

X-Disease Phytoplasma (Western X) in Washington



Introduction

The X-disease phytoplasma (*Candidatus Phytoplasma pruni*) is the primary cause of small, pale, tasteless, and unmarketable cherries in Washington State (Figure 1 and Figure 2). In peaches, plums, and nectarines, X-disease symptoms are typically yellowed, curled, and shot-holed leaves, and small, deformed fruit (Figure 3). X-disease is present across North America, widespread throughout Washington State, and occurs at high incidence in Yakima, Benton, Franklin, Grant, and Chelan Counties. It is also present in Douglas, Okanogan, Klickitat Counties, and in Oregon in The Dalles area.

Background

X-disease also known as Western X, Cherry Buckskin, and Peach X, is not a new disease, but Washington is experiencing new complications. It was first identified in Washington State cherry trees in 1946. In a 1947 survey, about 1% of cherry trees were found to be infected, and it has remained present ever since, fluctuating in frequency. However, it has increased in prevalence dramatically in recent years, with pathogen strains, vectors, and environmental conditions that were not present in the previous outbreak.



Figure 2. X-disease phytoplasma on Bing cherry.



Figure 1. X-disease phytoplasma on Cristalina cherry.



Figure 3. X-disease phytoplasma on nectarine.

Symptoms

Infection reduces fruit size and quality in sweet cherries. In contrast to little cherry virus 2 where fruit are often bitter, fruit from X-disease infected trees are often tasteless. Fruit from X-disease infected trees have reduced fructose, glucose, and sorbitol content and in some cases total phenolic content increases (Wright et al. 2021; Harper et al. 2020). The primary strains present in the Pacific Northwest do not generally express foliar symptoms on cherry, whereas strains in other parts of the country can produce enlarged styles and witches' broom.

Symptoms in Cherry

- Small and misshapen fruit.
- Poor color development.
- Fruit bitter or lacking in flavor.
- Symptoms can be confused with unripe fruit until close to harvest.
- Symptoms are restricted to one or a few branches unless trees have been infected for multiple years.

Symptoms in Peaches, Plums, and Nectarines

- Yellowed, curled leaves.
- Leaf shot hole.
- Small, deformed fruit.
- Leaf yellowing symptoms on infected peaches and nectarines begin to appear about two months prior to harvest and get progressively worse, with shot holes appearing as the season progresses.

Symptom Progression

1. Years 1 and 2: Small fruit may be restricted to one branch or cluster. Fruit color may develop normally, or individual pale to white fruit may be observed. Early infections may display no notable symptoms.
2. Years 3–4: Systemically infected tree. Small fruit observed on multiple or all limbs, and poor color development is pronounced.
3. 5+ years: Cultivar dependent, but characterized by reduced fruit yield and dieback of limbs.

Causal Organism

X-disease phytoplasma is not a virus but instead is a type of wall-less bacterium known as a phytoplasma. The X-disease phytoplasma lives and replicates in the vascular phloem of infected trees, interfering with tree growth and development. Five major strains of *Ca. P. pruni* have been found to cause X-disease in commercially grown *Prunus* species (Molnar et al. 2024). These strains differ in

geographic distribution, severity, symptoms, and vector transmissibility. Unfortunately, the dominant strains in the Pacific Northwest cause fruit symptoms, but not leaf symptoms or stunting, making them more difficult to scout for.

Occurrence

X-disease is present across North America and throughout Washington State, with high incidence in Grant, Yakima, Benton, Franklin, and Chelan Counties, and is also present in the Oregon counties of Okanogan, Douglas, and Klickitat as well as in The Dalles area (Figure 4) (Molnar et al. 2022).

