Recent Developments in the California Grapevine Nursery Industry

Widespread Red Blotch contamination in the UC Davis FPS Russell Ranch Vineyard is a critical blow to the production of clean vines in California and the United States.

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RUSSELL RANCH VINEYARD (RRV) is the **California Department of Food and Agriculture** (CDFA) Grapevine Nursery Certification Program's Foundation Block first planted in 2011 with vines derived through meristem tissue culture by **UC Davis Foundation Plant Services** (FPS) to provide clean propagation materials to participating grapevine nurseries. RRV was designed to fulfill the standards of the Protocol 2010 (P2010) **National Clean Plant Network** (NCPN) quality control guidelines, which include extensive virus elimination and confirmatory testing along with in-field monitoring practices to detect disease contamination (SIDEBAR 1).

On Oct. 21, 2019, FPS announced that 339 of 4,761 vines, or 7.1 percent, planted in RRV P2010 Foundation Block (FB) had tested positive for Grapevine Red Blotch Virus (GRBV) (TABLE 1). This represents a 14-fold increase from the 0.5 percent contamination level (24 of 4,406 vines) announced in Dec. 2018 and a 68-fold increase from the 0.1 percent contamination (5 of 4,132 vines) reported in 2017. With the likely continued expansion of infection in RRV, FPS announced, on that same date, the suspension of shipment of Foundation P2010 materials to nurseries until further notice. This signals the retirement of the only California source of Foundation P2010 materials.

The news release also noted that one of 4,075 vines planted in the Classic Foundation Block located on the campus at UC Davis tested positive for GRBV in 2019. Grapevine material from this block will continue to be available for distribution to nurseries and growers. Some of the vines in the Classic Block were planted in the 1970s.

SIDEBAR 1. Protocol 2010 Material Definition[1]

Compliance with the new NCPN standard will ultimately be required as a prerequisite to NCPN certification for a foundation vineyard on the 100-acre Russell Ranch parcel on the UC Davis campus. To qualify as P2010 plant material, two primary qualifications must be met. First, the FPS source vines are generated using microshoot tip tissue culture techniques, i.e., cut from a piece of the meristematic dome that is 0.5 mm or smaller in size. Second, these source vines must test negative for the extensive list of pathogens detailed on the P2010 list using testing techniques which include PCR, ELISA, herbaceous and woody indexing. This testing scheme is designated "PROTOCOL 2010."

TABLE 1.

Contamination of Foundation Block vines at RRV

	Russell Ranch Foundation				Classic Foundation			
Year	Vines Tested	Total Vines	Positive Vines	Infection Rate	Vines Tested	Total Vines	Positive Vines	Infection Rate
2013	1,106	1,142	0	0%	3,438	4,284	9	0.21%
2014	2	1,807	0	0%	1,010	4,081	6	0.15%
2015	1,002	2,616	0	0%	636	4,169	0	0%
2016	584	3,290	0	0%	2,276	4,163	0	0%
2017	6,761*	4,132	5	0.1%	3,604	4,088	1	0.02%
2018	6,013*	4,406	24	0.5%	4,127*	4,075	0	0%
2019	5,442*	4,761	339	7.1%	4,167*	4,075	1	0.02%

*Some vines tested multiple times

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Excepting that this significant increase in Red Blotch disease at RRV might have been predicted back in December 2018, this development raises many questions about what we think we know about GRBV and its transmission. While we don't know what caused this increase in Red Blotch disease at RRV, there are several factors and hypotheses that should considered.

Red Blotch disease was first discovered in October 2012[2] and methods for detection of GRBV were available soon after. TABLE 2 presents a snapshot of the widespread GRBV-contamination of CDFA classic certified and non-certified materials (subjected to independent testing by **Stamp Associates Viticulture, Inc.**) between 2012 and 2014 (Stamp and Wei, 2013, 2014). TABLE 3 presents data showing the effect of Red Blotch disease on wine quality from a Rutherford vineyard grafted to Cabernet Sauvignon FPS 04 that tested both positive and negative for GRBV (negative for all other viruses). SIDEBAR 2 summarizes our current understanding of Red Blotch disease and GRBV.

