



Grapevine Clones and Rootstocks

We have so many new wine growers coming into the industry and it is important that each of them get off to a good start and grow good grapes. It matters to everyone. There are hundreds of decisions that need to be made and each will have its own influence on the quality of the grapes they produce. Two topics that often do not get the attention they deserve are the choice of rootstocks and clones. This applies mostly to vinifera varieties but can matter to some hybrids also. In this article I wanted to comment on why rootstocks and clones matter to wine growers and some of the pros and cons of selecting the correct rootstocks and clones.

Grapevine Clones:

Definition of a clone (Hartman, et. al., 1990 from Ed Hellman, Texas A&M): a genetically uniform group of individuals derived originally from a single individual by asexual propagation (cuttings, grafting, etc).

Site selection is probably the most important component of making consistently excellent wines although as I point out in an accompanying article, viticultural competence can have a great impact on the quality of any vintage. Since I deal with so many new growers who are confronted with the question of what variety to plant, the matter of clones and rootstocks invariably surfaces. These are two highly underappreciated contributors to ultimate wine quality that require serious consideration. Yet, they can also be over-emphasized perhaps in an attempt to compensate for site deficiencies too much may be expected from rootstocks and clones. It's important to understand what they can and can't do for your vine's performance and grape quality. It's necessary to find the right balance and understand exactly what clones and rootstocks can contribute to overall wine quality from your vineyard.

The choice of species and variety of vines is influenced by primarily by site but also viticulture and marketing considerations. A variety needs to be adapted mostly to the climate in which it is expected to consistently produce fully mature grapes for wine production, that's the bottom line. In our climate it should also be expected to acclimate to a fully cold hardy condition. The degree of cold hardiness must be sufficient to withstand the historical low winter temperatures in the area. No matter what rootstock or clone you choose, a dead vine cannot produce good wine.

Within many of the vinifera varieties clones are very fashionable right now, particularly among wine makers. Heaven forbid if a grower doesn't plant the clones that are currently in vogue. Wine makers are often very fussy about clones, which may or may not be justified.

To be honest, most wine makers don't really understand the benefits or subtle differences between clones, they just read something about clone X or know that the wine maker next door likes clone Y so they think, "I better have it or I'll fall behind the quality or marketing curve." Suffice to say, like the iPhone, mini, or whatever the latest and greatest happens to be on any particular day, wine makers want it. This demand assures a logistical minefield for the grower, who, in the past only had to worry about having to order and plant Chardonnay or Cabernet. Now it's a variety on this or that rootstock and whatever clones are in fashion. This way of thinking can conflict with the basic nature of our business, which is long term and does not lend itself well to fad or fashion driven behavior. It's simply too expensive and complicated to change over varieties and clones. Durable and sustainable decisions about what to plant are necessary.

Some of the viticultural characteristics that make clones distinct include berry and cluster size and morphology, yield, fruit chemistry, color, phenolics, flavor, and aroma characteristics, time of budbreak and ripening period, vine vigor, perhaps cold hardiness and disease resistance but this is not well documented, and others, all are critical contributors in varying degree to wine quality. These must be matched carefully with the wine style and price point as well as the climatic and viticultural realities of the site on which they will be planted.

You can do your own clonal selection in your vineyard. If you find a vine with a particular praise-worthy trait you can take cuttings from the mother vine and propagate that genetic material into offspring that can be further planted. Wa-la! You have a field selection. I remember seeing a Cabernet Sauvignon vineyard devastated by winter injury in SE PA in 2004. Among the acre or so of dead vines were 2 or 3 that survived. Could these be a cold hardy clone of Cabernet Sauvignon? This is the process of clonal selection that has been going on for centuries in vineyards as growers identify unique qualities in certain vines in their vineyards and vegetatively propagate them. Paolo di Machi at Isole e Olena in Tuscany was unhappy with the Italian government's clonal selection for Sangiovese so he embarked on his own 30 years ago and now has multiple Sangiovese clones specific to his vineyard. Taste his wines and judge for yourself the success of his selection process.