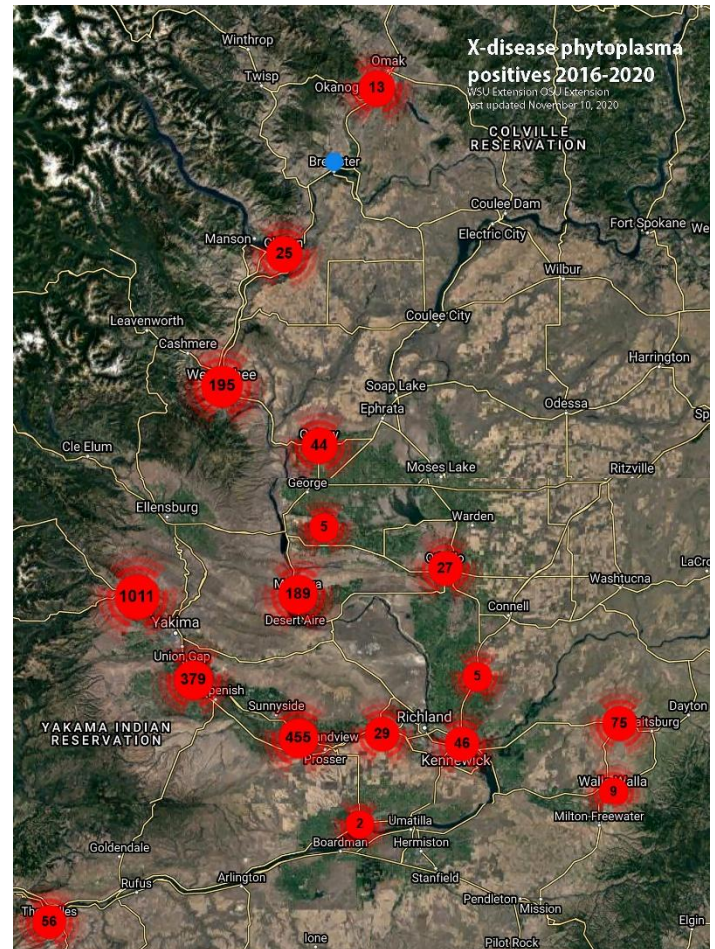


Figure 4. Distribution of documented positive samples for X-disease phytoplasma between 2016 and 2020.

Impacts

More than 238,856 sweet cherry trees (covering 974 acres) and 33,082 peach, nectarine, plum and apricot trees (covering 81 acres) were removed due to X-disease and little cherry disease (caused by LCV2 and LCV1) between 2015 and 2020 according to a recent survey conducted by Washington State University Extension and Oregon State University Extension. The survey included

81 respondents who collectively manage 15,420 acres, 26% of the total cherry acreage in Washington and Oregon (Molnar et al. 2022). Tree removals reduced industry revenue by an estimated \$30 million in 2020 and \$65 million between 2015 and 2020. Over the seven-year re-establishment period, estimated lost revenue and establishment costs to growers were approximately \$115 million.

Host Range

X-disease phytoplasma infects most *Prunus* species (e.g., cherries, peaches, nectarines, almonds, plums, and chokecherry). X-disease phytoplasma also infects a wide range of broadleaf plants. Previous studies found milkweed, alfalfa, clover, mustards, and plantains to be hosts (Jensen 1971; Chiykowski and Sinha 1982), but this was mostly through experimental inoculation. To identify the natural host range, a survey was conducted from 2021

to 2023 in which a total of 52 plant species, from 77 species tested, were positive for X-disease phytoplasma (Figure 5) (Shires et al. 2024). Plants from six families had significant numbers of positives, including members of the Asteraceae (dandelion), Malvaceae (mallow), Amaranthaceae (goosefoot/lambsquarter and pigweed), Polygonaceae (knotweed), Brassicaceae (flixweed, tumble mustard, hoary bittercress, and shepherd's purse), and Plantaginaceae (plantain). All these species are common components of the orchard floor or are present around orchard borders. Twelve other plant families were less prevalent in orchards and had a small number of positives for X-disease phytoplasma, including Apiaceae (e.g., queen anne's lace and wild carrot), Caryophyllaceae (chickweed), Fabaceae (clover), Geraniaceae (redstem filaree), Lamiaceae (henbit, purple dead nettle), Oxalidaceae (oxalis, ground sorrel), Poaceae (downy brome), Rosaceae (wild rose), Solanaceae (nightshades), and Tribulus (puncture vine).

