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Field Monitoring for Grapevine Leafroll Virus and Mealybug in Pacific Northwest Vineyards

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Oregon has been experiencing growing concern about vineyard viruses. This concern is heightened by the increasing incidence and spread of viruses and insect transmitters (vectors) in the California grape industry. Vineyards in grape-growing regions of California, Washington, and Idaho have battled the spread of grapevine leafroll viruses since as early as 2002. Several vineyards in Oregon have been identified with the viruses and mealybug vectors.

These viruses can cause decreases in vine health and compromise vineyard longevity and sustainability. Vines infected with grapevine leafroll virus can produce under-ripe grapes and have lower yields.

To prevent movement of virus and vectors into the region, producers should be equipped to do preliminary scouting to identify virus symptoms and insect infestations. This publication focuses on the in-field identification of signs and symptoms associated with grapevine leafroll-associated viruses and the insects that transmit them. This can be used as a guide for preliminary scouting of vineyard blocks that may be suspected of having grapevine leafroll viruses.

What are grapevine leafroll viruses?

There is no cure for vines infected with grapevine leafroll viruses. Grapevine leafroll viruses are members of the *Closteroviridae* family. Ten distinct viruses have been identified.

These viruses are systemic in the vine, although they are generally localized in the vascular plant tissue (phloem). Because the viruses are maintained in the vascular tissues of wood, they are often spread by cuttings and by grafting of clean scions onto infected rootstocks or infected scions onto healthy rootstocks.

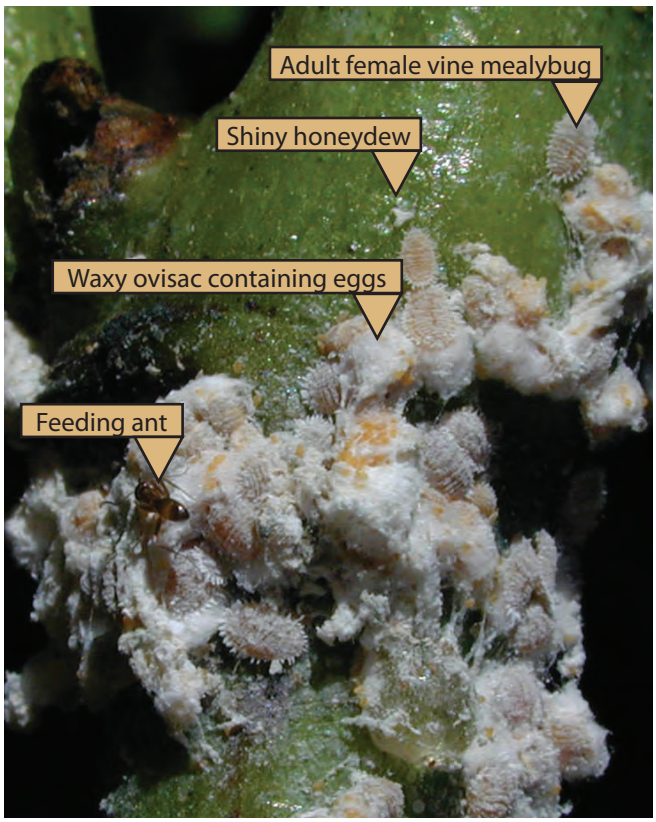

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Figure 1. Adult vine mealybugs are oval-shaped with filaments around their bodies. Egg sacs are small, ovoid, and yellow-orange. Ants feed on the honeydew secreted by mealybugs.

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How the viruses are spread

Grapevine leafroll viruses are transmitted (vectored) by several species of mealybugs (family *Pseudococcidae)* and scale insects (family *Coccoidea)*. Prominent mealybug vectors include the grape mealybug (*Pseudococcus maritimus*), vine mealybug (*Planococcus ficus*), and obscure mealybug (*Pseudococcus viburni*).

Soft-scale insects such as the European fruit lecanium scale, cottony maple scale, and wooly vine scale have been reported as transmitters of grapevine leafroll viruses. However, the efficiency with which they are able to transfer the viruses is not as certain as it is for mealybugs.

Significant spread to previously uninfected areas can occur rapidly when a vineyard has virus-infected vines and an insect vector. When vectors are present, vineyards with less than 10% virus infection can show greater than 90% infection within a period of 10 years or less.

Mealybugs are believed to be the most important documented vectors of the grapevine leafroll virus in these areas.