TABLE 1. Testing of RS and Scion Increase Blocks
Nov. 2012-May 2014

Material	Source	GRBaV	LR2	LR3	LR9
101-14MG	CDFA CERT	POS			
420A -1*	CDFA CERT	POS			
420A -2*	CDFA CERT	POS			
5C	CDFA CERT	POS			
VR 039-16	CDFA CERT	POS			
CH FPS 4	CDFA CERT	POS			
CS ENTAV 15 -1	CDFA CERT	POS			
CS ENTAV 15 -2	CDFA CERT	POS			
CS ENTAV 169 -1	CDFA CERT			POS	
CS ENTAV 169 -2	CDFA CERT	POS			
CS ENTAV 338	CDFA CERT	POS			
CS ENTAV 412	CDFA CERT	POS			
CS FPS 4	CDFA CERT	POS			
CS FPS 6	CDFA CERT			POS	
CS FPS 7 -1	CDFA CERT			POS	
CS FPS 7 -2	CDFA CERT	POS			
CS FPS 7	Field selection	POS			
CS FPS 31	CDFA CERT			POS	
CS FPS 33 (191)	CDFA CERT	POS			
CS FPS 47 (337) -1	CDFA CERT			POS	
CS FPS 47 (337) -2	CDFA CERT			POS	
MB FPS 9 -1	CDFA CERT	POS			
MB FPS 9 -2	CDFA CERT	POS			
ME ENTAV 181	CDFA CERT	POS			
PN ENTAV 943	CDFA CERT			POS	
PN FPS 90 Calera	CDFA CERT			POS	
PN Calera	Field selection 1		POS	POS	
PN Calera	Field selection 2	POS		POS	
PV FPS 2	CDFA CERT	POS			
SB FPS 1	WA STATE CERT			POS	
SB FPS 1 -1	CDFA CERT			POS	
SB FPS 1 -2	CDFA CERT				POS
SB FPS 1	Field selection	POS			

*-1, *-2: different increase block sources

POS: positive for virus

SIDEBAR 2. Biology and Impact of Red Blotch Disease

- Grapevine Red Blotch Virus is causal agent.
- GRBV is a geminivirus with a circular single stranded DNA genome. By comparison most grapevine viruses are RNA-based.
- GRBV is graft-transmissible.
- Symptom severity is directly correlated with virus titer level in the vine.
- GRBV is not mechanically transmitted.
- It is vectored by the three cornered alfalfa hopper (TCAH)—though only demonstrated under greenhouse conditions.
- TCAH is considered to be an inefficient vector—its native host is alfalfa (not grapevines).
- Independent reports suggest that the disease spreads rapidly, but our understanding of TCAH does not support rapid spread by this vector. Is this evidence for other vectors?
- It is managed by the removal of infected vines, or rogueing.
- Plant only virus-tested, clean vines to mitigate spread.

Red Blotch Disease Effects:

- Reduced vine growth
- Reduced fruit yield
- Reduced sugar in fruit juice
- Higher pH in fruit juice
- Higher titratable acidity in fruit juice
- Lower anthocyanins and tannins in berry skin
- Inferior wine quality
- Diminishing economic return
- GRBaV disrupts normal berry development and stress responses by altering transcription factors and hormone networks, which result in the inhibition of ripening pathways involved in the generation of color, flavor and aroma compounds.

TABLE 3. The Bottom Line: The Effect of Red Blotch on Wine Value at a Rutherford, CA Winery

Red Blotch	Wine category	Harvest sugar	Seed components	Tons/ acre	Cases/ ton	Gal/ ton	$/ gal	$/ case	FOB Gross wine revenue/ acre
NEG	Reserve	28 Brix	Complete ripening	3	50			$600	$90,000
POS	Bulk	25 Brix	Impaired ripening*	2		150	$25		$7,500

*immature pigment and phenolic components

Factors that may be involved in the spread of Grapevine Red Blotch Virus at RRV include:

- Selections planted at RRV before 2013 were not tested for GRBV (because the virus had not been identified).
- The testing procedures historically used by FPS for detection of GRBV in RRV have focused on testing petioles/leaves in spring and summer. The authors' experience, however, is that woody cane tissues tested in the fall (October onwards), when coupled with our own proprietary sample processing methods and testing protocols, are superior for reliable routine detection of GRBV in vines.
- All selections at RRV were derived through meristem tissue culture (TC)—a protocol designed to eliminate grapevine virus diseases in potentially contaminated stock.
- GRBV is a gemini virus (DNA virus) and has a much smaller genome than RNA-based grapevine viruses, which comprise the majority of economically important grapevine viral pathogens. It is feasible that TC procedures are less effective in eliminating these small genome DNA-based viruses.
- TCAH is the only vector of GRBV identified to-date—and the vector mechanism has only been demonstrated under greenhouse conditions—not in the vineyard. The rapid spread of GRBV suggests that other vectors are involved. Could whitefly, which is a ubiquitous geminivirus vector in many plant species and a constant companion of tomato plants and grapevine plants (especially in Yolo County where RRV is located), be a vector?
- There is anecdotal evidence that GRBV may express differently in different rootstock and scion varietal materials.
- Many growers have reported rapid spread of Red Blotch disease (as confirmed by GRBV testing) adjacent to neighboring disease epicenters, suggesting vector transmission from diseased to clean stock, and therefore supporting the presence of efficient vectors.

Is it possible that the TC process renders vines more susceptible to GRBV and other pathogens? Many industry experts believe this. Why does the Classic Foundation Block (located seven miles from RRV at the UC Davis campus) have so few GRBV infections? Does this reflect on the location of the block, the method of propagation, the absence of TCAH or a combination of these factors? Many selections in the Classic Foundation Block at UC Davis were also derived using meristem tissue culture procedures for virus elimination.

This raises other questions: Should FPS be open to independent sampling and testing? Were standard sanitation procedures at RRV sufficient to suppress the activity of potential GRBV vectors? Absent from the list of RRV-contaminated vines provided by FPS on Oct. 21, 2019, are ENTAV clones. Do these clones make up the majority of Proprietary clones listed on the FPS website?

The entire list of contaminated vines found during summer and fall 2019 at RRV is available[3]. **TABLE 4** is a screenshot of the first set of contaminated vines as listed on the FPS website.

TABLE 4. 2019 GRBV+ Vines Testing and Distribution History
List of plants tested positive for GRBV in 2019.

Cultivar (Selection) *=Proprietary	Date Planted	2015	2016	2017	2018	2019
Proprietary [*]	11-Jun-15			NEG	NEG	POS
Aglianico [04.1]	28-May-12	NEG		NEG	NEG	POS
Apple Grape [01.1]	13-Jul-11	NEG		NEG	NEG	POS
Arinto [01.1]	13-Jul-11	NEG		NEG	NEG	POS
Proprietary [*]	11-Jun-15			NEG	NEG	POS
Arvine [01.1]	28-May-12	NEG		NEG	NEG	POS
Assyrtiko [01.1]	13-Jul-11	NEG		NEG	NEG	POS
Proprietary [*]	6-Jul-16		NEG	NEG	NEG	POS
Bourboulenc [01.2]	30-Jul-12			NEG	NEG	POS
Brianna [01.1]	11-Jun-15			NEG	NEG	POS
Brianna [01.2]	11-Jun-15			NEG	NEG	POS
Cabernet Franc [01.1]	14-Aug-13			NEG	NEG	POS
Cabernet Franc [11.1]	11-Aug-14			NEG	NEG	POS
Cabernet Franc [13.1]	13-Jul-11	NEG		NEG	NEG	POS
Cabernet Franc [13.1]	13-Jul-11	NEG		NEG	NEG	POS
Cabernet Franc [13.1]	13-Jul-11	NEG		NEG	NEG	POS
Cabernet Franc [16.1]	28-May-12	NEG		NEG	NEG	POS
Cabernet Sauvignon [08.3]	28-May-12			NEG	NEG	POS
Cabernet Sauvignon [*]	31-Jul-13		NEG	NEG	NEG	POS
Cabernet Sauvignon [30.2]	11-Aug-14			NEG	NEG	POS
Cabernet Sauvignon [33.1]	11-Aug-14			NEG	NEG	POS
Cabernet Sauvignon [37.2]	11-Aug-14		NEG	NEG	NEG	POS
Cabernet Sauvignon [*]	31-Jul-13	NEG		NEG	NEG	POS
Cabernet Sauvignon [49.1]	13-Jul-11			NEG	NEG	POS
Cabernet Sauvignon [52.1]	11-Aug-14	NEG		NEG	NEG	POS
Cabernet Sauvignon [*]	28-May-12	NEG		NEG	NEG	POS
Cabernet Sauvignon [*]	28-May-12			NEG	NEG	POS
Cabernet Sauvignon [*]	28-May-12			NEG	NEG	POS
Proprietary [*]	11-Jun-15			NEG	NEG	POS
Proprietary [*]	11-Jun-15			NEG	NEG	POS
Proprietary [*]	11-Jun-15			NEG	NEG	POS
Proprietary [*]	11-Aug-14			NEG	NEG	POS
Proprietary [*]	11-Aug-14			NEG	NEG	POS
Proprietary [*]	6-Jul-16			NEG	NEG	POS
Proprietary [*]	6-Jul-16			NEG	NEG	POS
Proprietary [*]	6-Jul-16			NEG	NEG	POS
Carignane [11.2]	6-Jul-16			NEG	NEG	POS
Carignane [11.2]	6-Jul-16			NEG	NEG	POS
Carignane [13.2]	13-Jun-17				NEG	POS
Casetta [01.1]	11-Jun-15			NEG	NEG	POS
Casetta [01.2]	11-Jun-15			NEG	NEG	POS
Catarratto [01.2]	28-May-12			NEG	NEG	POS
Chardonnay [04.1]	31-Jul-13		NEG	NEG	NEG	POS
Chardonnay [*]	11-Jun-15			NEG	NEG	POS
Chardonnay [*]	11-Jun-15			NEG	NEG	POS
Chardonnay [*]	11-Aug-14			NEG	NEG	POS
Chardonnay [108.1]	11-Aug-14			NEG	NEG	POS
Chardonnay [*]	28-May-12	NEG		NEG	NEG	POS