Weeds positive for X-disease phytoplasma 2021 to 2023

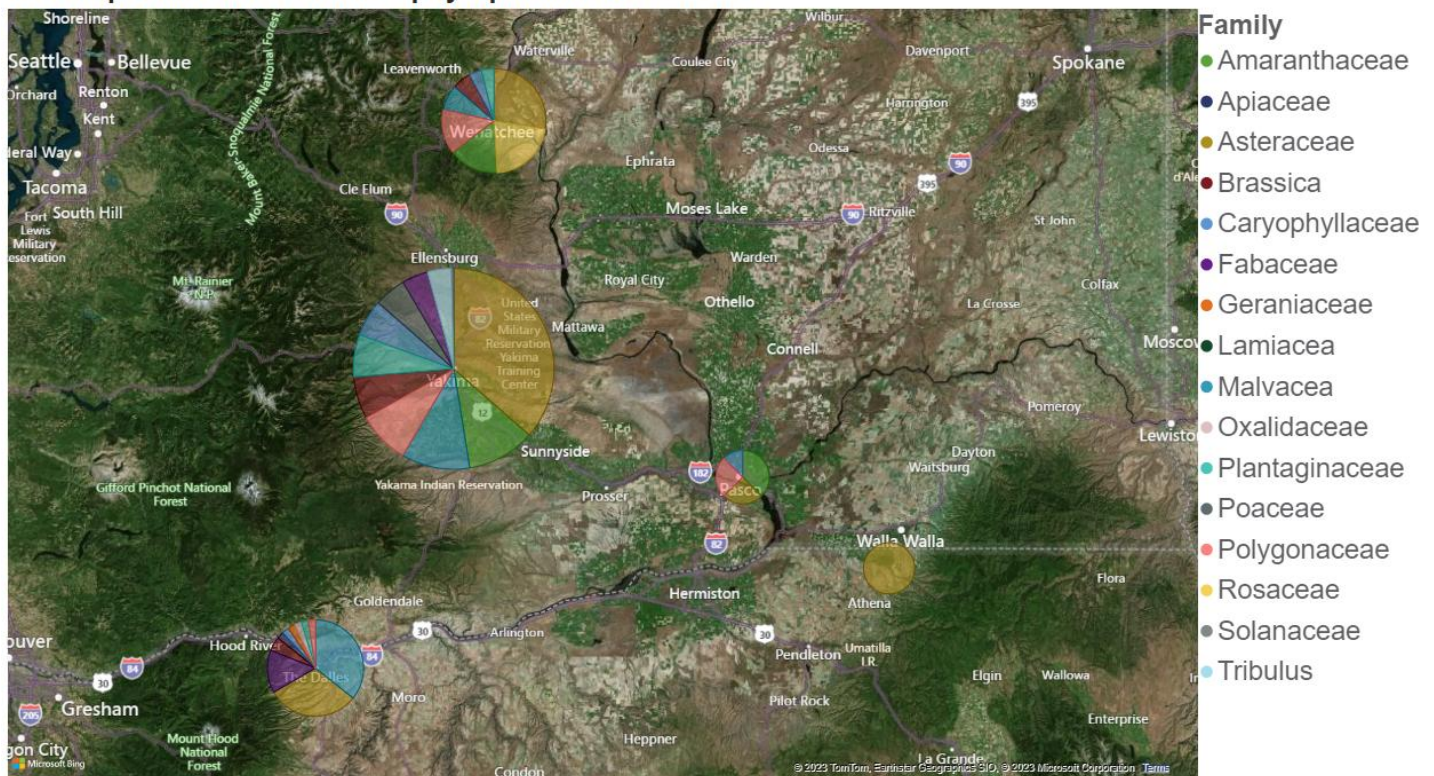


Figure 5. Map of alternative hosts for X-disease phytoplasma identified from orchards and orchard surroundings between 2021 and 2023. The larger the circle the greater number of positive samples.

