CONTINUING PROJECT REPORT **YEAR**: 1 of 2

Project Title: Field evaluation of leafhopper controls for X disease management

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Total Project Request: **Year 1:** $79,864 **Year 2:** $82,558

Other funding sources

None

Budget 1
Organization Name: WSU - TFREC **Contract Administrator:** Shelli Tompkins
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Item	2020	2021
Salaries[1]	50,039	52,040
Benefits[2]	17,325	18,018
Wages		
Benefits		
Equipment		
Supplies[3]	5,000	5,000
Travel[4]	7,500	7,500
Miscellaneous		
Plot Fees		
Total	79,864	82,558

Footnotes:
[1] New postdoctoral researcher position (100% FTE), Louis Nottingham (2%)
[2] 35% (postdoctoral researcher), 25.9% (Nottingham)
[3] Fieldwork consumables and X disease tests
[4] Domestic travel for research

Objective Recap, Goals, and Anticipated Accomplishments:

1. *Evaluate effects of kaolin clay applied post-harvest on X disease prevalence and density of leafhoppers and predators.*

   Kaolin clay application have shown to outperform insecticides for suppression of leafhoppers and Pierce's disease in California vineyards, cause direct mortality to leafhoppers, and even deter them from feeding to the point of starvation. As planned, we have finished the first year of the two-year trial evaluating the efficacy of kaolin clay to suppress the densities of leafhopper vectors of X-disease (*Colladonus reductus and C. geminatus*) in Yakima and Chelan county cherries blocks. Molecular testing of the leafhopper's guts will determine the efficacy of kaolin clay to deter feeding. Future greenhouse choice tests of clay sprayed vs. non-sprayed trees will assess leafhopper preference.

2. *Evaluate effects of UV-reflective mulch on X disease prevalence and density of leafhoppers and predators.*

   UV reflective polyethylene mulch use has demonstrated success in reducing the abundance of corn and potato leafhoppers even better than permethrin or thiomethoxrin. Our shipment of Extenday was delayed by 4 months due to COVID19 preventing us from deploying it in our experimental plots. Thankfully, the growers in Chelan county had Extenday in the cherry plots prior to harvest and graciously left it throughout the season for our experimental study. Therefore, in half of our cherry plots (Chelan county only) we were able to conduct the first year of evaluating Extenday for suppression and control of the X-disease leafhopper vectors. Our shipment has arrived and we will be able to include the other sites in Yakima county next year.

3. *Describe seasonal patterns of leafhopper abundance and map disease incidence in commercial cherry orchards.*
   A critical component to managing leafhoppers and X disease is understanding leafhopper phenology. We monitored leafhoppers in the blocks where we conduct the treatments described in objectives 1 and 2 to begin developing a general phenology for the growing regions of Wenatchee and Yakima valleys. We mapped disease incidence at harvest in our trial orchards, and will be able to identify patterns of disease spread within blocks throughout the following years.

Significant Findings:

- Surround reduced leafhopper numbers on 4 cherry plots in the Wenatchee Valley and 2 in Yakima County
- Extenday provided control surpassing Surround in 4 cherry plots in Wenatchee Valley
- Surround did not improve control in a trial in two Wapato nectarine plots, but leafhopper numbers were much lower than the other trials
- Optimal trap height for leafhoppers in cherry blocks depended on control method. In control sections traps at 6 ft high caught the most leafhoppers. However, in Surround and Extenday treated sections the most leafhoppers were collected at 2ft traps. 4 ft traps were often intermediate in each case.
- In no-choice tests, leafhoppers readily fed on Surround-treated leaves, suggesting that leafhoppers are able to detect leaves when presented with them.
- Phenology differed dramatically between Wenatchee Valley and Yakima County

Methods:

We evaluated two control methods (kaolin clay and Extenday groundcover) as additions to the spray rotation currently used on commercial cherry plots in the Wenatchee region (6 plots) and the Yakima region (2 plots) and evaluated kaolin clay in 2 Yakima region nectarine blocks. We targeted blocks with 1-10% disease prevalence to ensure that the block has disease to control, but that the disease prevalence is not high enough to risk block removal prior to the end of the experiment. Each replicate includes 12 rows with 200 feet of row, with three treatment locations randomized in a split-plot design. Thus, each plot included 36 rows, split in thirds for the three treatments. We evaluated leafhopper abundances and disease prevalence in the middle four rows and used the other rows as buffer rows to reduce spillover effects of the other treatments.

