Red Leaves in the Vineyard: Biotic and Abiotic Causes

Fact Sheet FS1260



Figure 1. Potassium (K) deficiency in Cabernet Franc. Note leaves turning red in between the vein.



Figure 2. Magnesium (Mg) deficiency in Chambourcin. Note wedges of discoloration, starting from edges.



Figure 3. Phosphorous (P) deficiency in Zinfandel. Note the reddening progression from the leaf margins.

Cooperative Extension

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Red leaves in the vineyard are caused by many biotic (viruses, bacteria, and fungus) and abiotic (nutrient deficiencies, cold injury, damage to root systems, etc.) stresses. Anything that can cause blockage or stress in the vascular system where water and nutrients are transported can result in the development of red leaves. Though the timing, pattern of appearance, and spread could be different, the overlapping of the symptoms, especially the reddening of leaves, makes it very difficult to identify the cause based only on visual symptoms.[1] The best strategy therefore is not to rely on guesswork, but to get the vines tested for accurate diagnosis as soon as possible.

Below are examples of abiotic and biotic stresses that are often associated with red leaves on grapevines.

Nutrient Deficiencies

Potassium (K) deficiency develops when vines receive less K than what is required for normal growth and development, or with low soil pH levels (i.e., less than 5 for *Vitis vinifera*) that decrease the availability of potassium to the roots. Potassium is a mobile nutrient and in the case of deficiency, the upper (younger) leaves receive K rather than the lower (older) leaves, therefore reddening the leaves in the lower part of the canopy first.

Symptoms typically appear in early to late summer.[2] In red grape varieties, leaves turn red in-between the veins starting from the edges, and as deficiency gets severe, they turn purple (Figure 1). In white grape varieties, deficient leaves turn chlorotic (pale yellow or white), due to insufficient chlorophyll.

To monitor plant K status, it is advisable to perform petiole analysis every 2–3 years, ideally during bloom. The target K level in petioles should be between 1.5% to 2.5% if sampled during bloom, and 1.2% to 2.0% if sampled 70 days after bloom. Apply potash (KOH) fertilizer either foliar or to the soil, depending on the urgency. When there is chronic potassium deficiency, laboratory soil testing for nutrient and pH levels should be conducted.

Magnesium (Mg) deficient leaves may resemble K deficient leaves; however the discoloration starts from the end, creating the wedge shaped pattern (Figure 2). As the deficiency becomes severe in red varieties,

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interveinal chlorosis could become red to brown. In white varieties, the chlorosis remains yellowish. Target Mg level in petioles should be 0.3% to 0.5% at bloom; or between 0.35 to 0.75% if sampled 70 days after bloom.[2] To correct the Mg deficiency, magnesium salt ($MgSO_4$), also known as Epsom salts, is used if soil pH does not require adjustments. If your soil is acidic, apply dolomitic limestone (Mg-containing limestone) as it will also raise the pH, improving the rate of Mg uptake.

Phosphorous (P) deficient leaves show interveinal reddening while white varieties show chlorosis.[2] Typically, initial chlorosis appears around leaf margins, which turn reddish in red varieties (Figure 3). Unlike other major nutrients, P offers greater flexibility in terms of timing of application as it is less mobile in soil and does not leech away easily. The target P level for leaf petiole should be between 0.13 to 0.30% depending on the type of rootstock. Mono-ammonium phosphate (MAP) and di-ammonium phosphate (DAP) are common sources of phosphorous fertilizer.[2] Adjust the soil pH if it is lower than optimum to improve P uptake.

Diseases

Viruses of grapes such as leaf roll and red blotch can also cause red leaves and result in reduced vine vigor, poor fruit set, reduced fruit quality, and early decline of vines. Since there is no cure available for viruses once vines are infected, the only way to cure the infected vineyard is rogueing out infected vines, and replanting with virus-tested planting materials from dependable nurseries.[3]

Grapevine leafroll disease symptoms typically appear around the onset of fruit ripening and spread as the season progresses. In red varieties, red to purplish discoloration is observed on interveinal areas of the leaf, but the veins stay green (Figure 4). In white varieties, the interveinal area will become pale green while the veins turn yellowish (Figure 5). In addition, downward cupping or curling from the edges is typical of leafroll symptoms (Figure 5). The discoloration of leaves will often develop randomly within the vine canopy. An upward or downward movement of the discoloration will not occur as it does with some of the nutrient deficiencies.