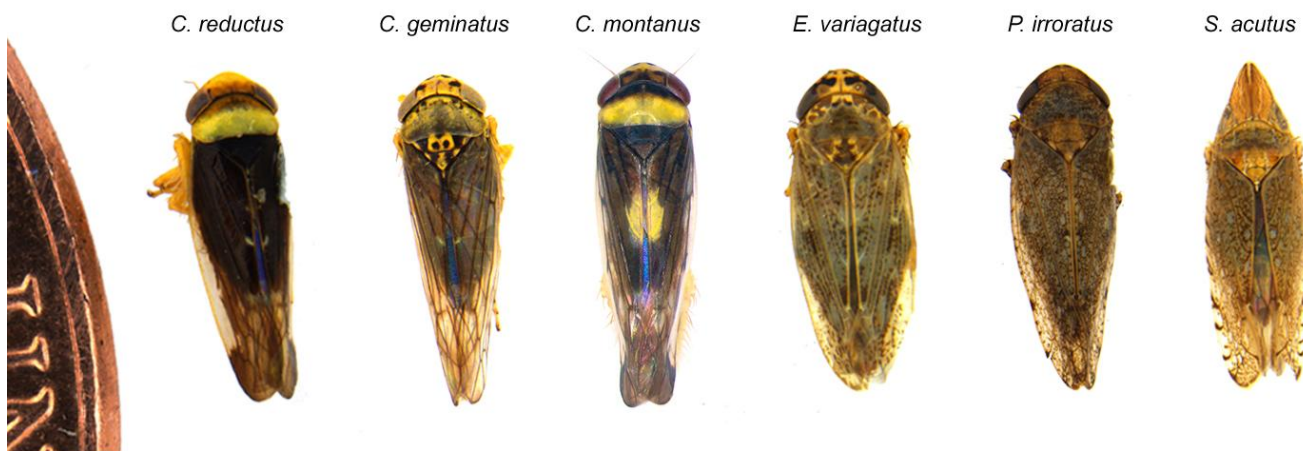
Transmission

Grafting: X-disease phytoplasma is readily transmitted by all types of grafting.

Vector: Leafhoppers are the only known vectors. Seven leafhoppers are known to transmit X-disease phytoplasma: *Colladonus reductus*, *C. geminatus*, *Euscelidius variegatus*, *C. montanus*, *Fieberiella florii*, *Scaphytopius acutus*, and *Paraphlepsius irroratus* (Figures 6 and 7) (Jensen 1969; Purcell and Elkinton 1980). In tests of over 2,000 individuals, no other leafhoppers were found positive for X-disease phytoplasma (Northfield et al. 2023). The only species found actively transmitting in that survey were *C. reductus* and *C. geminatus*. *C. reductus* is the most common X-disease leafhopper vector in Washington, followed by *E. variegatus* and, at a lower frequency, *C. geminatus*, although relative abundances differ by location. Low numbers of *S. acutus* were found in Washington surveys from 2021 to 2022 (Northfield et al. 2023; Northfield and Nottingham 2020). Research in the 1960s suggests that *E. variegatus* is a less effective vector than *C. reductus*, with a longer latency period (approximately 50 days compared to 30–35 days) (Jensen 1969). This study's results align with our finding that field-collected *E. variegatus* never had enough phytoplasma in their mouthparts for transmission (Marshall et al. 2025). Leafhopper vector transmission will vary depending on the level of infection in the block as well as the numbers of leafhoppers. For example, in a two-year study of managed orchards with some X-disease incidence, 9%–25% had acquired the phytoplasma, and up to 1.3% of *Colladonus* spp. leafhoppers were able to transmit it (Northfield et al. 2023). However, in an unmanaged orchard with high levels of infection (50 of 50 trees testing positive), 40% of *C. reductus* leafhoppers had acquired the phytoplasmas (Marshall, unpublished data).



Figure 6. *C. geminatus* (top) and *C. reductus* (bottom). Photo credit: C. Reyes.



Leafhopper sizes are not relative or proportional. Actual specimens may vary in size.

Figure 7. Leafhopper vectors of X-disease phytoplasma *Colladonus reductus*, *Colladonus geminatus*, *Colladonus montanus*, *Euscelidius variegatus*, *Paraphlepsius irroratus*, and *Scaphytopius acutus*. Not shown *Fieberiella florii*. Photo credit: C. Reyes.

Life Cycle of the Organism

The X-disease phytoplasma lives and replicates in the phloem tissues of the tree. Over the winter, the phytoplasma numbers in the aerial parts of the tree decline but do not die out completely, while higher levels of phytoplasma survive in the roots. In the spring, the aerial portions of the tree become re-infected as the phytoplasma moves through the phloem of the tree following source-to-sink pathways. As a result, you may see symptoms in one limb for a year or more, but symptoms will eventually appear in additional limbs. Removing a symptomatic limb does not eliminate the phytoplasma since it is already in the root system before symptoms appear.

