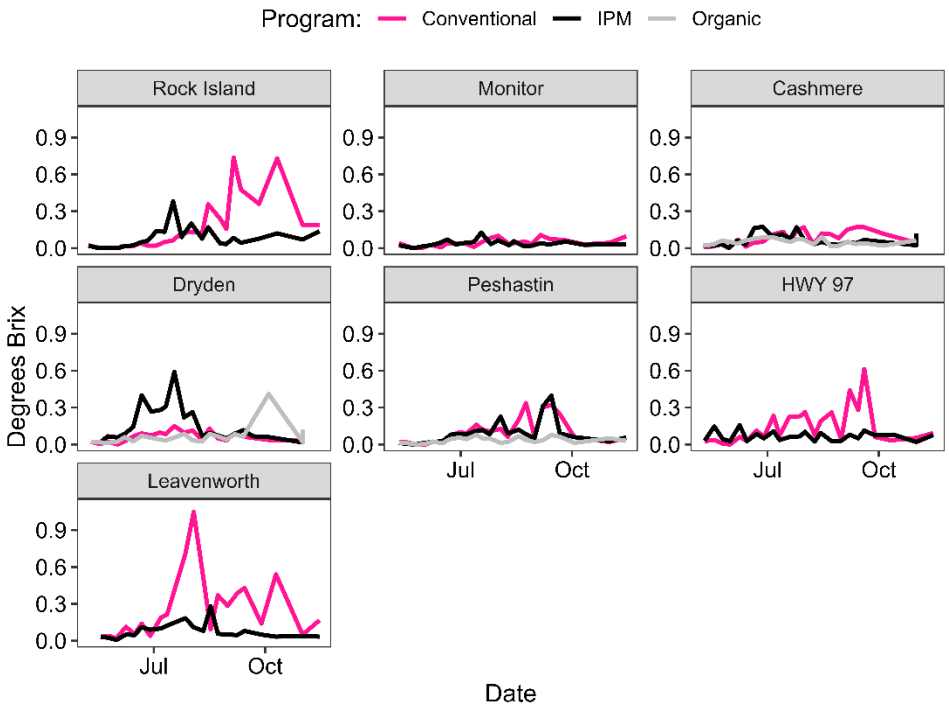

Figure 1. BRIX measurements in Washington commercial pear orchards (n=17) by region in 2023.

Figure 2. Example photograph of an individually tracked fruit at mid-season.

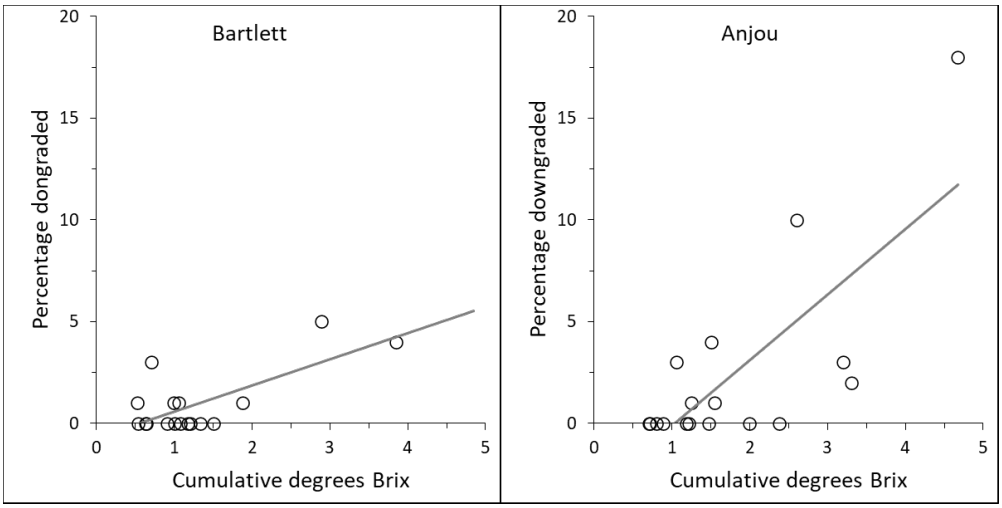

Figure 3. Relationship between the brix measurements and percentage fruit downgraded on Washington commercial pear orchards (n=17) in 2023.

