



## Soil Management and Fertilization

I once asked Kees van Leeuwen, the esteemed viticulturist at Chateau Cheval Blanc in St Emilion what were the keys to making great red wine. In a terrifically matter of fact statement, he said all you need to do is limit water and nitrogen. It turns out that in Bordeaux and Eastern North America, that is no mean feat. Kees' ultimate goal is to do two things in the vineyard, set small berries at fruit set and stop shoot growth before veraison. It sounds so easy but it is oh so difficult.

In arid regions, like California and much of Australia and South America, it is simply a matter of turning the water on and off. Not quite so easy here, where Mother Nature has a much larger role in our viticulture. In fact, that is the greatest impediment to fine wine in the East, uncontrolled water. Nutrients, like N, are a secondary concern because they need water to move into the plant. Even so, we do not want a vineyard site that is too fertile, which simply exacerbates our problems with vine vigor.

If you talk with almost any vigneron in France they will tell you that soil is the secret to great wine. This would be hard to dispute since the greatest wines come from France. The French understand their soils like no other viticulturists in the world. If you then go to California, they are much more nonchalant about their soils. In fact, soil is merely a convenient medium in which a vine is grown, simply add water and fertigate and the grapes will appear. With viticulture tools like deficit irrigation, arid region viticulturists are able to fine tune the performance of their vines like a Swiss watch.

In continental climates like Europe and Eastern N.A. unpredictable rainfall, especially after veraison, can be catastrophic for wine quality. In fact, if you track vintage ratings in Bordeaux there will be an easy and comfortable correlation between early harvest date (warm and dry) and the higher rank of vintage quality. In reductionist form, we can say that warm and dry makes fine wines whereas wet and cool makes, well, not so fine wines.

If one considers the components of terroir – soil, climate, plant and viticulture, it may be argued that soil is most significant contributor to wine quality. But unlike the French, who have studied their soils for centuries, we know precious little about ours. Only in a vague sense do we know what sites may be suitable for fine wine production. The soils should be well to excessively well-drained with low to moderate nutrient availability. Soils should be healthy and promote the growth of a healthy, if not small to modest size vine. Can the constituent parts of this soil be defined and quantified? Even in France, they are just beginning to understand their soils from a scientific perspective. In the past, they simply planted grapes and the best wines came from the best vineyards, end of story. At Cheval Blanc, Kees is studying the subtle differences between sand, clay and gravel soils and how they influence wine quality.

We can suggest to a grower that vines will grow well in a pH range from 5 to 8, organic matter in the range of 2-5%, and a range of plant available water, cation exchange capacity, percent rock content and these all represent significant guidelines. Ultimately, however, it is the complex interactions between soil-climate-plant and how we choose to farm the vines that will determine the quality of the wine that appears in the bottle. Guidelines are useful. They set the boundaries inside which we can comfortably and safely grow vines and be relatively assured of good wine. Then we can decide how much we want to push the limits in order to achieve greater stature in the wines. The more we can control and manipulate, the easier it is to achieve our goals. That is the main difference between arid and humid wine regions.

In an emerging region like Quebec, there is a great process of discovery that must take place to understand where the best wines can be grown. It begins with the basics, such as soil chemistry, which is the easiest to measure and manipulate. However, it is important to realize that we live in an agricultural world controlled by agronomists and we are not growing corn or soy bean. Therefore, our ideas and objectives must be shaped by in a viticultural context where maximum yield is not the ultimate objective. Wine growers seek to balance yield with quality and that is where the soil is so critical to the quality formula. It is important when considering soil management and fertility to keep these principles in mind. The manner in which soil will be used to achieve a specific wine style and price point must be understood even before the site is selected or vines are planted. A site and soil for \$10 fighting varietal white wine will be very different from one that is intended to produce a \$40 bottle of red wine.