Vector Biology

In Washington, *C. reductus* has three periods of peak adult abundance: early summer (June), late summer (August), and early fall after harvest (September and October), indicating a potential for three generations per year (Marshall et al. 2024). In California, *C. reductus* was found to have a generation time of 56 days (Severin and Klostermeyer 1950). *C. reductus* feed on a wide range of hosts according to feeding trials, including mallow, alfalfa, cherry, peach, white clover, and dandelion (Northfield and Cooper 2020). Current phenology of *C. geminatus* is largely unknown due to low abundance in recent years. Research in the 1940s and '50s suggested it had generation times of 60 and 56 days in Oregon and California, respectively, with adults emerging in May and September in Oregon (Nielson 1968), which is generally supported by recent research.

Sampling and Testing for X-Disease

Material to sample: Submit four five-inch cuttings from the diseased limb(s) including *young woody tissue* (pencil sized, previous season's wood), leaves, and fruit stems (Figure 8).

Woody material should be from the previous season or older because it has been found that the current season's growth can have variable pathogen concentrations. New research shows that leaves may test negative even though the wood they are attached to tests positive, therefore leaves by themselves are not recommended. Pencil sized wood from the previous season and fruit stems are the best tissue to sample.



Figure 8. To test for X-disease phytoplasma, submit four five-inch cuttings, which include pencil sized wood, leaves, and fruit stems from symptomatic limbs. Photo credit: T. DuPont, WSU Extension.

Where to sample: For trees with symptoms, sample from symptomatic limbs. For trees with no symptoms, sample from each leader. (Note that samples are only needed in unconfirmed blocks or adjoining trees.)

When to sample: The week before harvest to mid-August.

Sample condition: Keep tissue moist and cool (e.g., package with a cold pack). Old or dried tissue is more likely to have false negatives.

Controls

There is no cure, and an infected tree will remain infected for the rest of its life. There are no commercial products that have been shown to have an effect on the phytoplasma in scientific studies. Management requires a combination of strategies including planting pathogen free trees, identifying and removing infected trees, using cultural controls, managing vectors, and managing alternative hosts.

Pathogen-Free Planting Sources

Replacement trees must be obtained from pathogen-free planting stock. Nursery trees can be free of symptoms and still be infected. *Use certified trees.* Manage your risks—if in doubt, have the material tested before you buy or plant.

Identify and Remove Infected Trees

Primary control measures rely on identification and removal of infected trees. Remove infected trees following postharvest treatment for leafhoppers. Infected trees spread the pathogen to neighboring trees by insect vectors or via root-grafting from tree to tree. Treating stumps with herbicide immediately after cutting or injecting into trees before cutting trees (frill treatment) can help to identify adjoining root grafted trees and ensure roots are dead. Several glyphosate products are labeled; see these [best management practices \(BMPs\) for tree removal](#). An early study showed that when infected trees were removed as soon as symptoms were observed, the disease incidence remained below two percent and decreased over time (Van Steenwyk et al. 1995).

Cultural Controls

Kaolin. Recent research has shown that kaolin clay (Surround) applications can reduce leafhopper vector populations in high pressure blocks by 48% percent and reduce leafhopper movement into the canopy (Marshall et al. 2024). Kaolin not only deters leafhoppers from orchards but it also repels leafhoppers from trees.

Extenday. Extenday can reduce populations in high- or low-pressure blocks by over 80% (Marshall et al. 2024). The effectiveness of Extenday is likely due to removing access to alternative and reproductive hosts in the drive row of the orchards, such as dandelion and other broadleaf weeds.

Grass in drive rows. Planting grass in drive rows can reduce peak leafhopper numbers by approximately 50% compared to weedy drive rows (Northfield, 2023, unpublished data). Leafhoppers cannot survive on grasses (Northfield and Cooper 2020). The most common plants fed on by the leafhopper vectors of X-disease phytoplasma are broadleaf weeds such as dandelion, mallow, lambsquarter, chickweed, knotweed, and plantain (Cooper et al. 2022).

Remove suckers. Root suckers provide easily accessible feeding sites for leafhopper vectors. Root suckers also tend to have higher levels of phytoplasma earlier in the season, likely due to movement of the pathogen from the roots where it overwinters (Wright et al. 2022). Removing root suckers may reduce movement of leafhopper vectors into the canopy and reduce transmission (Marshall, 2023, unpublished data).

Monitor and Manage Vectors

Consider timing. Both leafhopper population numbers and X-disease phytoplasma concentration in the tree are likely to be higher after harvest. When phytoplasma concentration in the tree is higher leafhoppers are more likely to acquire and transfer the pathogen. Concentrate

monitoring and management efforts when risk is highest after harvest.

