Grapevine Nursery Stock
Observations From Recent Production Cycles

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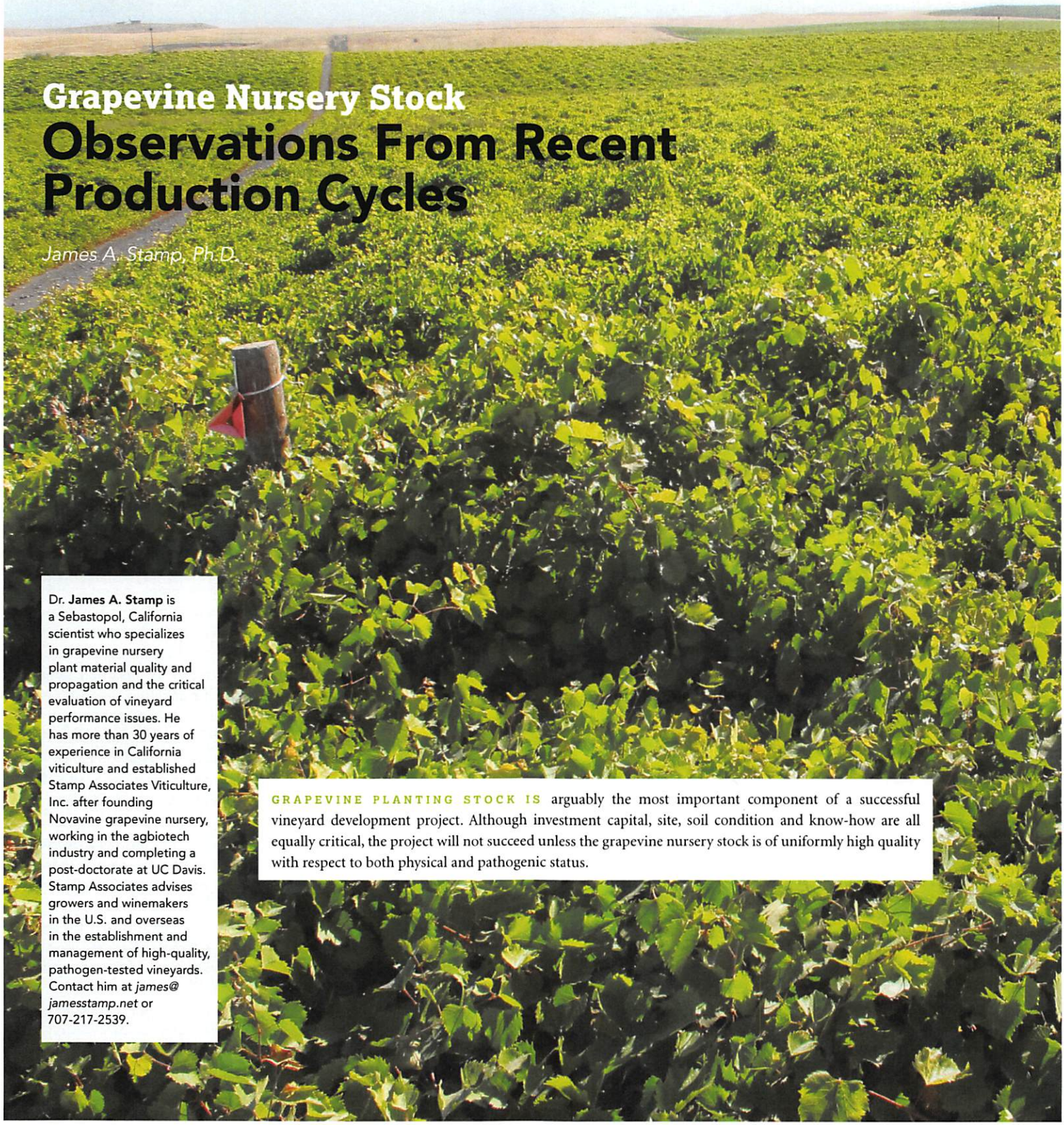

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GRAPEVINE PLANTING STOCK IS arguably the most important component of a successful vineyard development project. Although investment capital, site, soil condition and know-how are all equally critical, the project will not succeed unless the grapevine nursery stock is of uniformly high quality with respect to both physical and pathogenic status.