In 2024, seven orchards were under conventional management programs, nine were under integrated management programs, and three were under organic management programs. Honeydew levels were higher in IPM orchards than conventional orchards early in the season, but by mid-season, conventional orchards' honeydew load increased and exceeded the levels measured in IPM and organic orchards (Fig. 4).

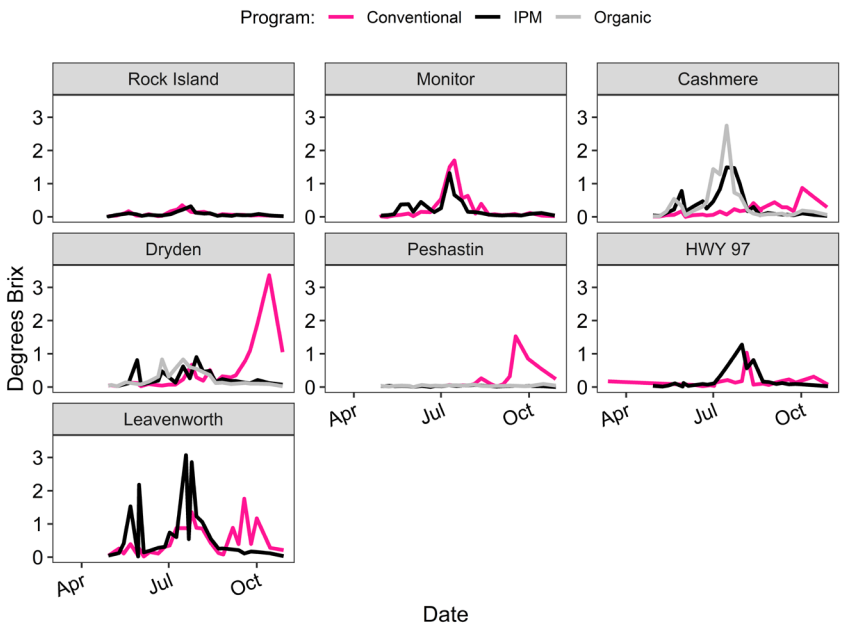

Figure 4. *Honeydew (as degrees Brix) on pear leaves measured weekly at seven locations in at 19 total orchards of variable management in 2024.*

Fruit damage assessments were conducted at all sites in 2024 on Anjou fruits within a week of their commercial harvest. There was a correlation between cumulative BRIX measurements and fruit downgrading (Fig. 5) in commercial orchards.

In addition to honeydew monitoring at the commercial orchards, individual fruits were visually and photographically monitored at the WSU-TFREC and -Sunrise orchards weekly through the season (e.g., Fig 2). Analysis of weekly fruit photographs from 2023 and 2024 is ongoing. However, at the otherwise unmanaged WSU-TFREC orchard, damage was high early in the season when psylla

pressure was high, but due to high rates of predation by yellowjackets, damage reduced through the season both years as pears grew, and damage was diluted across the increased fruit surface area.