Monitor. Monitor leafhopper populations in the early and late season, including postharvest in order to manage populations not controlled by your general insect management program.

- Use yellow sticky cards or sweep nets (Purcell and Elkinton 1980).
- Hang sticky traps two to four feet from the orchard floor.
- Place traps on orchard borders, in areas of concern in your block, and throughout block. Use approximately one trap per two acres.
- Monitor every one to two weeks.
- Identify leafhoppers that vector X-disease phytoplasma (Figure 9).
- Use presence (an average of one vector leafhopper per trap) as a threshold to spray.

Rotate leafhopper products when populations are present. Manage vector leafhoppers when they are present based on monitoring. In Washington this is often after harvest. If leafhoppers are present, apply sprays and rotate between pesticide groups considering efficacy (Table 1). Due to the residual of common conventional products, sticky cards will likely show 21 to 30 days of control, necessitating four to six after-harvest sprays per season.

The following is an example spray rotation:

- *group 3* pyrethroid (e.g., Warrior II)
- *group 4* neonicotinoid (e.g., Actara)
- *a new active group*
- back to a *group 3* or *group 4*
- *group 1* (e.g., Carbaryl) late in season when leaf drop is not a concern



Figure 9. *C. geminatus* (left) and *C. reductus* (right). Look for the face of a pirate with sunglasses and a handlebar mustache on the back of *C. geminatus*. Look for a distinct yellow stripe on *C. reductus*. Photo credit: T. Northfield, WSU Entomology.

Spray applications every two to three weeks should be the shortest interval needed. One reason more frequent sprays are not recommended is because it takes several weeks after feeding on an infected plant for a leafhopper to be able to transmit the phytoplasma. The phytoplasma must pass through the insect gut, into the “blood,” and to the salivary glands before it can be excreted into a new plant with the saliva. Additionally, with more frequent sprays, managers will likely exhaust the legally allowed number of applications before the end of the season when transmission is likely to be highest.

Manage Alternative Hosts of the Phytoplasma and of the Leafhoppers

Reducing broadleaf weeds in orchards can help reduce leafhopper numbers and potentially reduce transmission.

Grasses are poor hosts for key vectors and are not a common host for phytoplasma. Apply broadleaf herbicides to the drive row as well as tree row. For example, in a recent study, herbicide applications reduced leafhopper vector numbers by up to 50%, likely by reducing the preferred habitat of the leafhoppers (Northfield, 2023, unpublished data). Healthy, weed-free grass strips compete with broadleaf weeds and supply a non-phytoplasma host environment.

Summary

Control of this disease requires a community-wide effort. What a neighbor does or does not do will affect adjacent orchards (and vice versa). The key to ending the current X-disease epidemic relies on reducing the amount of pathogen present in the state. This can only be done by removing infected trees, because it is from those trees that leafhoppers are acquiring the pathogen, then subsequently spreading it.

Available Materials

Table 1. Materials labeled for leafhoppers in cherry in Washington. The relative efficacy of a pesticide against a given pest is denoted via a 1 to 4 scale, with 1 indicating low and 4 indicating high efficacy. This information is based primarily on research conducted by Washington State University researchers. The rate per acre is based on 100 gallons per acre.

Chemical	Rate per Acre	REI	PHI	MOA	Efficacy	Notes
Actara thiamethoxam	2.75 oz	12 h	14 d	4A	2–4	Actara at 2.75 oz/100 gal resulted in 100% mortality of <i>C. reductus</i> leafhoppers 24 hours after treatment in a 2020 WA trial (Nottingham and Northfield 2020). Actara maintains good control past 24 hours after treatments at 60%–80% mortality (Nottingham and Northfield 2021). Actara had more than 80% control in 10 CA trials, above 50% in 2 CA trials and 30%–50% in 1 CA trial (Van Steenwyk et al. 1988; Van Steenwyk and Fouche 1989; Van Steenwyk et al. 1990; Van Steenwyk et al. 2002; Van Steenwyk et al. 2003). Generally thought to work well on nymphs and poorly on adults.
Admire Pro imidacloprid	2.8 fl oz	12 h	7 d	4A	1–4	Admire Pro has had mixed success in lab bioassays on <i>C. reductus</i> , from 100% mortality in direct sprays to 15% by residues (Nottingham and Northfield 2021). Provado rated as high in efficacy on white apple leafhopper in WA trials. Provado provided 8%, 20%, 34%, 69%, 30%, 34%, 51%, and 73% control in eight CA trials (Van Steenwyk and Fouche 1989; Grant and Van Steenwyk 2000; Van Steenwyk et al. 2002). Many generic products are now available (e.g., Macho, Asada, Midash Forte).
Agri-Mek SC abamectin	See Label	12 h	21 d	6	2–4	Generally thought to work well on nymphs and poorly on adults. Rated excellent control on white apple leafhopper nymphs in West Virginia (Hogmire and Winfield 1999). 50% control of nymphs and adults in New York (Reissig et al. 1995).