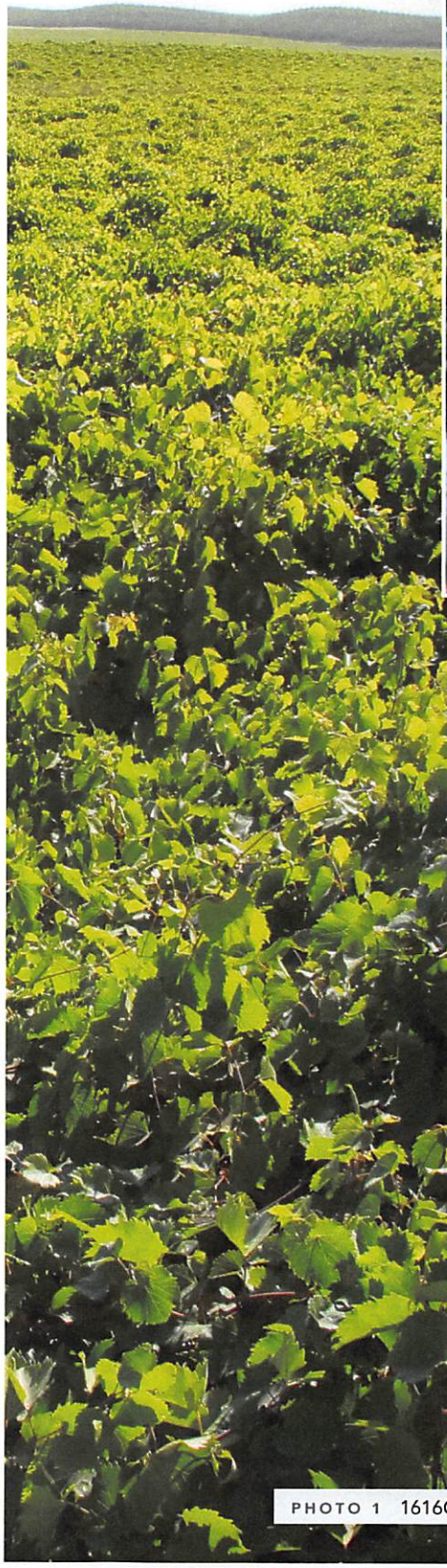

PHOTO 1 1616C increase block. October 2012

PHOTO 2 Crown gall on CS30.1/VR 039-16.1. June 2016

CDFA-Certified Stock

With few exceptions, all rootstock materials available from California nurseries are **CDFA**-certified (*www.cdfa.ca.gov/plant/pe/nsc/docs/regs/ccr_3024_grapevine.pdf*) as are the vast majority of scion materials. It is possible, however, that nurseries with insufficient certified scion material will substitute a non-certified scion source.

Foundation Plant Services (FPS) at **UC Davis** verifies the pathogenic status of new grapevine selections and establishes two vines from each selection in the Russell Ranch Foundation Vineyard located between Davis and Winters. Commercial grapevine nurseries request cuttings from Foundation vines and establish increase blocks (IB) consisting of rootstock and scion (often grafted) vines, which are, in turn, the source of cutting materials for production of CDFA-certified green and dormant vine products.

Currently CDFA-certified product is available as "classic" (derived from older increase blocks) and Protocol 2010-certified. "To qualify as Protocol 2010 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 have tested negative for the extensive list of pathogens detailed here (*fps.ucdavis.edu/fgr2010.cfm*), using testing techniques which include PCR, ELISA, herbaceous and woody indexing." (*fps.ucdavis.edu/fgrrussell.cfm*

Increase blocks are maintained at nurseries according to CDFA **Grape Registration & Certification Program** specifications (*cdfa.ca.gov/plant/pe/nsc/docs/regs/ccr_3024_grapevine.pdf*) and can vary in size from a small number of vines in a single row—for an unusual scion clone, for example—to many acres of impenetrable rootstock vines (PHOTO 1). The point to note is that should vines in an IB be found to be contaminated with virus, removal of that vine—or the increase block—can leave adjacent rows and possibly different increase blocks in place that were likely equally exposed to the virus-transmitting insect vector.

Crown Gall and Rupestris Stem Pitting Virus in Protocol 2010 Nursery Stock

It is generally considered that classic CDFA-certified grapevine stock is contaminated at some level with crown gall. There was hope that Protocol 2010 IBs should be free of crown gall—the cancerous-like growth that afflicts grapevines (and most woody plant species) and is caused by *Agrobacterium vitis* (Av). The tissue culture phase of disease elimination required for Protocol 2010 certification was considered to be effective for the elimination of Av, but galls have been found on 2016 and 2017 green vines and year-old dormant vines derived from Protocol 2010 materials. Because Av is commonly found in agricultural soils and is easily transferred to new sites, it is perhaps not surprising that Protocol 2010 IB vines may be contaminated. It is interesting, however, that vines derived from Protocol 2010 materials are producing galls more frequently at some nurseries than those derived from "classic" materials (PHOTO 2 *previous page*).

One strategy to decrease the likelihood of the production of crown-galled vines is to pre-screen propagation materials for the pathogenic strain of Av prior to testing for economically important viruses (EIV). To date, this strategy has been successful in avoiding the production of heavily crown-galled Protocol 2010 lots. Significant crown gall contaminations have not been observed in Protocol 2010 nursery stock callused under soil/compost-free conditions.

Rupestris Stem Pitting virus has been detected in Protocol 2010 nursery stock. This virus is pollen-vectored, and so transmission from contaminated stock is not unexpected. Fortunately, RSP is not considered to be an EIV. One hundred percent of four lots of Protocol 2010 1616C rootings tested positive for RSP in 2015: a total of 2,900 vines tested positive for RSP.

In 2016 the CDFA nursery certification regulations were revised to include Red Blotch as a non-permitted virus agent.

When to Order Grapevine Nursery Stock

Some nurseries are more skilled in the delivery of particular grapevine products than others. Some are expert at producing high-quality dormant rootings while others are a better bet for delivery of high-quality green vines. Some have access to a broad array of high-quality clean clones while others have difficulty securing CDFA-certified scion material from reliable sources.