The impact of mealybugs

Mealybugs feed on the vascular tissue (phloem) of grapevines. As a byproduct of digestion, they expel a thick, sticky, shiny substance known as "honeydew."

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Figure 2. A waxy, cotton-like residue is common with mealybug infestation. It may be visible on the surface and in the center of grape clusters. In less severe infestations, scouting may require moving some berries to see the mealybugs within the cluster.

Ants feed on honeydew and are often seen in association with mealybugs. These ants protect mealybugs from natural enemies, thereby impeding biological control.

Honeydew supports the growth of a common fungus called sooty mold. This black mold grows on honeydew covering the surface of the vine trunk, cordon, leaves, stems and clusters. Sooty mold reduces the quality of grapes and the photosynthetic ability of the vine leaves.

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Figure 3. Sooty mold covers a trunk laced with honeydew from mealybugs. Evidence of mealybug infestation is visible after pulling away the bark.

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Figure 4. Vine mealybugs are observed at the base of the trunk at the upper regions of the roots.

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Figure 5. Obscure mealybug found on the roots of a weed, common sow thistle.

Mealybug lifecycles

Female mealybugs undergo incomplete metamorphosis. Nymphs (crawlers) closely resemble adults in body shape. Adult females are flightless, 1 to 5 mm long, oval-shaped, and white with waxy secretions. Some have thin filaments along the margin of the body. Females lay several hundred eggs in cottony sacs. Crawlers hatch and emerge after 1 to 15 days during summer months, depending on climate.

Adult male mealybugs go through a more complete metamorphosis. They are tiny with long antennae and a single pair of wings, unlike crawlers and adult female mealybugs. The males do not feed during the adult stage. They respond to pheromones, chemical signals or scents given off by females. After they mate, they die.

Grape mealybugs have two to three generations each year. When gently probed, grape mealybugs secrete a reddish orange defensive fluid. Be sure not to crush mealybugs to observe this.

Vine mealybugs can have between three and nine generations each year, depending on the climate. They feed on all parts of the vine, including the roots.

Obscure mealybugs have two to three generations a year. When gently probed, obscure mealybugs secrete a clear defensive fluid. Be sure not to crush mealybugs to observe this.

Managing the virus and mealybugs

Mealybugs are difficult to eradicate once vineyards become infested, and the virus is impossible to cure. Prevention is key.

Knowing the common signs and symptoms of insect vector and virus infection may help growers manage insects and disease in the vineyard. Early recognition of vineyard infection with grapevine leafroll virus and/or its vector insects is vital.

Symptoms are not expressed consistently over years and may go unnoticed. Stressed vines may exhibit symptoms more readily. Without intervention, the virus becomes a larger problem and a threat to uninfected vineyard blocks and neighboring sites. The best defense is to train vineyard crews to identify signs and symptoms and report to the vineyard manager for further investigation.

Monitoring for mealybugs

Table 1 presents some guidelines for mealybug monitoring.

Finding mealybugs at very low infestation levels is difficult. Vineyard infestation may go unnoticed for several years. Many symptoms can be found by looking within vine canopies, peeling away bark on trunks and cordon, digging around the base of the vine trunk, and sampling the root zone of the alleyways or cover crop.

Crawlers are very difficult to find once they leave the egg sac of adult females. Often they can be observed close to egg sacs by using a hand lens.

Commercially available pheromone traps are available for the vine mealybug and can be used effectively to determine low infestation rates of that species by trapping male vine mealybugs. Traps for other mealybug species are currently under development.

In the Pacific Northwest, the best time to sample for mealybugs is mid-July through October, when populations increase and the insects are found in higher numbers in their preferred feeding spots. They tend to be found under bark and in pruning wounds and crevices. Other key areas to sample include exposed plant parts: trunk, cordon, canes, shoots, leaves, and clusters. Be sure to sample roots in sandy soils.

Honeydew, ants, and sooty mold are common signs of mealybug infestation and can be found on any part of vines. Peel bark away to look for egg sacs.

If you identify symptoms of mealybug infestation, record your observations and contact your Extension horticulture agent: http://extension.oregonstate.edu/locations.php. You can collect and submit samples to the Oregon State University Insect ID Clinic: http://www.science.oregonstate.edu/bpp/insect_clinic/index.htm. Consult a pest management guide and your local Extension horticulture agent before resorting to chemical control.

Table 1. Monitoring for mealybugs.