SIDEBAR 3. Grapevine Sampling and Testing

- Sampling strategy heavily depends on testing objectives
- Test every mother vine for economically significant viruses when sourcing budwood or rootstock materials
- Use statistically significant sampling methods to survey existing vineyards
- When applying for USDA/TAP assistance a minimum of 10 GRBaV infected vines should be tested
- Use composite sampling to reduce testing cost

Notes and Comments from the Ninth International Geminivirus Symposium

The Ninth International Geminivirus Symposium was held at UC Davis Nov. 9-13, 2019. **Professor Robert Gilbertson**, a recognized world authority in geminiviruses, organized the meeting. Our understanding of Red Blotch virus, despite much progress made since 2012, is still limited. Scientists have been unable to directly observe viral particles by scanning electron microscopy. Furthermore, no laboratory has been able to obtain antibodies that bind to the Red Blotch virus. Antibodies can be routinely raised against viral coat proteins of important grapevine viruses such as GLRaV-3, which can then be used in laboratory detection protocols. These facts suggest that GRBaV is an atypical virus. Together, they point to the possibility of a virus that may not be encapsidated or only transiently encapsidated. Recent work by Gilbertson's group suggests that all GRBV gene proteins are targeted to the nucleus of the plant cell where they work synergistically by "hijacking" the host's biosynthetic machinery to replicate the virus and to suppress the host defense mechanism.