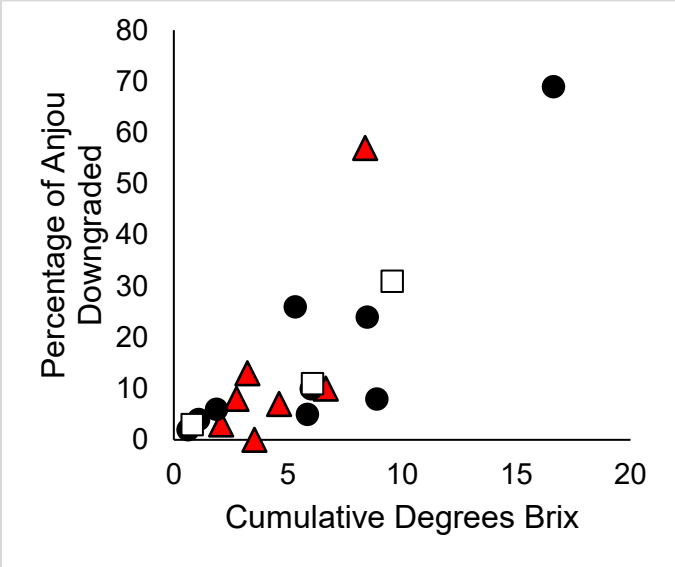

Figure 5. *Cumulative Degrees Brix from the beginning leaves until harvest time and percentage of Anjou fruits rated as downgraded in the field at harvest time at seven conventional (triangles), 9 IPM (circles), and three organic (squares) orchards in 2024.*

2) Compare honeydew washing efficacy with overhead, air blast, and handgun sprayers, and at seasonal wash timings.

Figures 6-8 show that washing had an impact on honeydew levels, but not psylla eggs, nymphs, or adults. However, the key observation from 2023 was that more water was needed to effectively remove honeydew. In 2023, we found it extremely difficult to apply enough water using the air blast sprayer. To spray water to the top of the trees, smaller droplets were required, however, the consequence was faster drive speeds. We attempted to ride the brake and drive slower than 1 mph and make 4 passes per plot, however, we still were not satisfied with the level of washing achieved with the air blast sprayer. These observations are reflected in Fig. 6 that shows poor results using the air blast sprayer compared to other methods. Calendar sprays, every two weeks achieved the lowest overall honeydew levels in among the plots, however, we believed better results could be achieved in 2024 with longer wash times.

In 2024, like much of the Wenatchee Valley, our test orchards had poor fruit set. It was difficult to find any fruit in some plots. Because of this, fruit evaluation was impossible to use as a measure of washing effectiveness. Without being able to measure honeydew accumulation on fruit and use it as a trigger for treatments, and unsatisfactory results in previous years with the airblast sprayer, we eliminated tractor-based treatments in 2024. In a slight modification from 2023, we evaluated overhead washing systems using 24-hour sets in 2024 instead of the 8-hour sets used in 2023. We expected to obtain significantly lower leaf honeydew compared to control plots and 2023 findings. In both years, with 8- and 24-hour sets, we did achieve better honeydew removal in washed plots than unwashed control plots. However, 2024 appeared to have a higher honeydew load on plots and we did not lower honeydew below 2023 levels (Fig. 9). Pear psylla populations were once again unaffected by the washing treatments in 2024 (Fig. 10). Immature pear psylla and eggs on leaves were also unaffected by the washing treatments in 2024 (Fig. 11).

3) Evaluate the impact of surfactants and/or soaps on honeydew removal

Figures 6-8 show that washing with surfactant may have a minor an impact on honeydew levels, but not psylla eggs, nymphs, or adults. However, the surfactant we tested did not achieve better results than water alone. In 2024, due to poor fruit set, lack of significant effect in previous years, and legal concerns with using soaps and surfactants for this purpose, we eliminated the

surfactant treatment. Previous studies reached similar conclusions, and we recommend against using this tactic to wash honeydew from fruit. Water alone, in high enough volume is just as effective, and is legal.

4) Provide Extension

PI Curtiss provided information to pear farmers at one formal extension event in 2023. The event detailed mid-season observations and extensively covered the need for high volumes of water for successful washing. Also in 2023, Co-PI Orpet co-organized (with ST DuPont and MW Sayles) one grower panel and four discussion meetings where stakeholders exchanged knowledge on washing strategies.

In 2024, we shared information on honeydew washing with growers at four extension events. Talks detailed year one findings, and discussions centered around soaps and surfactants ensued. Our recommendation against using these products for this purpose were reiterated.