Do clones really make a difference? Well, they can. The experience in Oregon with Chardonnay will illustrate the point. When Dave Lett and Charles Coury pioneered Pinot Noir in the Willamette Valley they brought with them two clones – Pommard (UCD 4) and Wadenswil (UCD 2A). I don't recall that any extensive research went into clonal selection it is likely that these were the available clones available to them at the time. It happened that they were very well suited for the growing conditions in the area and even as the Dijon clones became available two decades later, Pommard and Wadenswil continue to be the clonal center of the wine industry there. I think no one can argue with the success of Pinot Noir in Oregon.

Oregon wasn't so lucky with Chardonnay. The first clone to arrive was the 108 clone (UCD 4) with its big, tight cluster, high acid and late ripening habit it was not at all suited for the cooler climate in the Willamette Valley - we often picked it in November and it was prone to rot. In an area that should have excelled in Chardonnay (see Burgundy) the 108 clone doomed Oregon Chardonnay to critical and consumer failure. It wasn't until the earlier ripening and lower acid Dijon clones arrived that Chardonnay had a chance to make fine

wines but by then it was too late, Pinot Gris had taken its place in the white wine camp. Even now, Chardonnay struggles to establish itself in Oregon.

The history of modern clonal selection in the U.S. dates back to 1952 when Dr. Harold Olmo at UC-Davis began a program to clean up and identify existing grape stocks in California, which up until then had become riddled with virus and misidentification problems. The Foundation Plant Service (FPS), which currently serves the national fruit, nut and grape industries, evolved from that program and is now the primary repository and importation facility for wine grape plant materials. The clonal history for the past 50 years has been a fascinating and checkered one, with suitcase materials, mixed with field selections and legally imported clones permeating the vineyard landscape. It reads like a good whodunit and I would encourage you to read the James Stamp article (see reference resources) for a brief history of clones in California. Clones now apply to rootstocks as well as scion materials. So it really pays for a grower to understand the viticultural effects of clones both above and below ground and to get the right materials for a specific vineyard site.

Clonal selection can make a difference to quality especially in varieties like Sangiovese, Chardonnay, and Pinot Noir. A grower must weigh the viticultural performance and characteristics of a particular clone against the wine makers demand to have a particular clone. Of course, if a winery will only purchase a clone X, no matter how well you tend clone Y, you may not be able to sell it, the worst possible outcome for a grape. So growers need to be well aware of what clones are hot or cold and blow with that wind. It's not easy, especially in an area that cannot readily field graft to new varieties/clones. It means we have to be all the more aware of our selection of the proper clone.

Clonal designation and origin is incredibly complex and confusing. Many of the modern clones originate in Europe, the native home of *Vitis vinifera*. I should note that most of the interest in clones applies to the classic European varieties and, to my knowledge clonal selection has not extended into hybrid varieties, although I can't see any reason why it should not. Clonal designation can have many meanings and implied meanings. For example, in Oregon the Wente clone of Chardonnay pretty much referred to any small cluster clone of Chardonnay, often with "hens and chicks" berries. Yet the Pommard and Wadenswil clones were very distinctive in morphology, performance and sensory characteristics so they are easily identified. Pinot Noir is a variety that is especially susceptible to sports or spot mutations that create subtle variability within a variety. In fact, on a bilateral vine it is possible to have Pinot Noir on one side and Pinot Blanc on the other. FPS can be said to be the keeper of the clones for the wine industry in the U.S. They have the largest collection and are the main port of entry for foreign vine materials into the U.S. Unfortunately, they do not keep the same clonal designation as the originating material. For example, ENTAV (formerly ANTAV) Dijon clone Chardonnay 96 is FPMS 31 even though the trade name in the industry is Chardonnay 96. So there is plenty of confusion when talking about clones. Just make sure when you are talking to a wine maker or ordering a variety/clone that you are all talking about the same thing!

Another potential problem is when you finally receive the vines and plant them, once they are mature, in many cases it is almost impossible to tell them apart. Clonal identification resources are virtually non-existent in the U.S. For the most part a grower must depend on the

good faith of the nursery to supply the correct materials. This may not instill commercial growers with a tremendous sense of confidence. Just about the only recourse for a grower is to deal with a reputable commercial nursery and to study the known morphological, sensory and enological characteristics of the clones. If one were cynical, you might say it doesn't really matter because all the winemaker may care about is the number or name, for example Pinot Noir 667, 777, Martini, Swan or whatever, which will carry the quality association with the grapes.