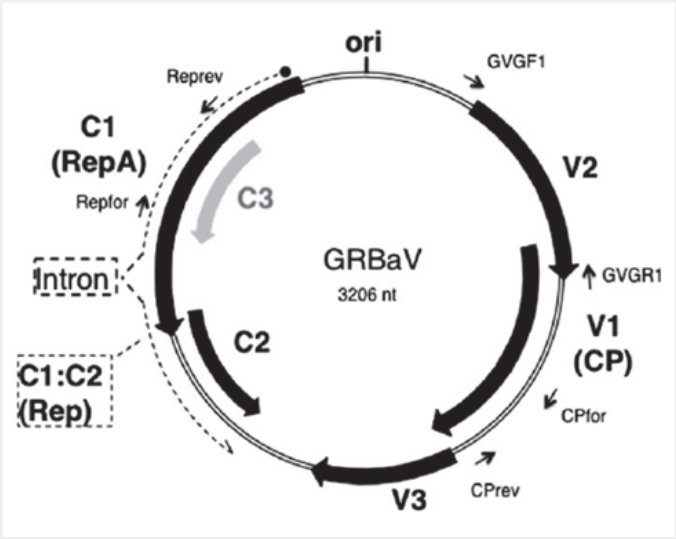


FIGURE 1. The Red Blotch genome consists of a circular single-stranded DNA of 3,205 nucleotides with three forward and three reserve open-reading frames that can be transcribed into six gene proteins (V1, V2, V3, C1, C2, C3). There are two genetic clades of GRBaV with up to 8 percent sequence heterogeneity with no recognized biological differences among known isolates.

SIDEBAR 4. Latest Research Findings Regarding GRBV at the Molecular Level

- All GRBV proteins were seen to be targeted to the nucleus of the plant cell
- Proteins C1, V1 and V2 exhibit DNA binding properties
- V1 is likely the capsid protein
- V2, V3 may mediate nuclear export of viral DNA and be involved in the host cell cycle and gene expression
- C1 and C2 are likely involved in the replication of viral DNA
- C3 is a movement protein and suppresses host gene silencing

Red Blotch disease consists of three dynamically intercative components, or a disease triangle: the Red Blotch virus, the vector and the grapevine host. The GRBV outbreak at FPS is puzzling because we simply do not understand the Red Blotch virology and dynamic interplay of the three compoents in this triangle.

Our current understanding seems to be limited to a static model where the virus is simply a particle that can be acquired by a vector and transmitted to healthy vines. Our countermeasures against GRBV are largely based on this static model and they have generally appeared to be effective under present conditions. However, geminivurises are considered the top viral pest in agriculture, causing billions of dollars of production losses worldwide. They are a class of viruses that appear to be more highly evolved and more lethal than other virus types.

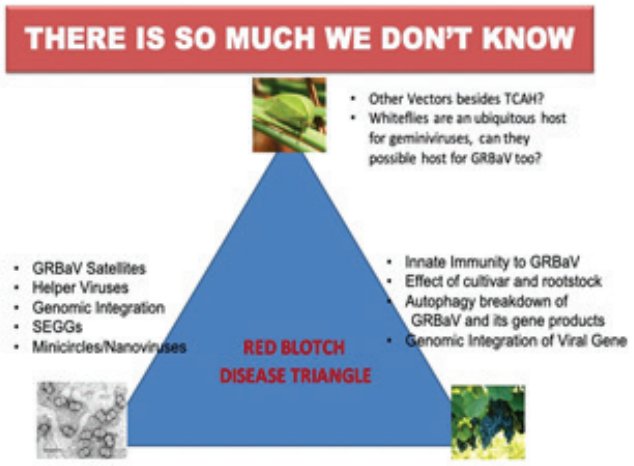
Geminiviral DNA has been found to be integrated into the tobacco genome. Integrated viral genome DNA can remain latent and be passively replicated, along with the host genome, and then passed to the cell's offspring. Environmental changes can reactivate the virus within the host, which can lead to viral transcription and the production of new infectious viruses. Although there has been no direct scientific evidence that Red Blotch Virus undergoes genomic integration in grapevines, observations of unexpected Red Blotch disease development could support a hypothesis that Red Blotch infection can be latent.

Many geminiviruses found in other plant species employ satellites, helper virus, SEGS, minicircles or nanoviruses to enhance their infectivity by increasing viral copy accumulation in the host cell, thereby boosting host symptom severity. If, and to what extent, GRBV employs these mechanisms is unknown. However, we do know Red Blotch Virus copy numbers in infected grapevine tissues can vary by several orders of magnitude. Viral copy is directly correlated with the severity of grapevine leaf symptoms[4].

Other host-plant species use autophagy to combat geminiviral proteins by moving them from the nucleus to the cytoplasm, where they can be broken down by cellular factors. If, and to what extent, grapevines use such mechanisms to defend against Red Blotch Virus is unknown. Autophagy in grapevines could be expressed by differential cultivar and rootstock responses to GRBV gene product.

