

Clean planting material - an effective strategy to prevent diseases in Vineyards

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- We are seeing a rapid expansion of wine grape acres in East coast , specifically the mid-Atlantic regions.
- While is a great news, we have to be very careful about what we are planting here, because whatever we are planting, it could be staying in ground for 30-40 years and we want them to.
- In wine grapes, specifically in east coast, vineyard diseases is always a big challenge. Some more than the others.
- But why should we be worried about diseases even before planting?

Diseases..... even before planting?

- Grapevine - History and Migration.
- Wine grapes are the repository of hundreds of pathogenic diseases.
- Some pathogens, specifically viruses can stay in vines without visible symptoms for many years.
- These diseases are typically spread through infected planting stock and plant propagation material.

- Wine grape is one of the oldest growing crop of the recent human history, which is full of migration events. Wine grape found itself travelling during the migration or colonial era, the most recent one were Spanish and English and French migration.
- When the grapevine travelled as a planting material it (1) carried the diseases it was exposed to in its native place and then (2) it was subjected to new diseases of new land or new world.
- Not only that it has higher susceptibility to variety of diseases . When it was introduced in France, the powdery mildew diseases were already present in other crops but in wine grape it was expressed virulently

Virus diseases can not be cured once infected

- Viruses can stay in cutting material for years.
- Propagation method is the main cause of virus diseases.
- What options do you have to prevent virus diseases diseases?

- Then there are viruses, which can stay in grapevines for years and then suddenly begins to express in your vineyard.
- Part of the problem is wine grape is predominantly propagated through cuttings and grafting, and that's why it can pass on the diseases to generations.
- The best way to prevent diseases is through the principle of avoidance.....use planting which is not infected with diseases or more specifically virus in other words use clean planting material or certified planting material.

What is clean or certified plant material?

- Clean or Certified material means cuttings come from a source block that was properly managed, subjected to regular inspections for insect pests, disease damage, and tested for virus right from propagation through packaging.
- These nurseries also go through independent third party audits.

‘Clean’ is more generic term for ‘certified’ however often used by growers and nurseries and extension professionals.

Why should you plant 'clean' or 'certified' grapevines?

- Planting 'clean' or 'certified' material helps prevent the introduction and spread of many unwanted diseases.
- Unlike insects and many fungal diseases, the *viruses*, *viroids*, *phytoplasmas* and *bacteria* cannot be controlled by chemical sprays after vines are infected.
- Once disease is established, it is difficult and costly to eradicate.
- Insurance

- Certified material provides a guarantee that the planting material is clean before it goes in to your soil of your vineyard, hence you prevent the introduction and spread in your vineyard.
- Modern science has led to control of most of the non virus diseases however some trunk based diseases or virus based diseases needs still have no cure, no control programs.
- Planting 'certified' vines is kind of best insurance for a healthy and profitable vineyard since you know absence of pre-existing pathogens.

Table 5: Grower Net Benefits from Planting Certified Stock

	Average Annual Discounted Benefit			Present Value of Net Benefits over 50 years		
	Per vine	Per acre	Region	Per vine	Per acre	Region
	<i>\$/Vine/Yr</i>	<i>\$/Acre/Yr</i>	<i>\$/Mill/Yr</i>	<i>\$/Vine</i>	<i>\$/Vine</i>	<i>\$/ Millions</i>
Without Replanting	0.23	305	30.7	5.78	7,637	767.0
Replanting with Non-Certified Stock	0.27	359	36.0	6.78	8,966	900.4
Replanting with Certified Stock	0.40	533	53.5	10.08	13,327	1,338.3

Kate B. Fuller, Julian M. Alston, and Deborah A. Golino, 2013

- Here is the result of a survey conducted by UC group in 2013, its about net benefits of a virus tested planting material in Grapevine Leaf-roll infected vineyards in the North Coast region of California.
- I just want to highlight 2 results.
- The average annual discounted benefit per acre without replanting the infected vines was 305\$, replanting with non certified material the benefit was around 360\$ and replanting with certified stock, the benefits could be as high as 533\$, if you translate over 50 years its 13,327\$ this is just one acre, if you have 10 acres, that would be 130K.
- I think the best advantage is the saving you make during the early years of vineyard establishment. We have a break even 8-10 years, you don't want to lose the crop. And there not much difference between certified and non certified material. An example.

Where does certified planting material come from?

National Clean Plant Network (NCPN) for Grape



Foundation Plant Services (FPS)

Foundation block Produce and maintain grapevine certified nuclear stock materials that become available to nurseries and growers in California, the United States, and foreign countries.