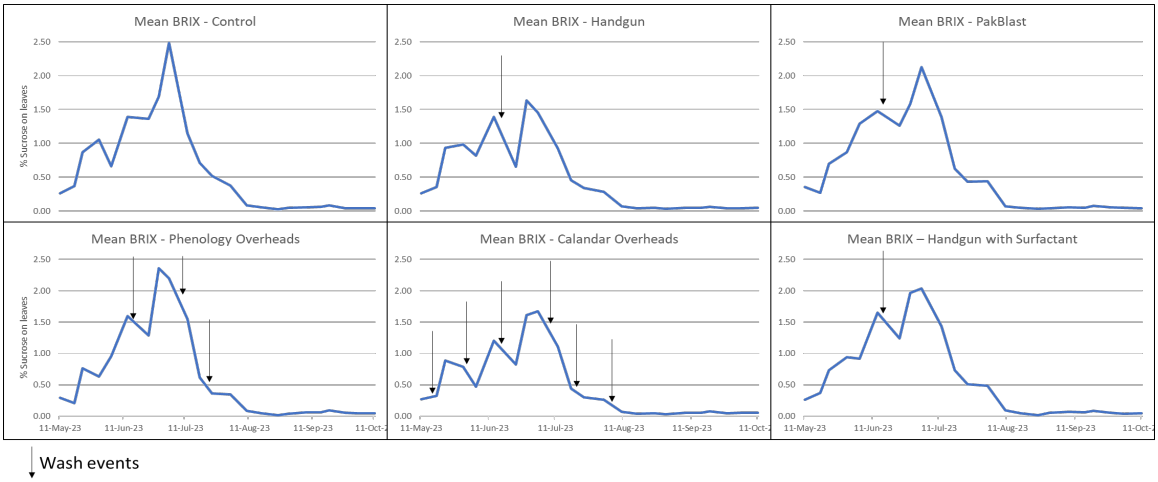

Figure 6. *Season-long BRIX measures (% soluble solids) in plots receiving six washing treatments in 2023. Arrows indicate timings of washings.*

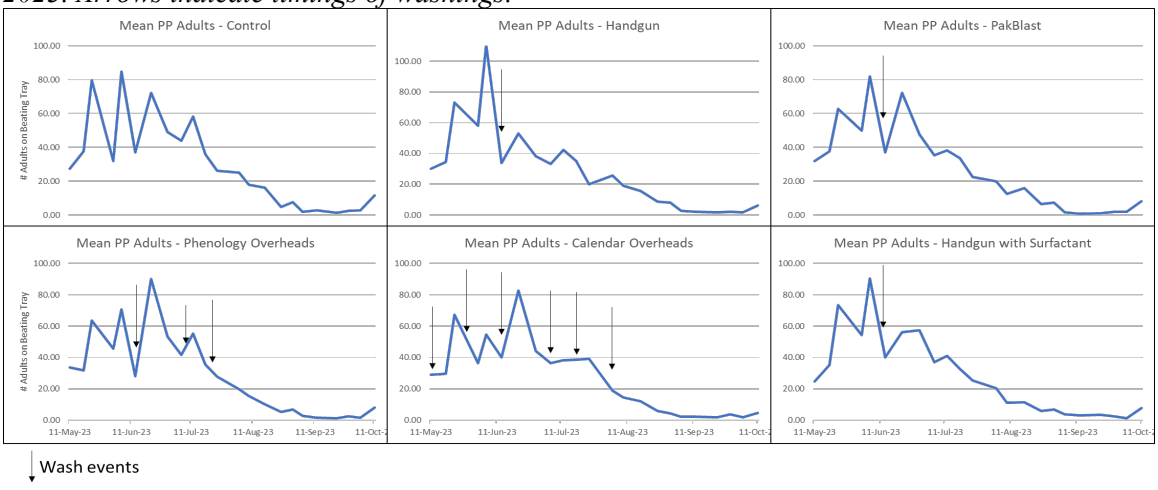

Figure 7. *Beating tray samples (number per tray) for adult pear psylla in plots receiving six washing treatments in 2023.*