The above are just some research foci the scientific community needs to address to help understand the alarming development at RRV—and to find solutions to safeguard clean plant production for the grapevine industry. We call on all members of the industry to advocate for increased support for Red Blotch research through grower associations, trade associations, local and federal governments, etc.

SIDEBAR 5: **What We Don't Know About Red Blotch**



Safeguarding Unique, Priceless Grapevine Genetics

The grapevine plant is arguably the most important component in new vineyard development, and the availability of healthy, physically sound vines for new vineyard establishment is something that should not be in doubt. That FPS has been unable to maintain clean Foundation stock from which nurseries can propagate clean vines is a severe setback to Californian and North American viticulture. Commercial propagation of grapevine stock is a process that has remained largely unchanged for centuries. Cuttings from *Vitis* species root easily and, with little effort, will readily graft between species/hybrids to enable delivery of familiar scion/rootstock combinations.

Arguably, the pathogens of greatest concern in the nursery business today are GRBV and Leafroll 3 virus, vectored by TCAH and mealybug, respectively. The diseases caused by these viruses affect fruit yield and wine quality. The CDFA Protocol 2010 program was designed to keep these and other important viruses out of the grapevine nursery propagation system. However, the unsophisticated nature of grapevine propagation is ideally suited to the production of vines contaminated with viruses, fungi and bacterial pathogens (SIDEBAR 6).

SIDEBAR 6. The Limitations of Traditional Grapevine Propagation

1. All Foundation and Increase blocks in California are currently exposed to the environment: vines growing within these blocks are exposed to soil-, wind-, mechanical- and insect-borne pathogens.
2. Vines are rooted in native soil and, therefore, are exposed to pathogens living in the soil and those that alight on the soil surface.
3. In many cases Foundation and Increase blocks—and nursery storage and processing facilities—are located close to commercial agriculture, including vineyards and citrus orchards.
4. Foundation and Increase block access is usually not sufficiently restricted; there is often no fenced perimeter nor sanitized entrance where foot and/or vehicular traffic are inspected/cleaned before entry.

The Need for Improved Propagation in Grapevines

Although the winegrape, table grape, raisin and juice industries are of multi-billion-dollar values, very little has been invested in propagation improvement. The **American Vineyard Foundation** research committees review many proposals for improvement of wine grapes for resistance/tolerance to factors such as Pierce's disease, powdery mildew, nematodes and viruses. However, as evidenced by industry wide difficulty in propagating the nematode/fanleaf virus resistant rootstock GRN-1, very little attention is directed to improved propagation of potentially interesting grapevine genetics.

Research needs to be undertaken to address the following propagation issues:

1. Increase the efficiency of propagation of difficult-to-graft rootstock varieties.
2. Consider establishment of clean CDFA Foundation Blocks under greenhouse and/or screenhouse conditions to prevent contamination of vines by soil and air borne vectors.
3. Develop clean methods of grapevine propagation including "green grafting."
4. Consider growing all Foundation Block (FB) and Increase Block (IB) vines using artificial media-based (and hydroponic) greenhouse intensive production methods to prevent contamination of vines by soil, air and insect borne pathogens.

Viruses and other pathogens found in Protocol 2010 Increase Blocks by Stamp Associates:

- GLRaV-3
- GRBV
- GPGV
- Agrobacterium vitis (tumorigenic strain)
- Various fungal pathogens

Just as the authors have found important viruses in classic and Protocol 2010 certified stock[5] (TABLE 2), it must be assumed that others, including participating nurseries, have also found virus in various CDFA nursery certified materials. There is currently no mechanism for this information to be released to the public—i.e., no format for the industry to be informed of the number of IB's testing positive and how often they are tested. Asked about the availability of this information, **Joshua Kress**, CDFA branch chief, responded, "I am currently working with our staff to provide an annual summary of testing activities and results, and we will be providing that summary to the public in the future via the IAB."

The Value of Grapevine Plants: Why it is Worth Investing in Improved Grapevine Propagation

A little math explains why grapevine plants are so important. All the investments in steel, plastic, drainage, irrigation, etc. are all well and good, but only the grapevine plant provides a real return on investment (FIGURE 2). Today the average price of a grafted grapevine plant is somewhere in the $4 range. Grapevine plants should be perceived as a bargain, considering the substantial value derived from them, and growers should understand they are purchasing something for which the unit price has remained virtually unchanged over the last 30 years or so.