Figure 1 A 5 × 7 inch yellow sticky card placed at 4 ft on a cherry tree branch

Prior to harvest, disease incidence and location within the block was surveyed and recorded for the Wapato plots. After harvest completion, treatments were applied to assigned plots. Kaolin plots received four kaolin (Surround WP) sprays, one in July, August, September, and October (Table 1) on top of the grower's baseline insecticide program. Kaolin was sprayed at 50 lb/acre and 200 gal/acre. The postharvest Surround treatment aligns with a typical spray to reduce doubling, and doubling will be recorded in each plot next year. Our order of Extenday was delayed 4 months due to COVID19. Thankfully, our cooperator in Chelan County had Extenday which was deployed in our trial plots from May 27 – October 30. This gave us four replicates of Extenday for the 2020 season.

Figure 2 5x7 Yellow sticky cards suspended at 2, 4, and 6 ft from the ground.

After initial treatment application, leafhopper abundance in each treatment (Kaolin clay, Extenday, Control) replicate was monitored using 10 yellow sticky cards (5 × 7 inch) (Fig. 1) in the middle four rows. A yellow sticky card was tied to a cherry tree branch 4 ft from the ground and 25 ft in from each corner of the plot, and two sets of three yellow sticky cards were hung in the middle rows at 2, 4, and 6 ft from the ground using a bamboo pole and braided fishing line (Fig. 2-3). Sticky cards were deployed July 23rd in the Wenatchee region plots and July 31st in the Yakima region plots. Cards were collected and replaced every two weeks through October, and collected cards were returned to the lab to record leafhopper abundance by species (*Colladonus reductus* and *C. geminatus*). More than 99% of leafhoppers were *Colladonus reductus*, so we do not present *C. geminatus* data. Periodical beat sheet sampling was conducted to observe population densities within the tree canopy, but the low numbers relative to sticky cards suggested it was not an effective method of sampling. Throughout the winter sticky cards will be re-examined for natural enemy abundance including lacewings, ladybugs, and syrphid flies.

Table 1. Kaolin clay application timing and rate by county

	KC 1st app	KC 2nd app	KC 3rd app	KC 4th app	Rate
Chelan Co.	Jul 21, 2020	Aug 6, 2020	Sep 4, 2020	Oct 7, 2020	50 lbs/acre 200 gal/acre
Yakima Co.	Jul 29, 2020	Aug 10, 2020	Sep 9, 2020	Oct 15, 2020	50 lbs/acre 200 gal/acre

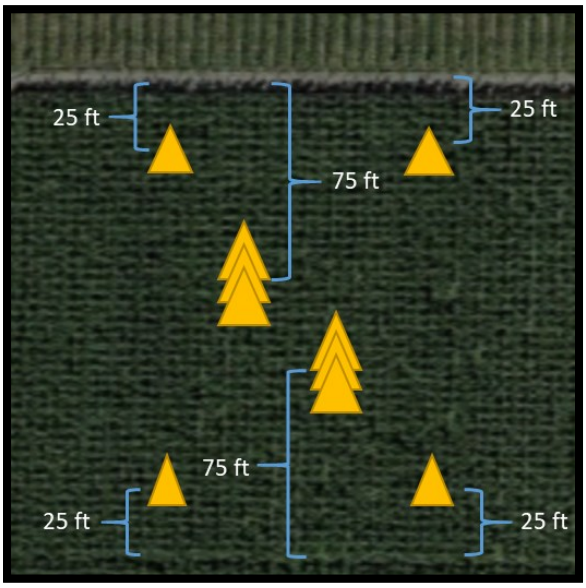

Figure 3 Trap deployment layout for each Surround, Extenday, and Control experimental plot.