Growers and extension educators have noticed recently in the East that "modern" clonal materials have displayed virus symptoms but it is not clear that virus is necessarily the cause. For reasons that are as yet unclear, there have been problems with viruses and virus-like symptoms in grapevine materials, and perhaps more significantly in new clonal materials, much of it originating from California nurseries. Clonal materials brought into the U.S. ENTAV through SW Missouri State University (then and now an importation site) were distributed to commercial nurseries. Those in California did not clear the state system for certification and may be subject to virus problems. At the very least, commercial growers should only plant certified materials in your vineyards as an assurance (NOT a guarantee) that the plants are free of designated plant pathogens. Again, only the most reputable nurseries should be used as a source for plant materials. As planting densities and the costs of these new and more specialized bench grafted, clonal materials increase the stakes are much higher for a successful and healthy vineyard. Engaging a plant material specialist like Dr. James Stamp to oversee the production and quality control of your grape plants is about the closest thing you can do to assure the health and quality of your vines.

Information about clones is probably best acquired by talking to fellow growers, wine makers and commercial grapevine nurseries. You'll find information on nursery web sites. The standard text for a decade was John Caldwell's "A Concise Guide to Wine Grape Clones for Professionals, 2nd Edition" but John has left the nursery business to start a winery and the book, while still a valuable resource, needs to be updated. Viticulture consultants such as Lucie Morton, Daniel Roberts, Mark Greenspan and others will have valuable information and insights into specific clonal performance and characteristics. The ENTAV and Rauscedo (Italy) web sites are very useful. As with all viticulture information, nothing trumps local experience so if there are growers with specific clones that you are interested in, try to find out in the minutest detail performance characteristics and taste the wines made from the clones. Chances are if they are sold to a good winery, the wine maker has kept them in separate lots. The wines may or may not be expressive of clonal differences. You'll have to have to judge based on the intimate details of viticulture and wine making production practices. Many winemakers will intentionally design wine making to try to isolate unique clonal character.

Clonal trials can be an excellent way of assessing performance, growth and wine quality of specific clones selected for a wine region. In Oregon, the clonal research performed at Oregon State University in the 1980's made a significant contribution to the confidence of the industry to adopt the French Dijon clones. Variety and clone trials in Geneva, Long Island and Virginia have yielded important data about the suitability of wine grape clones for our growing conditions and you should be familiar with this information before you place a vine

order. It is not easy to perform small lot, clonal research. A site that is somewhat representative of the region is necessary, the cultivation must duplicate industry standards and microvinification of separate lots of clones must result in wines that are of commercial quality and they must be critically evaluated by knowledgeable industry and research personnel. More trials are needed as the industry moves on to new clones and it would be helpful to the wine industry and the researchers who serve it to pursue and support clonal research.

Grapevine clones are not a quality panacea. Just because you plant the latest and greatest clones does not mean that fine wine will pop out of the other end of the production pipeline. There are a zillion other factors within and out of your control that influence final wine quality. Clones just happen to be prominent and easy one to focus on. The weather in any given vintage will likely have more influence on grape quality than the clone of a variety. Mark Greenspan says that, “site selection (soil and especially climate), trellising, spacing, water and nutrient management, training and pruning systems, etc are likely to play a larger role in the wine product than clone selection.” It appears that in some specific cases, such as Chardonnay FPS clone 4 in the Willamette Valley, clone can have a great impact but in most other cases, the qualitative impact is much more subtle and will require considerable effort in the vineyard and cellar to tease out and isolate. In the end, your site and the quality of viticulture you apply to it will have the final say on grape quality. The clonal selection may or may not be an important contributor to the terroir but it will be up to you to figure that out. All throughout the process of clonal selection and cultivation it is important for growers to work very closely with wine makers to assure that the desired benefits of the clones are ultimately expressed in the wines that are made.