There are several viruses that can cause grapevine leafroll disease, and grapevine leafroll-associated virus-1 and -3 (GLRaV-1 and -3) can be disseminated by mealybugs or scale insects (Figure 6). Scouting for these vector insects can be done during the season (around bloom) by carefully examining the basal area of shoots and underneath the bark. Mealybugs can be managed through insecticide treatment(s), however recent research showed that even a small population of mealybugs could quickly spread grapevine leafroll disease.

Grapevine red blotch disease is a recently recognized virus that has existed for a long time. As the name suggests, blotches of red pigment appear randomly on leaves of infected vines. It can be detected at any stage of vine growth in any part of a vine. It can easily be mistaken for potassium deficiency or leaf roll virus, especially when leaves cup or roll (Figure 7). Because of the recent recognition of the virus, there are ongoing efforts to understand how (or if) it spreads in vineyards. It is known that the red blotch virus can be disseminated through propagation and grafting with infected materials.



Figure 4. Grapevine leafroll disease symptoms on Cabernet Sauvignon. Note the reddish discoloration on interveinal areas of the leaf, but the veins stay green and the downward cupping or curling from the edges.



Figure 5. Grapevine leafroll disease symptoms on Chardonnay. Note the interveinal area turning pale green while the veins turn yellowish and the downward cupping or curling from the edges.



Figure 6. Grape mealybugs (Pseudococcus maritimus) on a grape shoot.

For the two viruses mentioned above and any other viruses, the vines will always be infected. Thus, it is recommended to obtain virus-tested materials from reputable nurseries when establishing a vineyard. Confirm that the nursery has virus-testing procedures in place such as Protocol 2010.[4] The materials from Protocol 2010 have been available since 2013, and availability has increased as more nurseries have adapted the protocol.

If you have propagated your planting materials from existing vineyards, or obtained materials from non-certified nurseries, consider sending a representative number of cuttings for virus testing before planting. Typically, 7–8 young, matured leaves per vine, and 30–50 leaves per sample are sufficient, but communicate with the virus testing lab (listed below) for their specific sampling protocol. When one of the vector insects and one of the grapevine leafroll-associated viruses (GRLaV-1 or -3) are present in your vineyard, management of the vector insect will be required to keep healthy vines clean of GLRaV.

Crown Gall is caused by a bacterium *Rhizobium* (= *Agrobacterium*) *vitis* and can be common in cool climates. Severe winters or temperature fluctuations in the early spring damage bark and vascular tissues and allow *R. vitis* to move into the vine cells and cause infection.[5] Typical symptoms are formation of galls on the trunk (Figure 8); however, these galls can be very small, and may be formed under the bark (Figure 9). Therefore, crown gall could be mistakenly identified as a nutrient deficiency, as red leaves resulting from the stressed vascular system are readily visible (Figure 10). Other wounding events, such as physical damage to the trunk by hitting it with equipment such as line trimmers, can also encourage the infection by *R. vitis*.

As with virus diseases, crown gall-infected vines are infected for life because crown gall bacterium is a systemic pathogen. Thus, management of crown gall is very difficult. Obtain clean plant materials (note: the procedure used in Protocol 2010 should considerably reduce the risk of *R. vitis* from the mother plant), and make sure to select varieties that suit your site. Cold tender varieties, such as Merlot and Tanat tend to have higher risk of crown gall than many others do. Moreover, stressed vines tend to be more cold tender, thus, proper viticultural practices such as site selection, crop load, and foliar disease management can lower the risk of crown gall. Having multiple trunks from above the graft union and hilling up to cover the graft unions during the winter months are other preventative strategies.

Assessment of Suspicious Vines

It can be very difficult to accurately identify the cause of red leaves. Virus testing (for leafroll, red blotch, and others) is expensive, hence the first recommendation in an identification flowchart is to inspect trunks for integrity, and then perform petiole analysis (Figure 11). If trunk diseases and nutrient deficiencies are ruled out, samples should be sent for virus testing. Below is a list of grapevine virus testing laboratories. Lab testing pricing varies, so make sure to contact several companies for cost comparison.



Figure 7. Grapevine red blotch disease symptoms on Merlot. Note red pigment appearing randomly on leaf. Reddening from edges can be mistaken for K deficiency and rolling or curling at edge can be mistaken for leaf roll virus symptoms.



Figure 8. Crown gall symptom at the graft union.