Certified Nurseries

'Mother Block' is planted at a nursery with vines obtained from a 'Foundation' program.

Vines from the 'Mother Block' are propagated to produce 'Certified' vines. If a vine is grafted onto rootstock, both the scion and the rootstock have to meet these standards to qualify as 'Certified'.

You



Here is the process cycle for certified planting material, we will go in to detail in next 3 slides.

What is the role of NCPN-Grape?

- Objective of NCPN
Conduct research to improve its diagnostic and therapeutic service.
- Send those guidelines to FPS (Foundation Plant Services)
- Important to remember that the role of the nurseries is to propagate the cuttings using NCPN regulations and guidelines.

- NCPN Grape is a part of an umbrella organization NCPN.
- The main objective of NCPN is to conduct research and come up with methods and guidelines for generating clean plant material.
- The guidelines keeps updated as new research or methods for virus identification develops.
- Remember that nurseries don't have means to identify viruses and eliminate virus from the cuttings.

Foundation Plant Services develops certified planting material

- FPS use micro-shoot tip culture which is specifically designed to eliminate major pathogens and viruses to generate clean grapevine in a foundation block.
- It starts with tiny tissues in to test tubes which grows into plantlets and then in to plants, which is tested for extensive list of pathogens and virus.

- Certified nurseries have to follow strict guidelines during propagation.
- By the time you order certified material, the source material has spent 8-10 years in the cleaning process.
- Does this efforts reflects in the pricing of planting materials?
No. Why?

- Then certified nurseries sources cuttings from FPS, and propagates into nurseries Mother Block.
- The label of 'certified' is the result of a healthy vine being propagated using procedures to minimize infection and disease, and this process is legally defined by each State's Dept. of Agriculture, but you still have to follow minimum steps decided by NCPN.
- Because Certified nursery receives the clean plant material from other agencies and their responsibility is not to create and but to maintain clean stock, so it is not very expensive.

Foundation Plant Services Available Tests for Protocol 2010

Group	Pathogen	Symbols	ELISA	qPCR	PCR	Herb. Index	Woody Index	
Nepoviruses	Grapevine fanleaf virus	GFLV	X	X	X	X	St. George	
	Tomato ringspot virus	ToRSV	X	X	X	X		
	Tobacco ringspot virus	TRSV	X	X	X	X		
	Arabid mosaic virus	ArMV	X	X	X	X		
	Strawberry latent ringspot virus	SLRSV	X	X	X	X		
	Blueberry leaf mottle virus	BLMV	X	X	X	X		
	Raspberry ringspot virus	RpRSV	X	X	X	X		
	Tomato black ring virus	TBRV	X	X	X	X		
	Grapevine deformation virus	GDefV	X	X	X	X		
	Artichoke Italian latent virus	AILV						
	Closteroviruses	Grapevine leafroll associated virus 1	GLRaV-1	X	X	X	X	Cab. Franc
		Grapevine leafroll associated virus 2	GLRaV-2	X	X	X	X	Cab. Franc
		Grapevine leafroll associated virus 2RG	GLRaV-2RG	X	X	X	X	
Grapevine leafroll associated virus 3		GLRaV-3	X	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 4		GLRaV-4	X gen	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 5		GLRaV-5	X gen	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 6		GLRaV-6	X gen	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 7		GLRaV-7	X	X	X	X		
Grapevine leafroll associated virus 9		GLRaV-9	X gen	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 10		GLRaV-10	X	X	X	X	Cab. Franc	
Grapevine leafroll associated virus 11		GLRaV-11	X	X	X	X	Cab. Franc	
Vitiviruses	Grapevine leafroll associated virus Car.	GLRaCV	X gen	X	X	X	Cab. Franc	
	Grapevine virus A	GVA	X	X	X	X	Kober 58B	
	Grapevine virus B	GVB	X	X	X	X	LN33	
	Grapevine virus D	GVD	X	X	X	X		
	Grapevine virus E	GVE	X	X	X	X		
Foveavirus	Grapevine rupestris stemmitting associated virus (all strains)	GRSPaV	X	X	X	X	St. George	
Maculavirus	Grapevine fleck virus	GFRV	X	X	X	X	St. George	
	Grapevine redglobe virus	GRGV	X	X	X	X		
Marafviruses	Grapevine syrah virus-1	GSyV-1	X	X	X	X		
	Grapevine vein feathering virus	GVFV	X	X	X	X		
	Grapevine asteroid mosaic virus	GAMV	X	X	X	X		
DNA Viruses	Grapevine red blotch associated virus	GRBaV	X	X	X	X		
Phytoplasma	Grapevine vein clearing virus	GVCV	X	X	X	X		
Pierce's Disease	Universal detection	Phyto	X	X	X	X		
	<i>Xylella fastidiosa</i>	PD	X	X	X	X		