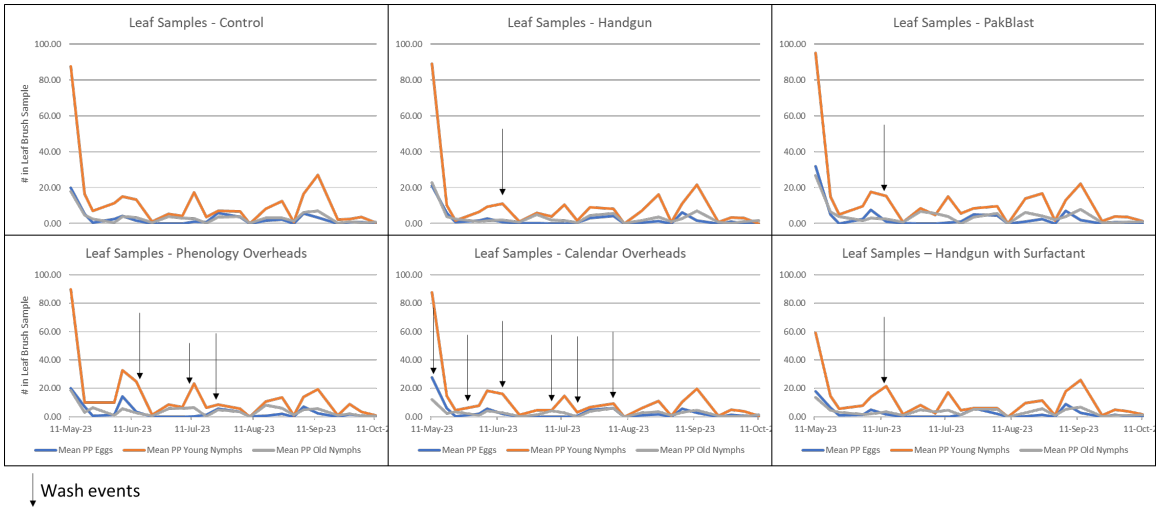

Figure 8. *Leaf brush samples for pear psylla eggs and nymphs (number per sample) in plots receiving six washing treatments in 2023.*

