Testing and tracking the spread of grapevine red blotch virus in Oregon vineyards

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Key points

- Presence of grapevine red blotch virus is confirmed in all winegrape-producing regions of Oregon.
- Spread of GRBV has been confirmed both spatially and temporally.
- GRBV incidence increased from two to 10 times annually in the Willamette Valley and Southern Oregon vineyards sampled and studied from 2014 to 2016.
- GRBV is difficult to control because it is not yet clear how the virus spreads.
- Despite anecdotal evidence and observation of various hopper insect species in infected vineyards, research has not proven that leafhoppers spread the virus. There is limited evidence of spread by treehoppers.

Introduction

Grapevine red blotch virus is one of about 80 viruses infecting wine grapes worldwide. It negatively affects fruit ripening and impacts the quality of finished wines.

Beginning in 2012, Oregon vineyard managers were puzzled by vines testing negative for grapevine leafroll-associated virus (GLRaVs) yet displaying leafroll-like symptoms. The puzzle was solved in 2014 by the identification of GRBV in Oregon vineyards. Both GRBV and GLRaV cause similar red discoloration of leaves in red-berried cultivars. The distribution of the discoloration can differ between the two diseases, however. One main difference in disease symptoms is that GLRaV-infected grapevines tend to have curled leaves, while GRBV-infected grapevines remain flat.

Our study examined vine tissue samples collected in late summer or early fall in Southern Oregon, the Willamette Valley and the Columbia Basin wine-producing regions of Oregon. At the time of the study (2013–2016), no samples collected from a vineyard block in the Columbia Basin tested positive for GRBV, although a more recent survey by the Oregon Department of Agriculture confirmed the presence of GRBV in all regions of the state.

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The disease triangle

The disease triangle is a classic model explaining the spread of infectious disease. The three components of the triangle are:

- The pathogen — the infectious organism.
- The host — the organism that becomes diseased.
- The environment — the physical conditions where the disease can persist (Figure 1).

A fourth component is present in the case of insect-transmitted diseases:

- The vector — the organism that delivers the agent to the host.

In the case of GRBV:

- The pathogen is grapevine red blotch virus.
- The host is the grapevine.
- The environment is the vineyard agroecosystem.
- The vector has not been determined.

GRBV is a newly identified member of the geminivirus family of viruses. Geminiviruses are single-stranded DNA viruses that infect many crops of economic importance, including vegetables and cotton. To date, known geminivirus vector insects include whiteflies, leafhoppers and treehoppers.

Many grapevine species, cultivars and rootstocks are documented hosts of GRBV. The symptoms differ between red- and white-fruited grapes (Figure 2). You can find resources distinguishing symptom expression between red- and white-fruited cultivars at the end of this publication.

Expression of viral symptoms can be confounded by:

- Concurrent infection with GLRaV or other viral disease of grapevine.
- Nutrient deficiencies in the vineyard, including phosphorus, potassium or various micronutrients, may also result in red leaves.
- Girdling by tie tape or other mechanical damage.
- Specific combinations of cultivars and rootstocks.

The identity of the vector spreading GRBV throughout vineyards remains a mystery. It is well-documented that infected rootstocks or budwood will introduce GRBV into the vineyard by way of the newly planted vines that are already infected. It is possible that the virus will spread to healthy vines if there is a vector. Through testing plant materials with polymerase chain reaction (PCR) (Figure 3), we have observed the virus spreading from the edges of vineyard blocks toward the interior sections (Figure 4).

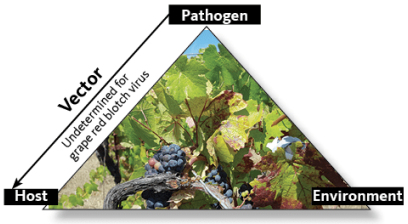

Illustration: Daniel Dalton, © Oregon State University

Figure 1: Disease triangle of red blotch disease. The infective process requires a pathogen and a susceptible host in a conducive environment. A treehopper (Hemiptera: Membracidae) is assumed to be the vector linking the pathogen to the host, but has not been confirmed.