Reference resources:

1. Concise Guide to Wine Grape Clones for Professionals, 2nd Edition (out of print). John Caldwell.
2. Wine Grape Varieties in California. Peter Christensen, et.al. University of California ANR Publication 3419.
3. Perspectives on French Clones. James Stamp. Wine Business Monthly. September, 2003.
4. National Grape Registry: <http://ngr.ucdavis.edu/index.cfm>
5. Foundation Plant Service at UC Davis: <http://fpms.ucdavis.edu/>
6. Catalogue des Varieties et clones de vigne cultives en France. ENTAV, INRA, ENSAM-ONIVINS. Published by the Ministere de l’Agriculture de la Peche et de l’Alimentation; CTPS.
7. ENTAV web site: <http://www.entav.fr/ANG/index.htm>
8. Rauscedo web site: <http://www.vivairauscedo.com/en/news.php>
9. Various commercial grapevine nursery web sites

Grapevine Rootstocks:

Most of the time when I ask what rootstock a variety is planted on the answer will be 3309. In most cases that is probably fine. 3309 appears to be as close to the default rootstock in

Eastern viticulture as we can find. It is versatile and highly adaptable to most site conditions. But it may not always be the best rootstock for a particular site or vine.

I like the saying, “The first duty of every wine is to be red.” Well, the rootstock adjunct to this would be, “the first duty of a rootstock is to be phylloxera resistant.” Rootstocks were developed for the species *Vitis vinifera* to protect them from the scourge of the rootlouse phylloxera that is indigenous to Eastern North America and was transported to Europe and California, where it eventually wiped out huge swaths of vinifera vineyards in the 1800s. Any grape scion variety now with pure or partial vinifera parentage should be grafted onto phylloxera resistant rootstocks. There are still some outposts in the wine world, such as Eastern Washington, Chile, Argentina, parts of Australia, and other areas that are on own-rooted vines. It can be argued that they are living on borrowed time but so far, the bug has not reached them. I experienced phylloxera infestation at Temperance Hill in Oregon and it causes grief and turmoil in the vineyard and ravages the bank account.

For practical purposes in Eastern N. America, the native home of phylloxera, it is assumed that all vinifera vines will be on rootstocks. For wine growers here, there are other rootstock attributes that have become important viticultural tools for the grower to ameliorate other challenges associated with a particular vineyard site. As rootstock breeding has evolved many more benefits to the scion could be derived from rootstocks.

Rootstocks should or may offer some or all of the following characteristics:

- Protection against soil-borne pests and diseases such as phylloxera and nematodes
- Tolerance environmental conditions such as drought, wet soils, salinity or lime
- Influence on vine vigor and size
- Influence on nutrient and water availability
- Effect on vegetative cycle and fruit ripening
- Ability to propagate

The phylloxera issue is a given in Eastern viticulture but nematodes are also an important soil pest, especially *Xiphinema americanum*, a vector of Tomato Ringspot Virus which affects two key white varieties, Chardonnay and Vidal Blanc. While little is understood about the relationship between rootstock, nematode and virus, it is thought that benefits can be realized by using particular rootstocks, in particular 3309. But this effect has not been scientifically tested. In California where nematodes are a serious problem rootstocks are being specifically identified and bred for their nematode resistant qualities but unfortunately they are not species of nematodes that pose a threat in our region. Also, the sought-after rootstock qualities such as salt tolerance are not an issue in Eastern viticulture.

Cold hardiness is an important consideration in continental climate wine growing. The question of whether rootstocks impart cold hardiness to the scion is often asked but the answer is not clear. If there is an effect it is probably indirect. Rootstocks can influence vine size, vigor, crop yields, vegetative cycle, ripening behavior, all of which can impact the acclimation process and final cold hardy condition of a vine. As I have always preached, the same viticultural virtues that ripen the fruit faster will probably also benefit cold hardiness.

From a rootstock perspective this would include any reduction of vine size and yield and shortening of the vegetative cycle with limits of the site conditions. A grower might find that Riparia Gloire or 101-14 has cold hardiness benefits over 1103P or, perhaps, even 3309.