- Order as soon as possible. There is only a limited supply of really high-quality materials available at a handful of nurseries, and these tend to sell out fast.
- At some nurseries VR 039-16 has been unavailable for 2018 green vines since June 2017. The shortage of VR 039-16 materials is exacerbated by a growing demand for uber (tall) vines.
- 1103P is also currently in short supply for 2018 green and 2019 dormant vines. This also relates to uber production and high demand for this rootstock from the Central Coast region of California.
- Most scion clones were available as of Sept. 1, 2017, but Protocol 2010 materials are in short supply compared with "classic" certified sources.
- Order in time to evaluate the condition of the vines in the nursery IB in October/November of the year prior to grafting. This is essential to provide comfort that the materials selected for your order appear healthy. This step should be followed by testing of IB vines for economically important viruses.
- Order in time to have product propagated specifically for your project. If you order late, the relative costs associated with virus-testing finished product are far greater than those associated with testing pre-propagation production materials.

This year was a "slow" green vine development year for many nurseries in California due to an overcast and cool extended winter period: vines did not develop as quickly as expected. Most nurseries do not possess artificial illumination, and so cloudy weather can severely impact vine development in the greenhouse.

SIDEBAR 1 Types of nursery product: Pros and cons

	Green		Dormant	
	Grafted vines	**Rootings**	**Grafted vines**	**Rootings**
Pros	Order in season prior to delivery	Back up if dormant rootings not available	Dormant products possess natural root architecture typical of the inter-specific hybrids from which they are derived.	
	May be better array of clonal material available	Option for production of VR 039-16 rootings	Available for planting early Jan/Feb onward allowing for a full season of growth	
	Not exposed to field conditions in nursery reducing risk of vector transmission of Grapevine Red Blotch associated Virus (GRBaV) and Grapevine Leafroll associated Virus type 3 (GLRaV3)		More likely to provide option to prune to wire rather than to two buds in following season - but many elect to prune to two buds regardless of vine product	Permits season- delayed selection/ identification of scion materials
	Best for some difficult to graft rootstock and scion combinations such as 420A with Pinot Noir			
Cons	Important to plant when "ready": i.e. when vines fill pot/container before they become pot-bound and suffer from root-binding.	May not size up suitably for field grafting in next spring field budding season	Grown for 6+ months in the nursery row at 17,000 vine/acre. An additional step for nursery miss-handling and opportunity for infection by Red Blotch and LR3-insect transmitted viruses.	
	It's a biological system: There is a bell curve of development. All vines do not mature/are ready at the same time. However, it can be advantageous to use this information to allow for example, uniform planting of two sub-lots of vines perhaps 2-3 weeks apart (PHOTO 3).		039-16 difficult to produce as dormant vines. Best option is to order green grafted vines.	Need to be field grafted
	As vines are young and still healing (propagation wounds) (roots hidden in potting medium) product difficult to inspect for quality of graft unions and root system development (SIDEBAR 3).		420A and Riparia Gloire are more difficult to graft - requiring greater overages to increase chances of success. Frequently a 3.5x overage for 420A is insufficient to guarantee fulfillment of order with high quality vines. Downside: substantially greater lab testing fees and uncertainty the order will be filled: use green grafted vines	Need to find budwood to graft to vines. Some nurseries do not like to sell budwood - their profit margin is greater if budwood sold in a grafted products
	It may be necessary/optimal to plant vines in more than one session as they become ready.		Compared with green vines, greater chance order will not be filled	Exposed, windy, cold sites may not be suitable for field grafting.
	Regardless of what the nursery contract says vines may not be completely ready until August or even later			Some varieties, such as 420A might develop crown galls at field grafting site causing rejection of bud.

PHOTO 3 Lot of 10,000 Cabernet Sauvignon vines planted in May and July 2015: Vines on left planted in May and pruned to wire in 2016, vines on right planted in July and pruned to two buds in 2016

PHOTO 4 Recently planted Cabernet Sauvignon 04/VR 039-16 uber vines. July 2017

SIDEBAR 2

Uber Vines vs. Standard Green-Grafted Vines

Uber vines are derived from rootstock cuttings that are usually about 35 inches long. The general concept is to position the graft union and scion growth close to the support wire without the requirements for suckering, training and enclosing in cartons (to protect from herbicide and rodent damage and to assist in training). (PHOTO 4)

Pros

- 35 inch length of rootstock to graft union
- Head at wire height at time of planting
- Larger container—should establish faster due to larger root system
- No grow tube/carton required (weather and animal pest protection)
- No suckering on rootstock required: labor and materials savings
- May possibly crop earlier than standard vines—this may not be a pro: see cons
- Could *potentially* apply Roundup direct to vine in second leaf but would recommend lower than normal concentration