Chemical	Rate per Acre	REI	PHI	MOA	Efficacy	Notes
Asana XL esfenvalerate	2–5.8 fl oz	12 h	14 d	3A	3–4	Asana resulted in 100% mortality of <i>C. reductus</i> leafhoppers 24 hours after treatment in a 2020 WA trial (Nottingham and Northfield 2020). Asana's efficacy drops to around 50% within 24 hours of treatment (Nottingham and Northfield 2021). Asana had 80%–90% control in 8 CA trials and 50%–79% in 1 CA trial (Van Steenwyk 1988; Van Steenwyk and Fouche 1989; Van Steenwyk et al. 1990; Van Steenwyk et al. 2002).
Assail 70WP acetamiprid	1.7 oz	12 h	7 d	4A	1–2	Assail had 20%, 25%, 40%, and 52% control in 4 CA trials (Van Steenwyk et al. 2002). Generally higher efficacy on younger instar nymphs.
Avaunt indoxacarb	6.00 oz	12 h	14 d	22	3–4	Rated good to high efficacy on white apple leafhopper in WA.
Aza-Direct azadirachtin	1–2 pt	4 h	0 d	un	1–3	Aza-Direct at 32 oz provided 62%, 78% control of white apple leafhopper and 63%, 25% of potato leafhopper in apples (DuPont et al. 2020; Wise et al. 2002). Aza-Direct 32 oz provided 64% of control for potato leafhopper nymphs (Harding et al. 2020).
Azera azadirachtin, pyrethrin	56 fl oz	12 h	0	3A	3	Azera (premix of pyrethrins 1.4% and azadirachtin 1.2%) achieved 100% mortality of <i>C. reductus</i> 24 hours after treatment in a 2020 WA trial (Nottingham and Northfield 2020; Nottingham and Northfield 2021). Residual control is unknown. Azera 40 oz provided 64% of control for potato leafhopper nymphs (Harding et al. 2020).
Beleaf 50SG flonicamid	2.8 oz	12 h	14 d	29	2–4	In contact bioassays caused 90% mortality 1 day after treatment and 30% mortality to 85% mortality 1 to 2 days after treatment, respectively (Marshall et al. 2025).
Bexar tolfenpyrad	21 fl oz	12 h	14 d	21A	NR	Additional testing is needed, but an initial lab bioassay showed 65% mortality of <i>C. reductus</i> (Nottingham and Northfield 2021).
Celite 610 diatomaceous earth	50 lb	none listed	un	un	3–4	Celite prevented leafhoppers from colonizing leaves compared to 1% oil by 50% and to untreated checks by 85% in 4 experiments (Nottingham and Northfield 2021).
Cinerate cinnamon oil	32 fl oz	none listed	0 d	un	3	67% mortality of <i>C. reductus</i> in a 2020 WA trial (Nottingham and Northfield 2020).
Danitol 2.4EC fenpropathrin	18 fl oz	24 h	3 d	3A	2–4	It is generally recommended that no more than 2 Danitol 2.4 EC apps per season. Danitol had 68%–94% control in 4 CA trials at 0.2 and 0.4 lb AI per acre (Steenwyk et al. 1993).
Entrust SC spinosad	8 fl oz	4 h	7 d	5	1–2	32% control of <i>C. reductus</i> in a 2020 WA trial (Nottingham and Northfield 2020).
Malathion 5EC malathion	2.8 pt	12 h	3 d	1B	NR	Additional testing is needed, but an initial lab bioassay showed 100% mortality of <i>C. reductus</i> (Nottingham and Northfield 2021).
Neemix 4.5%L azadirachtin	16.00 fl oz	4 h	0 d	un	1–3	Neemix was not different than the check for controlling of <i>C. reductus</i> (Nottingham and Northfield 2021). Neemix at 3.5 and 7 fl oz provided little control compared to the check (Sevin) for white apple leafhoppers for first or second generations (Beers 1995; Beers 1996). Neemix 4.5 at 8 oz provided 67% control for potato leafhopper adults 7 days after treatment (Patton and Dively 2002).
Sevin XLR Plus carbaryl	3.00 qt	12 h	3 d	1A	2–4	Can cause leaf drop in Canadian varieties. Use fall only. Sevin had 50%–90% control in 5 CA trials (Van Steenwyk et al. 1988).
Success spinosad	2–2.7 fl oz	4 h	7 d	5	3	Rated as good efficacy on white apple leafhopper in WA.