The rootstock is an elegant solution to a pest problem and though it is a complicated and complex solution it avoids the use of pesticides. Rootstock researchers in France, Germany and the U.S. used indigenous grape varieties as the foundation materials for their breeding programs. For example, Riparia Gloire and St George rootstocks are taken directly from *Vitis riparia* and *Vitis rupestris*, respectively. *V. berlandieri* x *V. riparia* hybrids include SO4, 5BB, 5C and 420A. *V. riparia* x *V. rupestris* hybrids include 3309, 101-14 and Schwarzmann. *V. riparia* x *V. berlandieri* hybrids include 110R, 1103P and 99R. These are just a bunch of numbers that have no meaning until you learn the particular attributes and faults that each species brings to the cross and the summary of performance characteristics that each rootstock is supposed to provide. The caveat is (and you knew there would be) is that rootstock performance is very site specific. General descriptions in books, guides, nursery web sites and other sources are just that, general. It's isn't until you see a rootstock's effects on various scions in your vineyard that you will know for sure what it can do. For that reason, it is probably wise not to put all of your rootstocks in one basket. Even if you have a flat field with uniform soils, it may be prudent to try a mix of rootstocks. If your vineyard is successful and goes the distance, meaning multiple generations of family ownership, there will opportunities to make rootstock changes. This highlights the permanence of the rootstock decision. Once the vine is planted, it's there, and unless you decide to yank it, you are stuck with it, so choose wisely.

Since excessive vine vigor is one of the greatest viticultural challenges to wine growers in the East, it makes sense that we would use rootstocks to attempt to mitigate this problem. Rootstocks have the ability to influence scion growth. Low vigor stocks like Riparia Gloire, Slate Quarry riparia, 420A and 101-14 may be used to this advantage. But rootstock alone cannot solve the big, bad vine problem. Site characteristics, primarily soil qualities and rainfall amounts, will significantly influence rootstock behavior. It has been my experience that high capacity soils (big vine, plenty of available water and nutrients) will diminish the influence of a devigorating rootstock. Lighter soils will yield the best effect on vigor reduction or enhancement. Rootstocks, used with other tools like cover crop, kicker canes, water and fertilizer management, can help to control vine vigor. Rootstocks are not a cure for a vigorous site. A strategy to control vigor should be planned and carefully managed before and after the vines are planted.

Choosing a rootstock in the East is a challenge. If you have a crystal ball or are good with a Ouija board, that might be a good place to start. We lack the advantage of proximity that reveals a lot about vine growth habit. Absent a close neighbors vineyard to observe, analysis of soil, and to a lesser extent climate, evaluation become essential to determining which rootstocks will perform the best. Soil chemistry and physical features are the most important indicators of soil capacity, or the ability of soil to influence vine vigor. If it is a fertile site with high water holding capacity the result will likely be a big vine. This will also, to some extent, guide decisions on vine spacing, density, training and trellis systems, equipment choice, all of which will affect the bottom line. Precision viticulture has been highly refined

in California where development costs often top \$50,000 per acre. There is a lot at stake when the expectation is a 95+ score from Parker or the Spectator and correct rootstock choice may be the difference between a 90 or 95, which in the cult wine world may be the difference between a \$100 bottle of wine or a \$200 bottle of wine. The secret here is that it takes an experienced eye and mind with vineyard soils and viticulture experience to interpret the results of soil tests and pits into a recommendation for a rootstock. A viticulture extension educator is most often a generalist, as are most of the vineyard consultants. Depending on the goals of the wine, a viticulture/soil specialist may be needed to achieve the desired results.

Like their scion cousins, rootstocks can have problems with diseases and viruses. With the demise of AxR1 as a common rootstock in California, and the proliferation of new clonal materials, the vine health situation in new high-tech vineyards often appears to be precarious. The expression of odd leaf and trunk symptoms seems almost normal. But the spread of leafroll virus now threatens wine areas in California and may eventually pose the same threat to vineyards in the East. Some rootstocks are particularly sensitive to viruses and if infected by the scion, may girdle the graft union and cause the vine to die. Viruses and other pathogens can be spread by graft or insect transmission.