Consider the value derived from an established Napa Valley grapevine plant:

Net per vine **fruit value** over 20 years Napa CS @ 10.56 lb/v: $572 *
Net per vine **wine value** over 20 years Napa CS @ $51/bottle: $3,233*

**Based on 2017 Grape Crush report data for Napa Valley Cabernet Sauvignon fruit at 907.5 vines per acre, fruit value of $7,500 per ton, 4.79 tons fruit per acre (Y/Pwt: 5, 4 shoots per foot: 10.56 pounds per vine), and $10,000 per acre farming costs. At 600 bottles per ton and 3.17 bottles per vine, with a retail value of $80 per bottle, less cost of grapes and winery cost per bottle ($51 per bottle x 3.17 bottles per vine x 20 years = $3,233 per vine). These are ballpark figures, and some would argue a yield to pruning weight of 5 is too high, but in my opinion it seems to work. Data provided by Doug Fletcher.*

FIGURE 2.
$4.00 investment options

Weed Removal is Essential for Improved New Vine Establishment

Weed control around newly planted vines is essential. Weed root systems are usually located above the roots of the vine, commonly situated between 8 and 12 inches below the soil surface. In typical drip-irrigated plantings, therefore, the weed root system has primary access to the water supply, leaving the vine root system situated six or more inches lower in the rhizosphere, with reduced water and nutrient supply.

FIGURE 3. Extreme weed competition

A grower recently noted, "We had managed cultivation between the vines in the rows very well. The under vine cultivator does leave some weeds around the base of the vines. When we went through and took those weeds out by hand, the vines seem to respond almost immediately. Most unexpected, but welcome."

Importance of Fallow Period for Vine Mealybug Eradication and Observations on Potential Spread of Grapevine Leafroll 3 Virus

According to **Monica L. Cooper**[6]: "The risk to newly planted vineyards from neighboring infected blocks is much greater than from remnant mealybugs surviving on infected roots. Although researchers from New Zealand and South Africa suggest that there is a risk from subterranean mealybugs surviving between plantings under their growing conditions, Cooper has not seen good evidence for this in California (where there are different growing conditions and different MB species).

"In heavy soils under normal rainfall years on California's North Coast, it's doubtful mealybug would survive in the soil on root pieces. Most belowground observations are in sandy soils from the Central Valley. We've never observed grape mealybug below ground, only vine mealybug. Additionally, grape mealybug (GMB) is typically in the egg stage (overwintering) when vines are removed. This makes it impossible for them to move from the vines to roots, as they would need to do to survive. We don't typically have GMB eggs hatching until closer to bud break. We've had a long-term GMB trapping program in Oakville, and we repeatedly see significant decreases in trapped males after a vineyard block is removed, and it takes several subsequent years for GMB to re-populate these blocks. This suggests that the removal of the block drops GMB populations.

Neither GMB nor vine mealybug have been found to survive long-term on hosts other than grapes in California, so I'm not sure what the effect of natural vegetation might be."

Avoiding Syrah Decline

ENTAV Syrah clone 877 is considered a bad choice if one is concerned about Syrah Decline. Both in France and California this is the clone that is most susceptible to Syrah Decline. It is not clear why Syrah vines fail to Syrah Decline (the decline is not associated with any known virus), but affected vines usually show decline within about five years of planting—and again, ENTAV 877 is associated with the worst symptoms. The best alternative is Syrah ENTAV 470. This has good yield, good quality, and is comparable to ENTAV 877—and is not known to be associated with Syrah Decline in California or France. A good rootstock choice would be 110R or 1103P: their drought tolerance is helpful with Syrah, which does not like overly dry conditions. It has been observed that Syrah Decline can be initiated as a result of water stress.

Grapevine Syrah virus-1 and rupestris stem pitting virus Syrah strains have been found in association with declining Syrah vines, but no cause or effect has been determined. It is recommended that Syrah materials purchased from grapevine nurseries should be tested for these viruses.