No-Choice Surround Feeding Study

Kaolin clay (i.e. Surround) covered trees have been shown to reduce feeding and survivorship of other leafhoppers. However, while collecting traps in the Surround sprayed cherry plots, we observed leafhopper presence on leaves frequently. To empirically test if *C. reductus* leafhoppers will locate and feed on Surround covered cherry trees we conducted a no-choice feeding study. On Sep 29, we placed four field collected adult *C. reductus* in each of five cages with only Surround covered cherry tree leaves (collected from a sprayed experimental plot (Fig. 7)) and five cages with only non-sprayed cherry trees. We then observed leafhopper feeding behavior at 24, 28, and 46 hrs after initial set-up, recording the number alive, dead, on-plant, off-plant, and actively feeding (Fig. 8).

Results & Discussion:

Objective 1.

Two of the experimental plots in Wenatchee Valley were not analyzed, because we only observed a single leafhopper (1 *C. geminatus* in a control plot) all season across 60 traps. In 4 other plots in the Wenatchee region we observed generally lower numbers of leafhoppers in the Surround than control

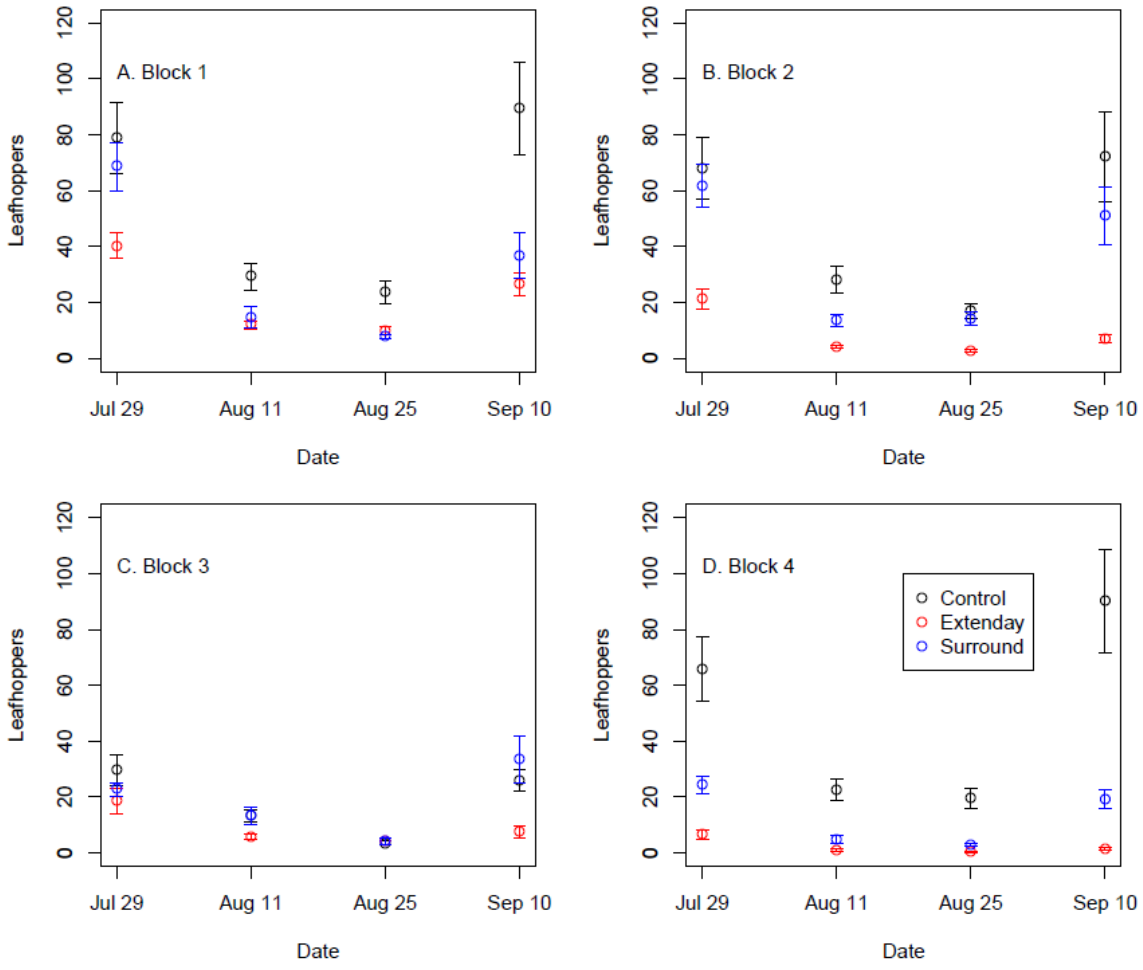

Figure 4 Mean *C. reductus* leafhoppers per trap in four plots in control (black), Extenday (red), or Surround (blue) subplots in Wenatchee region cherry blocks. Dates represent midpoints of 2-week sample periods, except for the September 10th date, which was a 3 week period.