In the good ol' days when you needed Chardonnay you called your nursery and ask them to send you Chardonnay vines. Now you have to specify variety, clone and rootstock and hope that the nursery can merge all three of these into a single plant. It can be a complicated and frustrating process. Maybe they will offer you two of the three. My advice is to toe the line on what you have decided will produce the best wine on your site. Remember that the nursery has to collect the rootstock and scion wood, graft and callus in the winter, plant out for the summer and dig the following winter before delivering. Some rootstock varieties are much more compatible with vinifera scions than others. 420A is a notoriously difficult grafter and hence it can often be in short supply. Needless to say, nurseries do not like working with rootstocks that have low graft take percentages. If you have a large order of a rare clone or rootstock, you need to give the nursery enough lead time to gather all the necessary materials. You should be ordering now for planting in the spring of 2010. Almost all vineyards in the East use dormant bench grafts and plant in the spring although there have been a few cases of planting green grafts in the summer or fall planting. We have had good success with spring planting. Planting rootstocks followed by field budding has not been tried here and would be difficult for the same reasons we have problems with field grafting – our spring weather is too cold and wet for successful cambium take in the grafting or budding process. Maybe with more research we can overcome these problems. The option to chip bud to rootstocks or field graft would greatly enhance the our ability to develop and change over vineyards.

I am constantly confounded by rootstock performance. For example, 3309 may demonstrate less vigor than Riparia Gloire in a vineyard. Because we never know exactly how a rootstock will perform, it's probably a good idea to use a shotgun approach to rootstock selection rather than deciding on the one stock that may be the best one for your vineyard. The site evaluation process will lead you to particular rootstocks but even on a flat, uniform field, you may want to mix the types of rootstocks you use to see what works best.

Reference Resources:

1. Rootstocks for Grape-vines. D.P. Pongracz. 1983.
2. A Practical Ampelography. Pierre Galet. Translated by Lucie Morton. 1979.
3. Choosing the Best Rootstocks. Curtis Phillips. Wine Business Monthly. December, 2006
4. Rootstock Review. Lucie Morton. Wines and Vines. November, 2007.
5. Rootstocks: What are their capabilities and limitations? Peter Cousins. Proceedings of the 2008 Lake Erie Regional Grape Program Annual Conference.
6. Commercial grapevine nursery web sites

Some final thoughts:

Picking a clone or rootstock that is suited to your particular vineyard site is not like choosing a tractor. The unique features of the site will directly affect the performance of a rootstock or clone. Your best strategy is to undertake a rigorous site evaluation using the knowledge and experience of experts to make the proper rootstock and clone assignments based on the data collected. To some extent, the choices will be based on the final wine style objective. One might say the fussier the viticulture and higher the price point for the wine the more rootstock and clone may matter to the outcome. A rootstock and clone should not choose you. Instead, there should be a clear understanding why and for what benefit particular choices are made. On the production side, a stock such as 3309 may be just fine for most sites and purposes. But the vetting process should not be overly influenced by availability or what happens to appear in a nursery catalog. A mix of clones and rootstocks is probably the best approach for most eastern vineyards where the soils and climate are not well defined or understood. Putting all of our eggs in one basket may lead to problems and disappointment. Even on a uniform field, a blended approach to clonal design may be the best. Every effort should be made to learn from these decisions for future reference and benefit. If possible, design the vineyard so rootstocks and clonal selections can be compared to one another. Try to keep rootstocks and clones separated, from the vineyard into the cellar in an attempt to isolate their particular virtues and problems. If a winemaker can be found who is willing to make small lots of wines that would be the very best way to learn how rootstocks and clones perform in your vineyard. In many respects you are doing this work for future generations of wine growers.

The quality of the plant materials you source is absolute critical both above and below ground. It needs to come from a reliable nursery with a stellar reputation. You should only buy #1 certified scion and rootstock materials. The materials should be examined before planting. You should not plant anything but the plants that meet your highest standards for quality.

Local information from reliable sources is a very valuable supplement to information found in books, web sites, anecdotal information or other resources. It should be weighed against the standards and applied for best effect. When in doubt ask someone smarter than yourself (well, at least about rootstocks and clones).

We plant rootstocks and clones with certain expectations in mind. Then we watch and hope that those expectations will be realized. We may think this clone will produce fruit with great color and certain flavors or that rootstock will be shallow rooted and reduce vigor but often the results do not match what we have led ourselves to expect. It is important not to impose our desire for an outcome on what actually happens. A clear and rational analysis of the results of our choices is what is needed and will be most helpful to craft the best possible wine from the vines we have planted and make the proper adjustments in the future.

Good luck and happy planting.

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