Cons

- Unwieldy—takes more time to plant—need to dig bigger holes
- Costs approximately twice as much
- More expensive to virus-test source materials as three times as many RS increase block vines required
- Ubers are bigger plants, and the root volume may be two to three times greater than standard vines—but the general size of the vine could lead to over-confidence in maturity of vine, encouraging premature cropping and thereby stressing vines
- Can't train sucker from base—as rootstock all way up to wire—as possible solution to Eutypa and other trunk disease infections
- Possible damage/failure at graft union during mechanical harvesting due to skid hitting graft union

SIDEBAR 3

Evaluation of green and dormant product quality

Green

- Vines should be firm in the potting medium – this indicates that root systems are fully developed
- Roots should appear healthy when vines are removed from the container
- Root ball should remain intact when vines removed from container
- Vines should have secure graft unions
- Vines should not possess rootstock suckers
- Vines should have acceptable shoot growth with good basal caliper and moderate lignification
- No evidence of crown gall development

Dormant

- Shoot spurs should be emerald green in section, moist and at least 3/16" caliper
- Graft unions completely healed
- Lesions >1/2" length should not be present at the graft union nor at the base of the vine. Sectors of the vine lacking roots can indicate the presence of rootstock lesions
- When subjected to moderate flexing the vine should not break.
- Propagation wounds should be completely healed
- Vines should not show substantial amounts of vascular discoloration more than 2" away from the base and graft union of the rootstock shaft. This discoloration is evidence of stress and/or the presence and activity of opportunistic pathogens which may cause vine decline, Esca and associated diseases in planted vines
- Vines should not possess rootstock suckers
- Vines should be of appropriate length - approx. 12-14" from base to graft or rootstock spur
- Root systems should be complete and full and milky white in section

Strategies for Securing Virus Test-Negative, Physically Sound Grapevine Nursery Stock

Although the CDFA nursery registration and certification program collects funds from participating nurseries to monitor the health/virus status of increase blocks, the available budget is limited: the sheer acreage of IB vines throughout California makes it challenging to evaluate and test nursery increase blocks to the extent that would be ideal. Additionally, considerable effort is required to monitor finishing dormant vines in the nursery row in fall—when virus symptoms may be observed. Over the years, a large number of increase blocks have been found to be contaminated with important grapevine viruses (*winebusiness.com/wbm/?go=getArticleSignIn&dataId=79008, winebusiness.com/wbm/?go=getArticleSignIn&dataId=112325*). In 2015, 31 participants provided approximately $300,000 to fund program-mandated IB nursery stock inspections and testing.

Perhaps one of the most important steps in the procurement of high-quality planting material is the selection of a nursery willing to cooperate in all aspects of a detailed virus-testing program. Ideally, the nursery will have good in-house IB virus test results and should be excited at the prospect of getting more information on the status of their vines.

It is far more efficient to test propagation materials before grafting than to test the finished product, both in terms of cost and outcome. When testing propagation source vines prior to grafting, each rootstock and scion IB vine required as a source of cuttings should be tested. If working with finishing or finished vine product, a statistically sound sampling protocol should be followed. Physical evaluation of scion IB vines should be undertaken in late fall—ideally just prior to leaf fall—when foliar symptoms associated with disease conditions are most likely to be evident (PHOTO 5A, 5B).

Evaluation of white varieties for disease is far more difficult because they do not turn red under conditions of stress. However, the foliage of white varieties afflicted with Red Blotch and/or leafroll often becomes chlorotic, and leaves may roll. Chardonnay vines contaminated only with GRBaV developed symptoms only in late November—the leaves possessed a metallic sheen—and as with other viruses, the leaves of infected vines tended to remain attached longer (PHOTO 6A, 6B).

Physical evaluation of scion IB vines is the most useful tool for securing clean plant material and is a critical part of a virus-testing program. This is much more important than evaluation of rootstock blocks as these tend not to show virus symptoms even when contaminated. If a nursery grafts at two times overage, it will, for example, graft 20,000 vines for an order of 10,000. If, for example, Cabernet Sauvignon FPS 30 IB vines produce 200 graftable

PHOTO 5A CS412 Increase block. Vines appear healthy. 9-24-12

PHOTO 5B CS412 Increase block. Red Blotch symptoms. 11-6-12

PHOTO 6A Chardonnay 04 Increase block. Vines look healthy. 11-4-14

PHOTO 6B Chardonnay 04 Increase block.
Green vines in foreground tested positive for GRBaV. 12-4-14.