Location on plant	Signs	When to scout
Leaves and canopy	Various stages of mealybug development from adults, immature stages and egg sacs (see figure 1).	Mid-summer to harvest
	Sticky honeydew and black sooty mold can be found on the surface and may be associated with the presence of ants.	Late summer to harvest
	Vines may become weak, and basal-shoot leaves may fall prematurely with heavy mealybug infestations.	Late summer to harvest
Fruit clusters	Sticky clusters on vines before harvest. Look inside clusters for waxy, sticky white residue between berries and on rachis (see figure 2).	Summer to harvest in vineyard and crush pad as well as during processing
	Black, sooty mold development	Late summer to harvest
Trunk or cordon	Wet or shiny appearance of bark caused by honeydew. This may be accompanied by black sooty mold (see figure 3).	Summer to harvest
Trunk (under bark)	The majority of the mealybug populations may be found under the bark (see figure 3).	Year-round
Base of trunk and roots (below soil surface 0"–6")	Adult mealybugs and immature crawlers. Waxy, fuzzy, white, cotton-like appearance (see figure 4).	Winter to early spring
Cover crop/weeds	Pull cover crops or weeds to look for mealybugs at the shoot-root-soil interface (see figure 5).	Late summer to fall
Vine debris (pruning wood, leaves, thinned fruit)	Leaves, canes and fruit may contain various stages of mealybugs as well as egg sacs.	Year-round

Monitoring vines for viruses

Symptoms of grapevine leaf roll viruses are similar to general stress responses in grapevine. Symptoms can be mistaken for other factors such as water stress, nutrient deficiency, crown gall, vertebrate damage, or mechanical injury. Table 2 lists symptoms or combinations of symptoms that may be observed with the viruses. Symptoms expressed vary, depending on the grape cultivars, age of the vineyard, stage of infection, viticulture practices, environmental conditions, and the strain of the virus.

Visual symptoms are not adequate to diagnose virus infection. Laboratory tests of tissue samples are required. If you believe you may have the virus in your vineyards, note your seasonal observation. Record the block information, date of observation, phenology and what you saw. Collect and submit samples for virus analysis to verify whether the symptoms are related to the virus. The best analyses for the viruses are the enzyme-linked immuno-sorbent assay (ELISA) and polymerase chain reaction (PCR) tests. Ask about specific tests conducted by analysis labs before submitting samples. The optimum time to sample for testing is in fall, during ripening through harvest. Collect leaf samples (blade and petiole) and submit to an analytical lab. Samples can be taken late season, even post harvest. Place leaves in a plastic, ziplock bag with a dry paper towel and ship overnight or drop off at a virus testing lab. Check with the testing lab to verify the appropriate tissue type, timing of sample collection, and handling before analysis.

If your vineyard tests negative, consult your vineyard management practices and consider nutritional tissue analysis.

Table 2. Preliminary scouting and identification for grapevine leafroll virus.

Location on plant	Symptoms	When to scout
Leaves	• Discoloration, generally between veins, but may vary. • Red cultivars—red to reddish purple (see figure 6). • White cultivars—yellowing or chlorotic mottling (see figure 7).	August until leaf fall
	Leaf margins may curl downward (see figures 6 and 7).	August until leaf fall
Fruit clusters *These symptoms are subtle, may not always be observed, or may be caused by other factors such as nutrition, disease, or vineyard management problems.*	Loose and smaller clusters. Poor fruit set and lower cluster weights and vine yield.	Fruit-set until harvest
	Poor color development in red cultivars.	Véraison until harvest
	Low °Brix (soluble solids).	Véraison until harvest
	Fruit never ripens to desirable soluble solids (°Brix) titratable acidity.	Harvest
Vine Growth	Decreasing vine growth and yield.	Year-round
	Delayed bud break and shorter shoots in spring.	Early spring
	Infected vine increases susceptibility to winter injury and pathogens.	Véraison until harvest
	Problems with graft union establishment.	Vineyard establishment

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Figure 6. Cupping and discoloration of a Pinot Noir leaf infected with grapevine leafroll virus in early September (left). Symptoms become even more evident by late September (right).

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Figure 7. Leaf curling can be observed on this Chardonnay vine infected with grapevine leafroll viruses in Idaho.

Contact information

Department of Horticulture, Oregon State University: http://wine.oregonstate.edu/faculty

Extension Service, Oregon State University: http://extension.oregonstate.edu/locations.php

Laboratories and Consultants Serving Agriculture in the Pacific Northwest. http://wsprs.wsu.edu/AnalyticalLabsEB1578E.pdf

Additional information

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