Illustration: Daniel Dalton, © Oregon State University

Figure 2: Grapevine red blotch virus infects both red (left) and white (right) varietals, but the expression of the disease may differ between the two. Note that leaves of these GRBV-infected vines remain flat.

Photos: Daniel Dalton, © Oregon State University

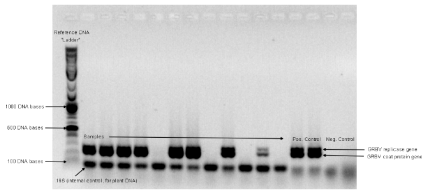

Figure 3: Polymer chain reaction gel results of a GRBV-positive sample. PCR sorts molecules by size, creating a characteristic fingerprint that can be compared to patterns created by known molecules.

Photo: Alec Levin, © Oregon State University

Pruning shears are not known to transmit the virus from plant to plant. We do not observe obvious streaks of virus-infected vines in the rows, as we would if pruning shears spread the virus.

Multiple insect vectors have been assumed to spread the virus, including the three-cornered alfalfa hopper (*Spissistilus festinus*). Although grape mealybug (*Pseudococcus maritimus*) spreads GLRaV, field research has not supported that mealybugs can spread GRBV. Leafhoppers and treehoppers spread other geminiviruses. However, researchers have not been able to induce GRBV infection in the vineyard with leafhoppers, and only on occasion with great effort in the greenhouse with treehoppers. Thus, the role of leafhoppers, treehoppers or other insects as potential vectors of GRBV is unclear.

Testing for GRBV

Vineyard managers cannot rely on visual inspection of individual grapevines to differentiate GRBV infection from GLRaV infection. Virus diagnosis can only be confirmed by submitting tissue samples to a laboratory specializing in viral plant diseases. Tissue analysis is also a sure way to diagnose plant nutrient deficiencies. Whether the problem is virus- or nutrient-based, symptoms can be subtle and easily confused. Multiple disease or management problems can occur together or be mistaken for one another. Autumn is the best time of year to collect tissue samples for diagnosis of viral disease.

See the “Other resources” section of this document to find laboratories conducting tissue analysis diagnosis of these viruses. Always check with the lab before submitting samples to confirm how tissue samples should be collected and submitted.

These are terms used to discuss diagnosis of viruses in tissue samples:

- Polymerase chain reaction is a technique that duplicates a short fragment of DNA millions of times so that further analysis can be done. GRBV is a single-stranded circular DNA virus.
- PCR gel electrophoresis sorts molecules (like DNA) according to their size and charge. As the molecules travel via electrical current running through a gel medium, they group with like molecules, and form a pattern in the gel. Those patterns are printed out and serve as a fingerprint when compared to patterns formed by known viruses (Figure 3).

In our study, vines in four Oregon vineyards were assessed for GRBV infection using PCR and PCR gel electrophoresis analyses. The results of those analyses (positive or negative) were tied to the vines’ coordinates in the vineyard.

USDA Farm Service Tree Assistance Program

Overall, effects of GRBV on grape berries consistently show decreased °Brix and lower anthocyanin levels, compared to berries from uninfected vines. Depending on severity of the infection and the rate of spread year-to-year, growers may decide to remove infected plants (or replant the entire block) because the fruit is considered unmarketable.

The USDA Farm Service Program offers financial assistance to growers through its Tree Assistance Program.Producers of qualifying crops can receive support to replant crops damaged by GRBV. See the resources at the end of this publication to learn more about this program.

Figure 4: GRBV spreads along spatial lines in the vineyard, as shown here (foreground, background). Several insects have been suspected as vectors, but none has yet been confirmed.

Photo: Alec Levine, © Oregon State University

Results of spatial analysis indicate the degree of randomness or order of the aggregation of infected vines in a vineyard.

Our results showed that GRBV spreads from a diseased vine to neighboring plants.

The spread of this virus within a vineyard from year to year showed significant relationships between the coordinates of vines testing positive for GRBV in the current year to the coordinates of vines testing positive in previous years.

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Other resources

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