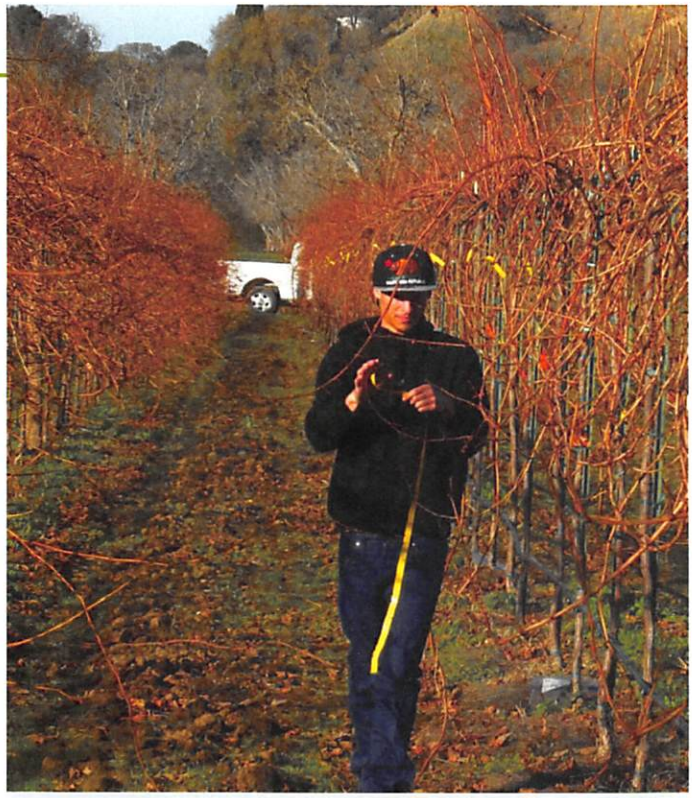

PHOTO 7 Sampling and tagging Malbec increase block vines, December 2015

buds, then 100 plants need to be identified as a source of budwood. Avoid any IB vines that are of questionable appearance and ideally have the nursery test these. Find 100 contiguous vines of good health, tag and ID them and collect samples for virus testing (PHOTO 7). If the block looks questionable, do not use it. If vines in adjacent blocks are symptomatic, consider alternative blocks or using alternate nurseries.

Ensure that cuttings from tagged vines are harvested and labeled appropriately and check to see that appropriately identified materials are present on the grafting table (PHOTO 8). Follow the vines through grafting and production and check that the vines are true-to-type and that sufficient high-quality plants will be available at grading time.

If dormant vines are under production from pre-propagation-tested IB materials, screen plants for Red Blotch and GLRaV3 in the nursery row in fall and again at the time of final grading.

PHOTO 8 ID tags placed on PN37 increase block vines in the fall are checked at time of grafting.

If working with nursery stock that was not derived from pre-screened propagation materials, use statistically sound sampling strategies to provide comfort that materials are virus test negative. Woody tissues should be taken from the vine lot and submitted for testing. Depending on the type of product, this testing protocol may be destructive or non-destructive. Make sure that tested vine bundles, lots and bins are tagged and photographed.

USE OF NON-CERTIFIED SCION MATERIALS

During the 2012-2015 season Red Blotch and leafroll-3 crisis it was fairly impossible to find clean certified materials of Cabernet Sauvignon and other important varietals. In many instances non-certified materials were cleaner than those available as certified from participating CDFA-certified nurseries ("Red Blotch Disease and the Virus Status of CDFA-certified Grapevine Stock," Stamp and Wei, August 2014, *WBM*).

Although politically incorrect, an apparently healthy block backed by good history, timely physical evaluation and in-depth lab testing can be a reliable and unique source of budwood.

Pinot Noir selections (often referred to as clones), such as VR and Chardonnay Montrachet, are in demand but under the radar of the CDFA nursery certification program. Clean materials are available, however, and some growers understand the importance of including these materials in their preferred clonal mixes. With appropriate observation and testing and given access to a "secure" source of material, these special selections can be reliably chosen for propagation.

TABLE 1 presents the results from testing speculative production dormant vine lots of Cabernet Sauvignon/1103P at the nursery immediately prior to intended delivery.

TABLE 1. Virus status of "spec" CS4/1103P and CS7/1103P dormant vine lots determined by sampling finished product in February 2015: 17,000 vines in each lot

Scion	Rootstock	%Samples Positive	
		GRBaV	LR3
Cabernet Sauvignon 04	1103P	0%	63%
Cabernet Sauvignon 07*	1103P	10%	10%

* Different samples tested POS for GRBaV and LR3

Source: Stamp Associates Viticulture, Inc.

Drones in Nursery Vine Evaluation and Production

There is no substitute for hard work, and it seems that we have some time to go before the careful walking and examination of each side of single IB rows in the fall can be replaced by other means. The opposite sides of a vine row can look very different, especially on sunny days when the sun maybe shining on or through the leaf canopy. On one side, a leaf might look dried and brown, but from the other the same leaf might appear crimson red and symptomatic of leafroll or Red Blotch. So while at this point there is no substitute for on-the-ground examination, the development and promise of remote sensing drone technology for determination of the virus status of thousands of rows of IB is an exciting prospect (SIDEBAR 4).

This technology should also be applicable to the evaluation of finishing dormant stock planted in the nursery row at 17,000 vines per acre. Overhead visual evaluation of the vines would allow for the detection and location of stressed and virused plants and would permit more accurate determination of stand and likelihood of filling orders with high-quality stock.

SIDEBAR 4. Drones in Nursery Vine Evaluation and Production

REMOTE SENSING

Aerial remote sensing is a quickly evolving and powerful tool for vineyard owners and managers. Combined with on-the-ground expertise, remote sensing can help assess overall vine health and monitor emerging issues. A variety of imaging sensors exist, and each provides unique insights that can be used to efficiently leverage the expertise of vineyard staff while increasing their coverage and ensuring that problem areas are not missed.

RGB: Standard photography, also called RGB (for "Red-Green-Blue"), can be used as a baseline for other imagery and help provide a point of reference for analyzing other images that might show things not visible to the naked eye.