A soil management plan begins with site selection and evaluation. Soil and climate should be analyzed in detail for suitability for the species/varieties of grapes and the style of wine being produced. A soil can be evaluated by just standing on it, but it helps to go deeper, of course. But you can tell a lot about a soil just by looking at the topography and existing vegetation, finding out where the wet spots are around swales or springs or looking to see where the grass is growing tall or rocks protrude. Knowing the history of a field can also reveal a lot about the soils, like finding out the corn yields in certain sections of a field will speak to its fertility. The more you can learn about the soil before a vine is planted, the better you will be able to manage both the soil and the vines.

Most growers are comfortable with the soil chemistry analysis which is done routinely even for yards at home. The results of a soil test are just a set of numbers on paper and the wisdom in interpreting the data will determine whether the wine quality objectives will be met. An agronomist and a viticulturist will have a different view of the data. A wine grower seeks a viticultural interpretation of the data. Soil pH below 5 may indicate a potential problem with aluminum toxicity or a soil high in magnesium will lack structure and cause problems with potassium uptake. These are the kinds of problems that need to be detected and treated before vines are planted.

A fine example of the influence of soil pH and rootstock can be seen in research done in Western New York by Dr. Terry Bates. He designed an experiment that looked at the interaction and impact of low pH, 3 rootstocks and own-rooted vines, on four different varieties. The results were dramatic, as much for the influence of pH as for soil physical features and their impact on

rootstock performance. By mixing and matching the right variables, significant improvement in wine quality can be achieved.

Next a backhoe or deep soil core sampler is needed. Soil samples should be taken at various depths. While the effective root zone for most varieties is around 36", we know roots can go much deeper. Soil chemistry can dramatically affect root growth so it is helpful to have a profile wherever the roots may be. The soil pit will expose the soil physical properties for close examination. Most wine growers are looking for soils that promote drainage in order to fulfill Kees' wishes for small berries and terminated shoot tips. Drainage can be promoted in many forms in soils, from high rock content, to sandy soils and even to clay soils with properties that promote drainage. The pit will allow the soil viticulturist to detect any severe physical impediments to root growth such as hard or fragi-pans. If discovered, they can either be treated or avoided altogether.

Soil biology is the least understood part of the soil complex. We know that it is an incredibly rich ecosystem with countless organisms, large, small and microscopic plying the paths between particles and aggregates. Their roles in the soil-root interface are beginning to be better understood. At this time, most growers try to avoid doing harm to this biological system by avoiding the use of harmful practices like too much cultivation or the overuse of herbicides. We do not yet know or appreciate what we can do to enhance the soil biology or what the interactions are between soil organisms and plants. We recognize, however, that there are specific soil pests and diseases that can cause problems in vineyards such as phylloxera, nematodes, soil-borne pathogens, not to mention vertebrates like gophers and woodchucks.

Once a soil is properly analyzed many viticulture decisions can be made such as variety and rootstock assignment, training and trellis system, vine density and spacing, irrigation, tile drainage, cover crops and pre-plant site amelioration.

Soil erosion is one of the most significant problems in agriculture and everything should be done to minimize the effects of erosion. Fortunately, vineyards can be designed to prevent soil erosion. To a large degree, this involves the control of water movement across the surface. The USDA Natural Resources and Conservations Service has specialists that can analyze your field for erosion potential and design mitigation projects with surface and subsurface diversion and drainage that will help to reduce the effects of soil erosion. The wine grower should also consider the need for tile drainage to improve wine quality, quite apart from large scale erosion prevention systems. In Ontario's heavy clay soils, almost all vineyard are installed with drain tile. This helps to moderate the effects of summer and harvest rainfall on vine vigor. All of these soil projects should be planned and designed before the vineyard is installed.

Oddly, drip irrigation for fine wine production needs to be considered in modern vineyard installations. As much effort that goes into removing excess water from the soil there can be a reverse effect of creating water deficiency if a drought year occurs. Then it will be necessary to supplement natural occurring soil water with irrigation, which can also be used as a fertilizer delivery system. Installing drain tile and drip irrigation can be very expensive. They are the price we pay for living in a very unpredictable climate.