Chemical	Rate per Acre	REI	PHI	MOA	Efficacy	Notes
Surround WP kaolin clay	25–50.00 lb	4 h	0 d		3–4	Kaolin confuses insects where they don't recognize which plants to feed on. Two initial postharvest applications, followed by monthly reapplication of Surround at 50 lb/acre, reduced leafhopper numbers 20%–80% in traps in a 2020 WA study (Northfield and Nottingham 2020). Kaolin prevented leafhoppers from colonizing leaves compared to 1% oil by 50% and to untreated checks by 85% (Northfield and Nottingham 2021). Kaolin reduced disease transmission of Pierce's disease by glassy winged sharpshooters better than conventional products in 1 trial (Tubajikaa et al. 2007). 100% control of white apple leafhoppers (Wise et al. 2002). Surround + Trilogy 49% control potato leafhopper adults 7 days after treatment (Patton and Dively 2002).
Transform sulfoxaflor	2.75 oz	24 h	7 d	4C	3–4	Laboratory bioassays show 85%–95% mortality of <i>C. reductus</i> (Nottingham and Northfield 2021).
TriTek petroleum oil, summer	2 gal	4 h	0 d		3	Oil at 1% reduced leafhoppers in choice tests by 75% (Nottingham and Northfield 2021). Oil at 2% reduced white apple leafhopper oviposition, resulting in fewer nymphs (Fernandez et al. 2001).
Warrior II lambda-cyhalothrin	2.56 fl oz	24 h	14 d	3	NR	95% control potato leafhoppers (Laub et al. 2003). For potato leafhoppers Warrior II CS at 1.9 fl oz had numbers 40% lower (but not significantly different) than untreated control (Kuhar 2009).

Note: Use pesticides with care. Apply them only to plants, animals, or sites listed on the labels. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock. YOU ARE REQUIRED BY LAW TO FOLLOW THE LABEL. It is a legal document. Always read the label before using any pesticide. You, the grower, are responsible for safe pesticide use. Trade (brand) names are provided for your reference only. No discrimination is intended, and other pesticides with the same active ingredient may be suitable. No endorsement is implied.

Additional Information

Internet Resources

X-Disease and Little Cherry Virus Scouting and Sampling Guide <http://treefruit.wsu.edu/crop-protection/disease-management/western-x/sampling-guide/>

Little Cherry Virus <http://treefruit.wsu.edu/crop-protection/disease-management/little-cherry-disease/>

Symptoms Gallery <https://treefruit.wsu.edu/crop-protection/disease-management/western-x/symptoms-gallery/>

Nursery Prevention of X-Disease Phytoplasma and Little Cherry Virus Recommendations <https://treefruit.wsu.edu/nursery-prevention-lcd/>

X-Disease Phytoplasma Vector Gallery <https://treefruit.wsu.edu/vector-gallery/>

BMPs for Tree Removal for X-Disease and Little Cherry Virus Infected Trees <http://treefruit.wsu.edu/article/bmps-for-tree-removal-for-x-disease-and-little-cherry-virus-infected-trees/>

Case Studies on Tree Removal for X-Disease Phytoplasma and Little Cherry Virus

<http://treefruit.wsu.edu/article/tree-removal-case-studies/>

Alternative Weedy Hosts for X-Disease Phytoplasma <https://treefruit.wsu.edu/article/alternative-weedy-hosts-for-x-disease-phytoplasma/>

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Videos

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