Avoiding Cold Damage to Recently Planted Green Potted Grafted Vines

Early spring 2019 revealed significant fatalities in new vine plantings, resulting from severe cold weather during the winter of 2018/2019. On examination of dead plants that had grown remarkably well during late summer and fall of 2018, it was clear that vines were not defective: root systems were full and well-developed, graft unions were healed perfectly, and shoot growth, in some cases trained to a single shoot that reached over 6 feet in length over a 3-month growing period, supported the conclusion that vines were healthy when planted. Lake County can have particularly cold winters, and in one instance a high proportion of July- and August-planted green-potted SB01/SO4 vines planted near Kelseyville died—seemingly from cold damage as, on examination, the dead vines were of perfect physical condition.

TABLE 5. Daily High and Low Temperatures Kelseyville Fall 2018 (Western Weather)

Date	Daily Max Temp (°F)	Daily Min Temp (°F)
11/28/2018	61.3	41.5
11/27/2018	54	38.5
11/26/2018	63.6	34.6
11/25/2018	66	36.2
11/24/2018	63.2	40.9
11/23/2018	59.3	45.7
11/22/2018	55	43.7
11/21/2018	58.4	42
11/20/2018	68.9	26.6
11/19/2018	74.4	26.7
11/18/2018	76.3	22.8
11/17/2018	69	23.5
11/16/2018	66.8	25.1
11/15/2018	71	24.5
11/14/2018	69	22.7
11/13/2018	64.2	26.9
11/12/2018	68.5	23.1
11/11/2018	66.9	20.7
11/10/2018	60	24
11/9/2018	62.5	22.3
11/8/2018	68.1	24.7
11/7/2018	77.1	30.2
11/6/2018	76.1	27.7
11/5/2018	76.1	33.9
11/4/2018	78.8	34.9
11/3/2018	80	36
11/2/2018	80.8	36.9
11/1/2018	79.8	39.9
10/31/2018	72.5	34.7
10/30/2018	70.1	30.6
10/29/2018	68.7	38.1
10/28/2018	69.6	43.9
10/27/2018	80.6	42.9
10/26/2018	83.3	39.6
10/25/2018	83	38.9
10/24/2018	77.8	39.4
10/23/2018	72.7	31.9
10/22/2018	80.9	32.2
10/21/2018	83.3	34.4
10/20/2018	85.9	35.5

Recent Developments in the California Grapevine Nursery Industry

Hal Huffsmith, formerly of **Trinchero Family Estates**, commented on his experience with sudden vine death in Middletown (and occasionally Lakeport) vineyards). Without seeing the SB01/SO4 vines in question he noted, "I have seen enough damaged first year Lake County vines to offer some plausible direction concerning the cause of this phenomena. It's my guess that the vines were damaged from a fall cold temperature event. Here's why: It's difficult to get first year vines forced into dormancy or hardened off prior to a Lake County cold-temperature night. Without a crop, young vines continue to grow through the fall (without ripening a crop, their physiological timing is off, plus SO4 tends to have a long season growing cycle) and Lake County has regular warm day/cold night temperatures in October or November (TABLE 5). Actively growing green tissue is particularly susceptible to cold damage and, if the terrain has low spots that are displaying greater vine death, that may also be an indication of cold temperatures. I think it was Jim Wolpert (based on his research at Michigan State) who encouraged us to make sure the young vines had abundant K levels and to cut off water early in the fall, around the middle of September. The potassium ensured vascular cell strength and the lack of water forced the young vines into dormancy prior to a cold temperature event."

Mounding especially susceptible plants is a strategy that works to prevent cold temperature death of recently planted green vines. This is especially useful for VR 039-16 grafted vines whose tissues are especially low-temperature sensitive, due to the genetics of this hybrid rootstock. Other strategies used to reduce cold-temperature damage in recently planted green potted vines include temporarily removing cartons to allow for hardening of shoot and graft union tissues (and then replacement before frost), filling of cartons with soil, rice hulls and/or grass or straw, and timely shut-off of irrigation to promote vine lignification.

Sauvignon Blanc is considered to be among varieties with the lowest cold hardiness.[7] WBM

References

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FIGURE 4. Mounded CS07/VR 039-16 vines planted July 2019 (Oakville 11.22.19)