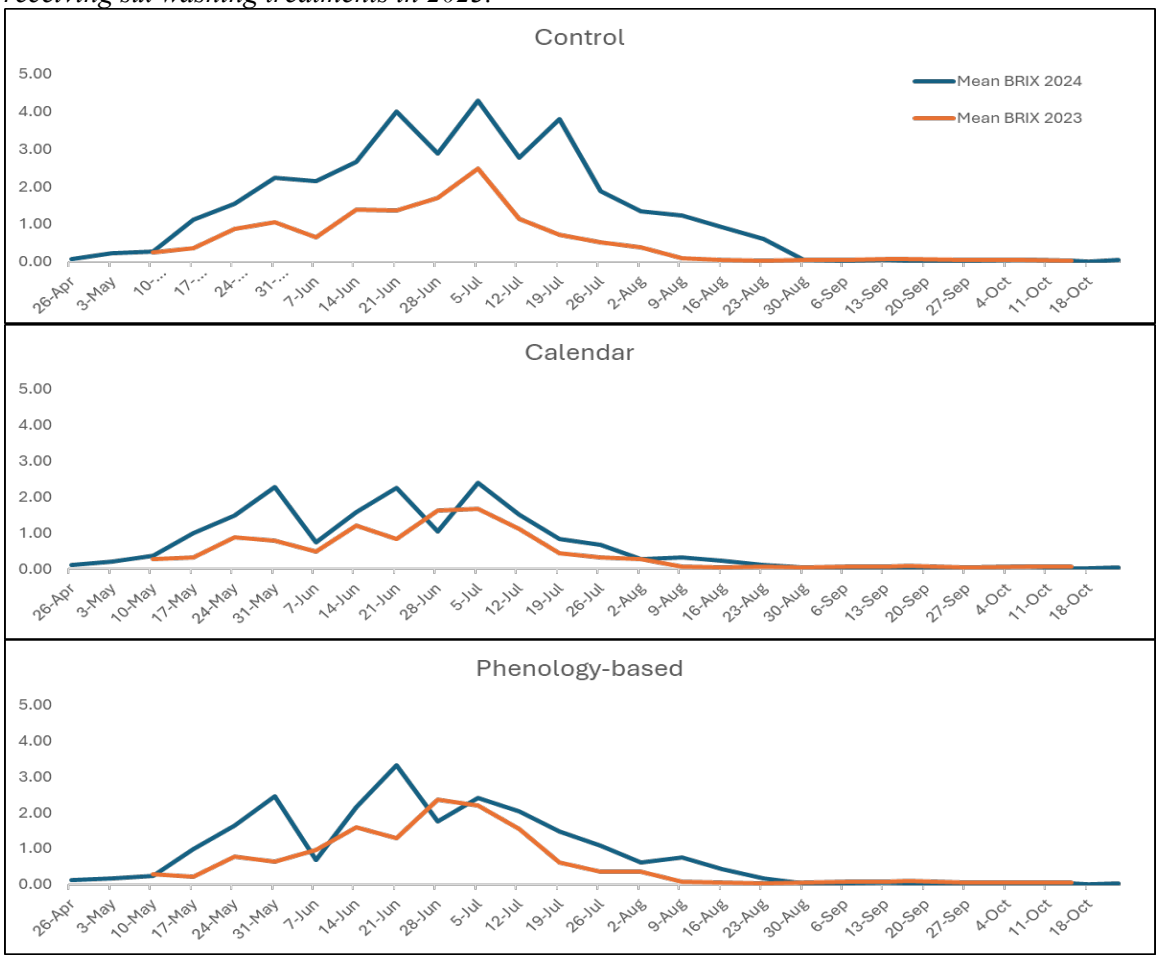

Figure 9. *Season-long leaf BRIX measures (% soluble solids) in plots receiving overhead washing treatments in 2023 and 2024.*

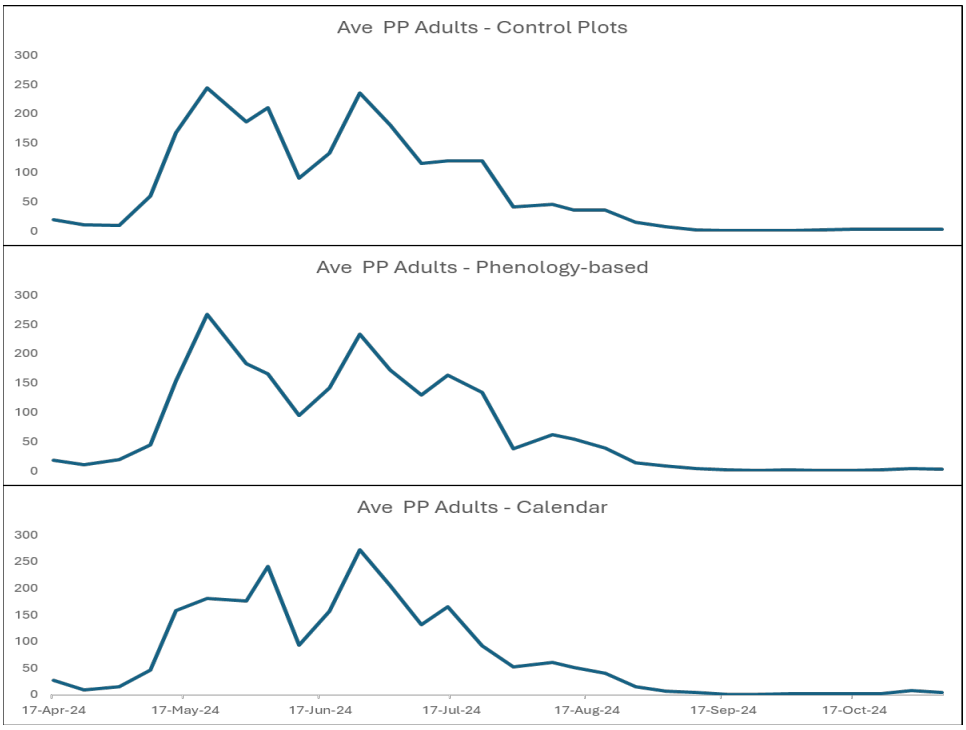

Figure 10. *Beating tray samples (number per tray) for adult pear psylla in plots receiving overhead washing treatments in 2024.*