plots (Figure 4). Similarly, Surround reduced leafhopper numbers on traps in 2 Wapato region cherry plots (Figure 5). In contrast, Surround did not improve control in nectarine plots with low leafhopper counts, with 2 and 1.25 leafhoppers per trap in the control plots and 1.875 and 3.62 leafhoppers in the Surround plots (averaged over 4 weeks of post-harvest sampling). In no-choice experiments *C. reductus* readily fed on leaves collected from one of our Wenatchee region Surround – treated plots,

with similar mortality over 48 hours compared to untreated leaves, suggesting that kaolin clay does not inhibit leafhopper feeding.

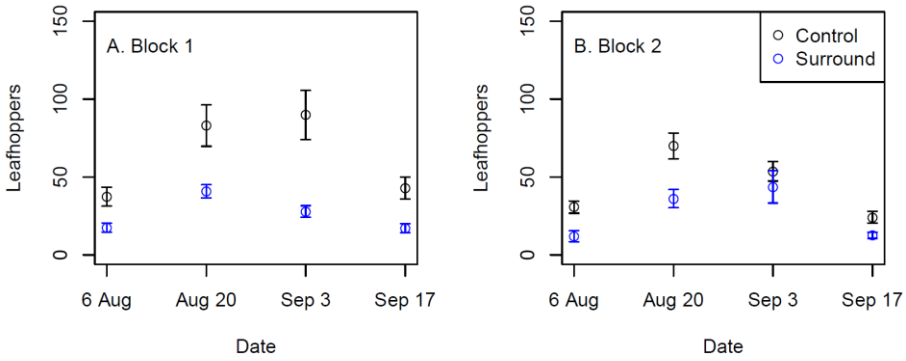

Figure 5 Mean *C. reductus* leafhoppers per trap in four plots in control (black) or Surround (blue) subplots in Yakima region cherry blocks. Dates represent midpoints of 2-week sample periods.

Objective 2.

Extenday reduced leafhopper numbers in the 4 Wenatchee region cherry plots, providing the best control (Figure 4). While further research is needed, it is likely that the control provided by Extenday is simply covering up the weedy hosts that leafhoppers commonly feed on (see continuing report on "Identifying sources of X disease in cherry orchards"). In some cases where leafhopper counts were higher than expected we observed weeds growing over the Extenday from the weed strip or it had come unattached and was pulled back, revealing ground cover.

Objective 3.

We observed different seasonal patterns of abundance in Wenatchee and Yakima regions, with leafhopper numbers highest in mid-August and early September in Yakima region plots, while Wenatchee leafhoppers were more abundant earlier and later. Sampling efforts in these plots are ongoing, as we anticipate leafhopper capture through the end of October. We did not observe strong edge effects in our blocks (data not shown) in leafhopper numbers.