Key:
 X Test performed at FPS.
 X = test is available;
 X gen. = ELISA using generic antibody which detects GLRaVs-4, 5, 6, 9 and Car. in a single test;
 qPCR= quantitative PCR= real time RT-PCR with TaqMan probe; PCR= will include RT-PCR for RNA viruses.

Source, Foundation Plant Service, UC Davis

- The standards for what is considered clean plant is periodically reviewed by NCPN and as a result more and more pathogens are being added to the list of pathogens to be cleared of as the technology to determine and diagnose diseases, specifically viruses diseases improve.
- This is the recent development from NCPN. Under new 2010 protocol developed by NCPN, there is an extensive list of viruses which were not previously included or mandated.
- For example Grapevine Red Blotch virus is very important and recently identified and sequenced.
- Nurseries have started selling 2010 protocol vines from 2013
- Peace of mind.

Can crown gall be prevented via clean material?



- Possibly, YES.
- Currently results indicate that plants free of the crown gall pathogen can be generated (Tom Burr and Tim Martinson, 2015, NCPN Grape).

- I have seen that in NJ, may be true for parts of mid-Atlantic. Due to cold damage high incidence of crown gall in north east compared to any regions.
- All it needs is a cold injury for bacteria to get an entry into wounds and then you see tumor like this.
- All we know so far, young vineyards are more susceptible than the old one.
- so its valid question to ask, Can crown gall be prevented via clean plant material??
- Answer, is possibly YES, Based on current research funded by NCPN we know that agrobacterium free planting material is a real possibility, though no very soon!!
- Because Protocol 2010 uses micro shoot tip culture, it should eliminate *Agro. vitis* from the mother plant, it is less likely to be infected than cuttings from previous protocols.
- So, in near future it is going to be like 'must' buy from the certified nurseries.

Perform detailed inspection of your planting material



- Make sure that the planting material came in a dormant condition and was still moist.
- vines should look clean, bright and have an earthy aroma.
- If there are bad odors indicative of rotting vines then identify the batch and avoid planting the entire batch.

- So we talked about certified material, but even if the material is certified there are the chances of getting weak or undesirable planting material which can later develop some diseases. If you are little bit careful you can avoid future trouble.
- So when you order your vines, you know which specific date your planting material is going to come. So spare some time for evaluating the material when it arrives, for example.
- As you open your shipment, make sure your box ventilated enough to ensure vines were moist but not soggy or dormant but not dehydrated during transportation.
- Bad odors.. Make sure that planting material comes with documents or labels that will help in tracing plants back to the original source.
- Use the labels and batch information for requesting compensation or refund in case the material was not good enough.

Perform detailed inspection of your planting material



A bundle of healthy grafted grape vines. These vines are moist, have healthy roots, and are clearly labeled.

- Vines should be uniform in size, without scars or damaged buds. Shriveled branches or dried vines are indicators of non-vigorous vines.
- Similarly, roots should be healthy, untwined, downward pointing with fibrous cream-colored branch roots.
- Vines with excessively curvy shoots could be difficult to train on the trellis system and should be sorted out.

- Also make sure you got what you ordered. Each bundle of vines should have proper labels describing primary information such as variety, clone, rootstock and some kind of batch number.
- Weak vines will be more susceptible to Winter damage which increases the chances of crown gall. Your vines should be uniform in size, without any visible scars.
- Inspect your roots, you are not going to inspect each and every root, but you should clearly see fibrous cream-colored branch roots.
- You want to grow your trunk straight. These vines are prone to trunk damage during vineyard operations such as hilling-up and hilling-down.

Make sure planting material was shipped promptly



A bundle of grape vines that have broken dormancy and started to grow before arrival at the vineyard. These vines will be weakened and should be rejected.



Vines with broken dormancy when planted in the field, shoot from the primary bud died within hours.