Prior to planting and trellis installation is the best time to apply soil amendments. For example, lime and compost spreaders are big and wide and need an open field to operate. A field is cleared and prepared in the year before planting. Weeds are controlled through a variety of means from herbicide to cultivation. Bioremediation methods such as rapeseed and sudan grass can help to suppress parasitic nematodes and also add organic matter to the soil that will improve tilth. Large rocks, stumps and other obstacles should be removed.

Soil examination may recommend ripping the soil to loosen compaction or break up hard pans. The standard method for ripping is to use a 1-1.5m shank in two directions. In California, it is now common to use a vibrating, winged plow to rip on the vine row. This implement lifts and fractures the soil and gently lays it back in place. It creates an even soil environment for vines to grow which promotes uniform growth. Whenever any kind of soil cultivation is done, ripping, plowing, harrowing, discing or dragging, it should be done when soil moisture conditions are just right and minimally to avoid compaction. No matter how hard you try to avoid compaction, during the vineyard development process soils will be run over and the soil surface will be pulverized, often into a fine powder that once it gets wet, will form a hard layer that may be impermeable to water. It may be well worthwhile to top dress and cultivate a vineyard with compost before planting to restore soil structure.

Once a vineyard is planted, care for the soil must continue, although it becomes more difficult. Organic systems stress the use of non-synthetic fertilizers such as cover crop legumes and compost to maintain soil structure and fertility. Performing soil analysis every three years will help develop a history of the nutritional status of the soil and provide information that can guide fertilizer recommendations. Soil tests should always be compared to tissue tests to make sure that values correlate and that what is in the soil is getting into the vine in sufficient quantities.

Compaction is always a problem in vineyards with repeated tractor passes from mowing, spraying and other vineyard operations. Compaction reduces the amount of air and water available in the root rhizosphere hampering nutrient uptake and root growth. There are many ways to reduce soil compaction, from using cover crops, especially broadleaves with large taproots, to mechanical means such as ripping on the wheel paths. A penetrometer can help determine if compaction is becoming a problem.

Growers should have a strategy for row middle and vine row maintenance. Row middles in the Eastern US are usually planted to a cover crop. There are many options for cover crops and each can serve a different purpose. It is important to have a clear idea of how the cover crop planted will affect vine performance and the ecology of the vineyard. In organic applications, cover crops often serve to extend biodiversity in the monoculture vineyard, attracting beneficial insects. But broadleaves can also be a host from Tomato Ringspot Virus, a serious problem in two of our most important white wine varieties, Vidal Blanc and Chardonnay. A cover crop can be used to provide competition for resources with the vine so it will moderate vine vigor. A legume cover can be used as a green mulch, adding fertility to the soil.

In the current vineyard aesthetic, a clean vine row is demanded. Usually this means an herbicide strip that keeps the area under the vines weed-free. That aesthetic is slowly changing with more sustainable practices being used in vineyards. Plants can be allowed to grow in the vine row as

long as they do not detract in some way from wine quality, for example, causing too much humidity in the canopy or competition for water and nutrients. There are many mechanical tillage tools that work effectively in a wide range of soil conditions. Some growers are even letting their row middle cover crops grow under the vine and using special articulating mowers to reach under the vine to keep the grass mowed.

No matter what you do to the soil, the grower should always ask, “why am I doing this and what impact will it have on wine quality?” Do I want to push yields to increase profitability? Or do I want to reduce vine vigor to allow the fruit to more fully ripen? The goals are as numerous and diverse and the means to achieve them. Soil is still a mysterious realm, one so close and always under foot but so little understood. As wine growers we need to take advantage of every shred of knowledge and tool to better understand and maintain our soil’s health. Like the wine, it will be our legacy.

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