Long Wave Infrared: Also called thermal imagery, long wave infrared can be used to assess heat levels in the soil or canopy, allowing vineyard managers to assess relative water retention, evaporation and saturation.

Multispectral: By dividing visible and near-infrared light into discrete bands, multispectral photography allows comparative analysis of light reflected in different parts of the spectrum. NDVI imagery, for example, uses measurements of red and near-infrared light to determine the relative vigor of vegetation.

Hyperspectral: Taking multispectral imagery a step further, hyperspectral imagery divides the spectrum into even smaller bands, allowing one to not only determine general traits of plants and soils, but specific ones as well, potentially identifying pathogens and other stressors by name. Recent work by MacDonald et al (Computers and Electronics in Agriculture, 130, (2016), 109-117) demonstrated the potential of hyper spectral imaging for detection and mapping of GLRaV-3 in infected Napa Valley vineyards.

Will Daley, Benjamin Falk, Altilytics, LLC., www.altilytics.com

Viruses Most Commonly Found in Grapevine Nursery Stock

Today, and since 2012, Red Blotch and GLRaV3 are still amongst the most commonly found viruses in certified grapevine nursery stock. GLRaV-9 was the most commonly detected virus in certified stock according to testing conducted by **Stamp Associates Viticulture** in 2015-2017 (TABLE 2).

TABLE 2. Most commonly found economically important pathogens in certified materials: 2015-2017

Virus/pathogen	Frequency of detection
GLRaV-9	Most frequent
GRBaV	
GLRaV-3	
GLRaV-5	
Xylella fastidiosa (bacterium)*	
GLRaV-2	Least frequent

*causes Pierce's Disease

Source: Stamp Associates Viticulture, Inc.

TABLE 3 Percentage of Positive Samples of All Samples Tested by Agri-Analysis since March 2014

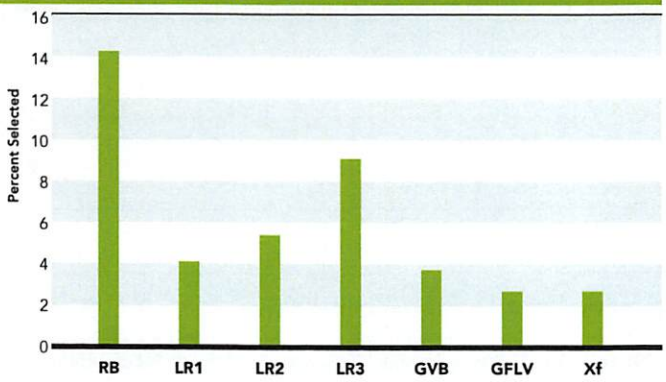

TABLE 3 illustrates the most commonly found viruses in all grapevine materials tested at **Agri-Analysis, LLC** from March 2014 to-date.

It was very concerning when Grapevine Pinot Gris Virus (GPGV) was characterized in Italy and subsequently found in late spring 2016 in Cabernet Sauvignon vines in Oakville and Rutherford (*apsjournals.apsnet.org/doi/abs/10.1094/PDIS-01-16-0055-PDN*). After the catastrophe of Red Blotch and the ongoing problems with GLRaV3-contaminated certified stock, it was hard to contemplate the emergence of yet another serious threat to California viticulture. Although GPGV has resulted in severe vine decline, yield loss and death especially in Italy, a correlation between vine decline and this virus in California has yet to be reported. In fact, since a diagnostic test for this virus became available in February 2016, GPGV has not been detected in any certified stock tested by Stamp Associates Viticulture, Inc.

MANAGEMENT OF LEAFROLL AND RED BLOTCH CONTAMINATED VINEYARDS

The following recommendations for reducing the economic impact of grapevine leafroll disease in California were published in an ***American Journal of Enology and Viticulture*** in 2015 (*ajevonline.org/content/66/2/138*):

- Rogueing vines, in combination with mealy bug insecticides, can significantly reduce contamination if leafroll disease prevalence is less than 5 to 10 percent.
- A full vineyard replacement should be considered if disease prevalence is above 25 percent.

This same strategy should be considered for Red Blotch-contaminated vineyards. If the presence of Red Blotch is low, confirm vines are infected with GRBaV and remove affected plants.

Fungal Pathogens in Grapevine Nursery Stock

The CDFA grapevine registration and certification program does not control the fungal pathogen status of certified nursery stock. Opportunistic fungal pathogens, such as *Phaeoacremonium*, *Phaeomoniella* and *Cylindrocarpon* species, are widely present in nursery stock and can induce young vine decline and Esca in new and mature vineyard plantings.

The only effective way to reduce the potential impact of these and other opportunistic fungal pathogens is to work with nurseries that follow excellent sanitation practices and focus on the production of sound cutting materials with good carbohydrate reserves. Some nurseries sell fruit from their IB blocks, and such competition between berry production and wood maturation results in inferior cutting material quality. Inferior cutting materials result in poor propagation wound response—inadequate healing of the graft union, inadequate callusing of rootstock base and disbudding sites and weak root initiation. The overall quality of vines derived from inferior cuttings will be compromised. The vines may have incomplete graft unions, lesions running down the rootstock shaft from the graft union and up from an improperly callused vine base (PHOTO 9). When examined internally, these vines are more likely to show vascular streaking and exude black gums at the cut surface (PHOTO 10). These are symptoms correlated with physical stress and the activity of opportunistic fungal pathogens.