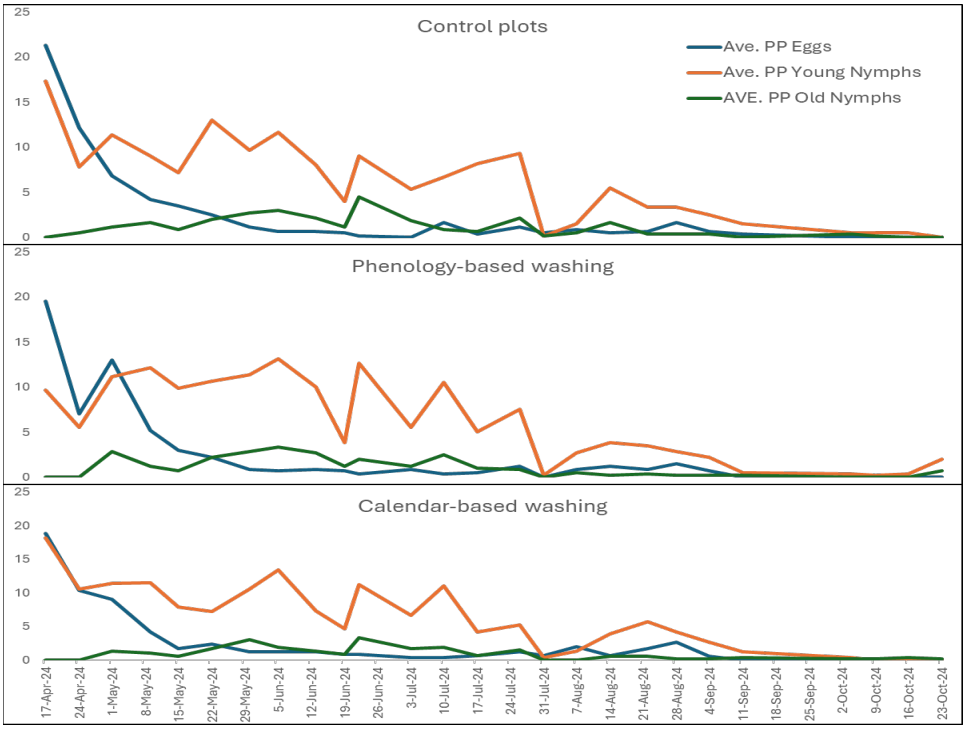

Figure 11. *Leaf brush samples for pear psylla eggs and nymphs (number per sample) in plots receiving six washing treatments in 2024.*

Executive Summary

Project title: Optimization of honeydew washing systems in pear orchards

Key Words: Overhead washing, Pear psylla, *Cacopsylla pyricola*, IPM, natural enemies

Abstract: Pear psylla honeydew is the primary cause of fruit downgrading. Fruit is marked by honeydew and growth of black sooty mold in the highly concentrated sugar water solution. However, honeydew is soluble and may be washed off with water. Water may be applied to trees in the field by several methods, including overhead systems, tractor-driven air blast sprayers, or hose-based systems. This project was designed to understand honeydew deposition patterns in commercial and experimental orchards, to test honeydew washing tactics, and provide the industry with scientifically-based guidance on optimizing washing. From this study we now understand that conventionally-managed orchards typically experience honeydew accumulation later in the season than IPM-and organic-managed orchards. In addition, IPM and organic orchards have lower honeydew pressure before harvest but may be damaged by honeydew earlier in the season. Of the honeydew washing tactics we tested, overhead washing systems used every two weeks resulted in the lowest overall honeydew load on leaves and fruit. Although it is possible to run washing systems timed to pear psylla phenology and remove significant amounts of honeydew, our studies found this method to be inferior to regular washes. We tested washing with a tractor-driven air blast sprayer but found this tactic to be unsatisfactory. We were not able to drive the tractor slowly enough, nor spray enough water into the trees to effectively wash off honeydew. The addition of soaps or surfactants to the tank of an air blast sprayer, however illegal, did not improve washing; we do not recommend this tactic. Although pear psylla themselves were not impacted by washing, neither were the natural enemies, leaving them free to contribute to pear psylla management. Based on our findings, it appears that regular washing using overhead systems is the most effective tactic in high honeydew pressure situations.