Figure 9. A series of small crown gall formed under the bark of Merlot.

Virus Testing Labs

Agri-Analysis LLC: 930 Riverside Parkway, Suite #30, West Sacramento, CA 95605

Phone: 800-506-9852 Email: info@agri-analysis.com

AL&L Crop Solutions: 7769 N. Meridian Rd., Vacaville, CA 95688

Phone: 530-759-9460 Email: info@allcropsolutions.com

Eurofins STA Laboratories: 7240 Holsclaw Road, Gilroy, CA 95020

Phone: 888-782-5220 Email: juditmonis@eurofinus.com

Sunburst Plant Disease: Clinic 677 East Oliver Avenue, Turlock, CA 95380

Phone: 209-667-4442 Email: slivingston@sunburstpdcinc.com

WSU ELISA Virus Testing Lab: 24106 N. Bunn Rd., Prosser, WA 99350

Phone: 509-786-9382 Email: Tina_Vasile@wsu.edu

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[2]Tony Wolf (ed.) 2008. Wine Grape Production Guide for Eastern North America, Plant and Life Science Publishing. NRAES 145

[3]Hemant Gohil, Gary Pavlis and Daniel Ward. 2015. Rutgers NJAES Cooperative Extension fact sheet FS1252, Evaluate Your Planting Material Before Planting Your Grapevine njaes.rutgers.edu/pubs/fs1252

[4]Adib Rowhani and Deborah Golino. 2010. Grapevine Disease Testing Protocol 2010. FPS Grape Program Newsletter, October 2010

[5]Stephen Vasquez and Jodi Creasap Gee. 2013. Crown Gall: in Grape Pest Management third edition, UCANR publication. Pp. 71–74

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Figure 10. Red foliar discoloration caused by crown gall. Note the gall formation on the trunk.

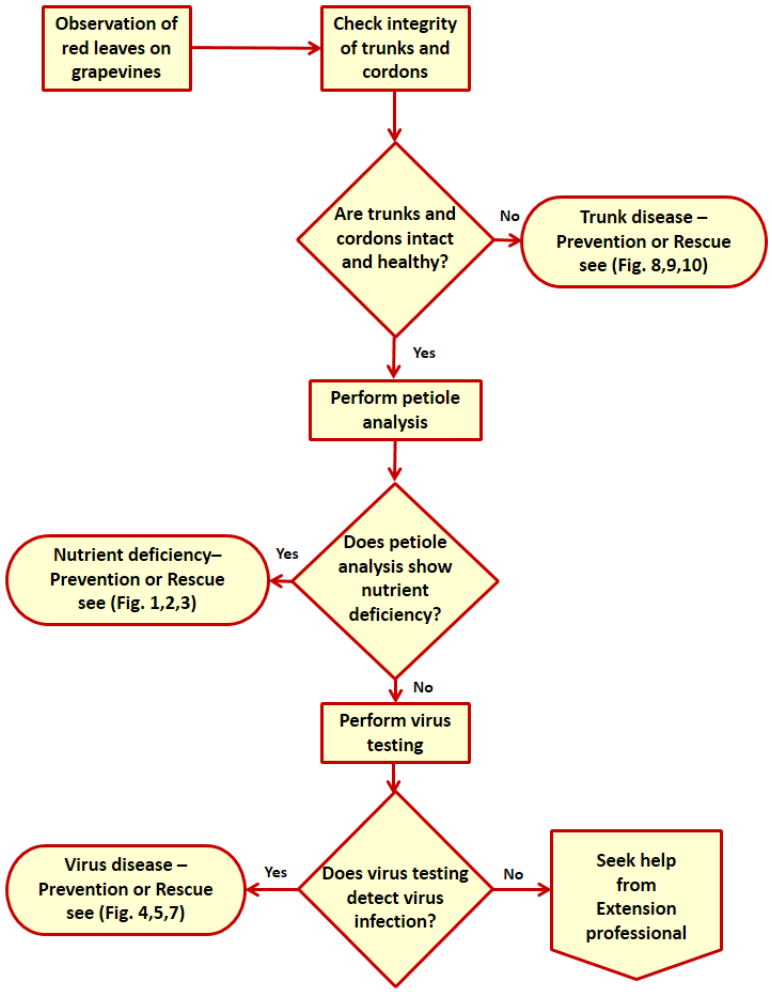


Figure 11. A flowchart for actions to be taken after you observed red leaves on grapevines.

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