The best way to avoid planting dormant vines with possibly high loads of fungal pathogens is to select physically sound specimens. Judicious two-dimensional flexing of dormant vines will reveal the presence of rootstock lesions and weak graft unions: the vine will fracture. It is more difficult to assess the quality of young green vines: modest pressure should be applied to

PHOTO 9 Basal rootstock shaft lesion (and defective root system): dormant 420A rooting

PHOTO 10 Transverse section through rootstock shaft of 420A rooting: symptoms of stress and fungal pathogen activity are evident.

SIDEBAR 5 Evaluation of green and dormant product quality

Green	Dormant
Vines should be firm in the potting medium – this indicates that root systems are fully developed	Shoot spurs should be emerald green in section, moist and at least 3/16" caliper
Roots should appear healthy when vines are removed from the container	Graft unions completely healed
Root ball should remain intact when vines removed from container	Lesions >1/2" length should not be present at the graft union nor at the base of the vine. Sectors of the vine lacking roots can indicate the presence of rootstock lesions
Vines should have secure graft unions	When subjected to moderate flexing the vine should not break.
Vines should not possess rootstock suckers	Propagation wounds should be completely healed
Vines should have acceptable shoot growth with good basal caliper and moderate lignification	Vines should not show substantial amounts of vascular discoloration more than 2" away from the base and graft union of the rootstock shaft. This discoloration is evidence of stress and/or the presence and activity of opportunistic pathogens which may cause vine decline, Esca and associated diseases in planted vines
No evidence of crown gall development	Vines should not possess rootstock suckers
	Vines should be of appropriate length - approx. 12-14" from base to graft or rootstock spur
	Root systems should be complete and full and milky white in section

the graft union, and the vine should not be loose in the potting medium. The vines should possess good shoot spur caliper and ideally show a reasonable degree of lignification (SIDEBAR 5).

Rootstock Notes

Due to considerable interest in planting vines with long rootstock shafts ("uber" vines) where the graft union is approximately 30" above the soil level, in-demand rootstocks, such as VR 039-16 and 1103P, are selling out much more quickly than in previous seasons. Approximately three times as much rootstock material is required to produce an uber vine compared to that required for standard size grafted vines.

VR 039-16, GRN1 and RS3 show resistance to *Xiphinema index* and other important nematodes and tolerance to fanleaf degeneration disease.

VR 039-16 is the only practical rootstock choice for soils contaminated with *Xiphinema index*, the vector responsible for transmission of fanleaf degeneration disease. VR 039-16 is planted almost exclusively in many areas in and around Oakville, Rutherford and Geyserville, California.

There is no real alternative to VR 039-16 as GRN1 (*Vitis rupestris* x *Muscadinia rotundifolia*, considered to have tolerance to fanleaf) (*fps.ucdavis.edu/fgrdetails.cfm?varietyid=2641#7899*) is very difficult to propagate, so much so that it is virtually impossible to order rootings or vines grafted to GRN1 and expect to receive a reasonable amount of quality finished product.

As with GRN1, the rootstock RS3 (Ramsey x Schwarzmann) features broad-spectrum resistance to nematodes (*fps.ucdavis.edu/fgrdetails.cfm?varietyid=2114#7478*). Unlike GRN1, RS3 is relatively easy to propagate, and green-grafted vines can be reliably ordered. RS3 has been successfully substituted for VR 039-16 in locations with X. index; however, a 2016 planting proved susceptible to overwinter waterlogging in the Geyserville region in the extremely wet spring of 2016.

420A

420A (*V. berlandieri* x *V. riparia*) is the rootstock of choice for some winemakers looking for ultra-premium quality fruit. It is a difficult rootstock to propagate, however, due to its propensity for limited root development, poor grafting ability and susceptibility to crown gall. Early in this decade it seemed that dormant bench-grafting with 420A was quite successful, but over the last several seasons production of 420A dormant benchgrafts has been mostly unsuccessful even at generous overages. To come close to guaranteeing production of dormant 420A-grafted vines, it would be prudent to graft at 4.5x overage, but this, of course, represents tremendous loss to the nursery and requires exorbitant laboratory testing of rootstock IB vines. Production of dormant benchgrafts of Pinot Noir on 420A seems to be especially difficult. Far simpler is to elect to work with green-grafted vines where the outcome is fairly certain with 1.7-2.5 x propagation overages.

Protocol 2010-certified 420A has only recently been released to nurseries for establishment of increase blocks. There may be small amounts of Protocol 2010 420A available as rootings or grafted green vines in spring 2018, but previous to this the industry has relied on a very limited number of clean sources of 420A. This was one of the first rootstocks to test positive for Red Blotch in 2012; and since then, most classic CDFA-certified sources have tested positive for the virus.

Dormant 420A rootings and grafted vines can fail if planted in cold wet soils in spring.