- I took this picture last year, when I received a call from a growers, that all his Cab Franc planting material has all pushed the buds. When he asked this nursery, it's a reputed nursery from California.
- He found out that they shipped more than 10 days earlier and it came in train, so there are some uncertainties. He told him that considering much cooler climate during spring this should just be fine. Now he did not know that it could get warm in late spring in south Jersey.
- So, after the assurance grower planted these vines, those buds which had pushed shoots (they were yellow, bud in the absence of light), died of sun burn or just fell off in few hours after the planting. How fortunately other buds pushed, but typically your most vigorous primary buds are developed first and then your secondary. So you are not strong how strong the shoots will be, I think they will still be fine, but the point is try to get dormant material.
- Make sure your planting material was shipped promptly after packing and came in a temperature-controlled vehicle.

Pay close attention to the graft union



Examples of healthy graft unions on these grape vines.

- Graft union should be completely healed without bulging.
- The scion (upper portion) and the rootstock (lower portion) should be of matching thickness.
- Destructive testing of a few randomly selected vines
- Visit the nursery before you order materials for the first time.

- If you are in east coast, most likely you ordered grafted vines.
- According to Lucie Morton a viticulture consultant based in Virginia, from the lot will be very useful to find out the quality of grafts, for example checking the depth into the pith by disbudding or applying thumb pressure at the graft union.
- I know a grower, who likes to take vacation in CA, and during his vacation, he goes to tasting rooms and also goes to nursery to see how his ordered vines are looking. Ask the questions about the procedures, Look at the nursery sanitation, especially in the grafting area, etc.
- Often, to keep up with the high volume orders, nurseries use green bench grafting which is more prone to diseases and handling damage than dormant grafting or field grafting which is superior.

Avoid green bench grafted vines



Jim Wolpert and Andy Walker, UC Davis

- Green grafting is popular with some nurseries.
- Only four to five months are required between ordering and delivery.
- Small root systems are not robust, and periods of prolonged hot weather can cause considerable damage to, or even kill, these young plants.

- Green-growing bench grafts have increased in popularity in the last decade partly because the demand for planting material far exceeds the supply as a result nurseries focused on a immediate orders.
- Assuming that a nursery has the desired dormant rootstock and scion cuttings available for grafting. Decisions can even be made well into the growing season.
- Sometimes, when you are late in ordering your vines and if nursery may not have the stock of one your old vines, you may get green grafted vines However, you should be wary of agreeing to accept green-growing plants.
- There is no problem as such, it just that root system may not be as vigorous or extensive, in nurseries, its ok, since they have mist and irrigate frequently. But when you plant them in the field, especially in summer, you will see more weather being transpired compared to absorbed by small root system, and there could be dehydration and other problems.
- I think typically it's a growers urgency,make decision on variety, root stock and clones 1.5 years in advance.

Always prefer dormant bench grafts



An Omega cutter (L) and bench graft.
Photos by Mercy Olmstead, Uni. of FL

- Dormant bench grafts are planted directly into a nursery row where they grow for a full growing season.
- After rooting over the growing season, they are dug in fall, sorted, trimmed, bundled, and stored for delivery in spring.
- Dormant grafts have vigorous root system and greater chances of thriving.

- As far as grafting process it is the same as green graft, however after grafting, instead of being potted they are planted directly in to nursery rows, where they grow for full growing season.
- One season is enough to grow extensive root system and callus development so that your graft union is also strong.
- Dormant plants, as their name implies, are not growing when delivered, and therefore have greater stored reserves and are much hardier.

What if the nursery is not certified?

- Make sure nursery is at least reputed or in the process of improving propagation standards.
- Avoid using planting material from other vineyards.
- Ask for warranty and return policies.
- Randomly select few plantings for virus screening.

- There are nurseries with high reputation of providing clean material even though they are not certified, but they are in the process of becoming Certified nursery, they are reputed, very large and known for producing clean plant material even if not certified, they have their own protocol, but it may not be as extensive as say protocol 2010.
- Symptoms of specific diseases may be unseen in sourced vineyards however, your vineyard could provide perfect conditions to spread that disease, especially trunk based diseases such as Phomopsis, Esca and die-back
- What you can do is send few randomly selected vines to virus testing lab and get the idea and peace of mind.
- Most importantly, it is not expensive, you can see in the bill, there are only several cents extra for the 'certification'
- Cutting corner at this stage could result in paying enormous costs as the vineyard matures.

Remember!!

Certified material does not guarantee disease-free grapevines after planting; it only ensures that planting material is clean before it goes into the soil. You still need to follow proper cultural practices and spray programs to ensure healthy vine and quality wine grapes!

Thank You!

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