Our interior traps included traps at 2ft, 4ft, and 6 ft, allowing us to evaluate optimal trap height for monitoring leafhoppers. These evaluations depended on the control method applied, presumably by altering the number of leafhoppers feeding on the trees versus ground cover. In control plots leafhopper counts were highest in the highest traps, whereas in Surround and Extenday plots leafhopper counts were highest in the 2 foot high traps (Figures 5,6).

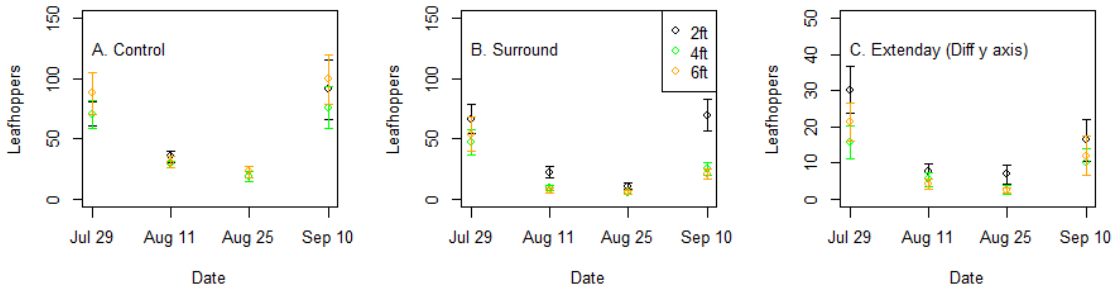

Figure 5 Mean *C. reductus* leafhoppers per trap averaged across 4 Wenatchee region cherry plots, at 2 feet (black), 4 feet (green), or 6 feet (orange) high in control (A), Surround (B), or Extenday (C) plots. Note the different axis for the Extenday plots (C).

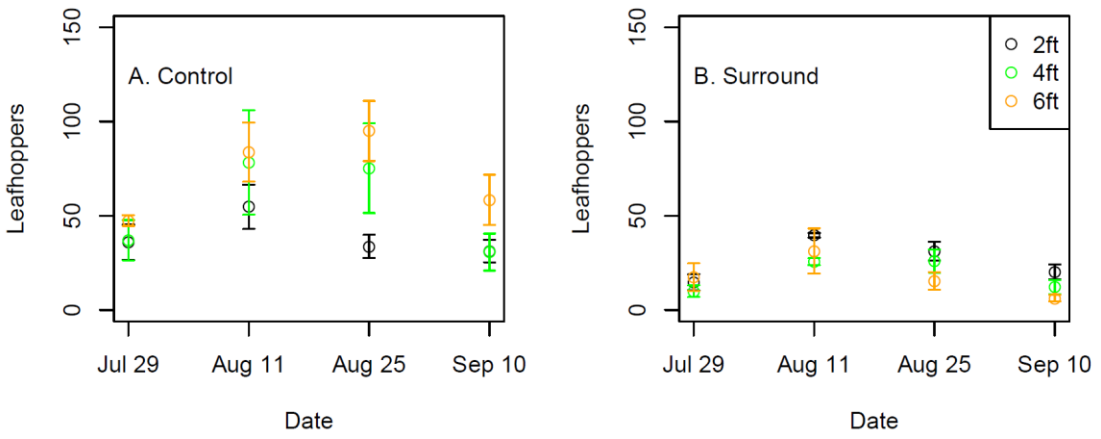

Figure 6 Mean *C. reductus* leafhoppers per trap averaged across 2 Yakima region cherry plots, at 2 feet (black), 4 feet (green), or 6 feet (orange) high in control (A) or Surround (B) plots.

Future plans: We are still collecting leafhoppers from traps in the 2020 season, which extends through October. Next year, we plan to continue trials on the identified plots to track disease progression from year to year, with a few key exceptions. First, now that we have Extenday we will implement it on all cherry blocks. Second, we will discuss the future of the blocks with grower cooperators and if any blocks are set to be removed we will identify other plots for research. We will also reconsider the plots where we did not collect leafhoppers, and search sticky traps on those plots for any potential vectors, which will guide future research. In addition, we have collected leafhoppers from the blocks and stored them in ethanol for gut content analysis after the season.