1103P

1103P (*V. berlandieri* x *V. rupestris*) is currently selling out early. It is in demand because of its moderate vigor and excellent drought tolerance. It is widely requested for plantings in the Central Coast (San Luis Obispo County) and grafted to a wide range of clones that do well in this location's cool to warm climate range.

SIDEBAR 6. Rootstock selections used for recent Napa and Sonoma county plantings

Most commonly selected rootstock in 2017	
Rootstock	**% Total of all selected**
VR 039-16	23%
1616C	21%
420A	14%
101-14	13%
3309C	10%
110R	8%
Riparia Gloire	6%
1103P	4%
RS3	1%
GRN3	1%

SIDEBAR 7. Cabernet Sauvignon, Cabernet Franc, Chardonnay, Pinot Noir and Sauvignon Blanc clones planted in 2017

2017 Cabernet Sauvignon		
Clone	**ENTAV/Old FPS #, Common Name**	**% Total**
CS47	CS337	24%
CS43	CS15	15%
CS04		14%
CS07		10%
CS30	Disney/See	9%
CS35	CS685	7%
CS412		4%
CS29	Niebaum-Coppola	3%
CS05		3%
CS33	CS191	2%
CS02	Oakville	2%
CS169		2%
CS34	CS191	2%
CS06		1%
CS Martha's		1%

2017 Cabernet Franc		
Clone	**ENTAV/Old FPS #, Common Name**	**% Total**
CF11	CF214	65%
CF12	CF327	18%
CF14	Niebaum	16%

2017 Chardonnay		
Clone	ENTAV/Old FPS #, Common Name	% Total
CH04	Martini	65%
CH66	Mt. Eden	26%
CH17	Robert Young	9%

2017 Pinot Noir		
Clone	**ENTAV/Old FPS #, Common Name**	**% Total**
PN91	04 Pommard	30%
PN15	Martini	13%
PN37	Mt Eden	12%
PN97	Swan	10%
PN73	PN115	9%
PN943		8%
PN90	Calera	7%
PN72	PN667	5%
PN23		4%
PN71	PN777	2%

2017 Sauvignon Blanc		
Clone	**ENTAV/Old FPS #, Common Name**	**% Total**
SB01	Château Yquem	71%
SB14	SB316	14%
SB31	SB297	9%
SB30	Musque	3%
SB18	SB317	2%
SB27	Musque	1%

Stamp Associates Viticulture Inc., data.

SIDEBAR 8. Vine mealybug on green vines; Monica Cooper

In early August 2016 a newsletter from the UC Cooperative Extension (*cenapa.ucanr.edu/newsletters/Vineyard_Views_Newsletter_-_Events 70517.pdf*) announced that vine mealybug had been found on recent nursery shipments of green-growing vines in the North Coast region. When asked, **Monica Cooper** noted, "Most of the shipments have come into Sonoma County, so I am not in the loop on which nurseries. For the one that came into Napa, the grower would not say the nursery of origin." The recommendation from the **Napa County Agricultural Commissioner**'s office is to contact them to have all incoming Napa County shipments of green-growing vines inspected by their staff. In addition the newsletter can be used as a training tool for crews inspecting vines as they are received.

Endnote

Considering the state of play in 2013 ("The Impact of Grapevine Red Blotch Virus," Stamp and Wei, March 2013, *WBM*, pp. 56-67) when it was virtually impossible to find grapevine nursery stock free of either Red Blotch or GLRAV-3, the nursery industry has come a long way, and arguably the vintners and winemakers have a better array of stock available to them than at any other time in the last 20 years.

A prominent viticulturist and winemaker asked in summer 2016, "Given all the issues with Red Blotch and leafroll, should those wishing to plant a new vineyard be advised to wait?" The answer today is no: don't wait. It seems it is only a matter of time before the newly planted Protocol 2010 blocks become contaminated with Red Blotch and leafroll and potentially other viral, bacterial or fungal pathogens of which we are currently unaware. If this article had been written in August 2012, there would have been no mention of Red Blotch. The real issue going forward is that although we can devise protocol for producing clean stock from an array of questionable materials, these plants are most likely to be planted next to established vineyards that are diseased. And given the rapid transmission of Red Blotch and leafroll by insect vectors, it is likely that clean stock will quickly become contaminated.

Some growers are erecting tall screens around their vineyards to reduce insect movement, and this should have some effect. However, the answer to infection of clean stock is genetic engineering. The tools are available and well understood, and just as with corn, potato, avocado and myriad other crops, leafroll virus-resistant vines could be available commercially today. The argument goes that customers are concerned that GMOs will harm the environment or wine quality or that a genetically engineered Cabernet Sauvignon vine is not Cabernet Sauvignon. In reality—just like humans—grapevine plants are a symbiotic ensemble of thousands of microbial species—producing fine wines. A Cabernet Sauvignon vine free of foreign DNA could not exist in the vineyard. And grapevines that are genetically engineered to resist *Xylella fastidiosa*—the bacterium responsible for Pierce's Disease—would be far more genetically identical to the parent vine than those resulting from traditional ongoing breeding projects. WBM