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Soil, Water and Wine Quality

By Mark L. Chien, Wine Grape Extension Educator

I was scraping at the side of soil pit with a small hand trowel and just barely getting enough dirt to fulfill the 1 cup requirement for a soil test. At the bottom of a 3' hole near Arendtsville in Adams County I was smiling and thinking that this is as good as gold. In this case the gold is a metaphor for high quality wine and these soils are the recipe for success. The hole was dug for me by a fruit grower who sees the writing on the wall for apples and wants to try something new. So he pushed out a 60 year old orchard and decided to try wine grapes. I asked him to dig some 4' soil pits for me but his hoe couldn't penetrate any deeper than 3'. The 12-18" of topsoil transitions quickly to fractured and weathered rock and a soil texture and profile that appear to epitomize that much sought after concept in site selection - drainage. When I see drainage potential like this, I begin to imagine fully mature grapes, possibly even small berries. These Arendtsville soil series are also relatively low in fertility, an additional asset in the quest for a modest size vine that yields good wine. Really good land for wine is a rare commodity when you think of all the land and what little specks are known for good wine.

In my previous career as a wine grower, I scratched my head for 16 years about how to grow great Pinot noir, which means getting the fruit fully ripe in a cool climate. It was a constant intellectual and physical challenge. After arriving in the East in 1999 it became clear that the great challenge here was also to ripen grape but that the impediments to maturity were of a very different sort – too much water at the wrong time of year. The Willamette Valley receives about the equivalent amount of annual precipitation as southeast Pennsylvania but distribution is more important that total amounts. Oregon summers are actually quite dry and while rains often threaten harvest, they are not the certainty that they are here and certainly not punctuated by the occasional hurricane. Arid regions that excel in wine production have mastered deficit irrigation as a way to control vine function and growth. That is the one tool that we do not have available to us most years and must look east towards Europe for answers. The rainfall pattern of a region is closely linked to its soils' ability to shed that water during the critical period around veraison. Up until fruit set the total available water in the soil is at capacity and as that water drains out, it places just the amount of stress on the vines to get shoots tip growth to slow. The magical fulcrum of available vs. non-available water is somewhere between field capacity and permanent

wilting point. That's where we need to be. It is in this zone that the future of overall quality of our wines (particularly reds) and the consistency of that quality will be determined. I have come to believe that soil-water-plant relations are the secret to the production of consistently fine wines in the East. Temperature is also intrinsically involved in this equation, especially after veraison. I wonder if it is really as easy as dry year = good wine, wet year = bad wine. I have been up and down this roller-coaster with our growers since 1999 and the correlations are too obvious to ignore. So the question must be, "how do we get vines in a wet year to perform more as they do in a dry one?" I think the answer is in the soil but it's a very tricky balance in our climate because of the often dramatic variability in precipitation amounts and distribution. We need soils that hold water but also easily release it.

Dr. Kees van Leuween is the viticulturist as Chateau Cheval Blanc and a hydrologist by training. It's actually brilliant to have a water guy analyze one of the great viticulture conundrums. His terroir study[1] published in 2004 compares soil-climate-variety and gives us the information we need and expect – that in the best vintages the plants experience mild water stress from flowering to harvest and the best soils encouraged this water deficit resulting in shoot growth cessation and smaller berry size. At CB the goals are to match their particular soils to the right varieties to yield optimal wine quality.

Arendtsville may be our equivalent to the gravelly soils that Cheval Blanc favors for Merlot. It may be the closest example of an ideal wine soil that I have seen in the East and I hope it will be thusly exploited for that purpose. It certainly is a persuasive argument for careful site selection. If the goal is to make consistently fine wine, then this is the starting line. Everything we do from here to artificially manipulate the soil-water relationship may have some impact on quality. Most vineyards, in fact, are not planted on ideal soils and still suffer this problematic soil-water-vine relationship. There is probably no way to artificially transform a non-ideal vineyard site into an Arendtsville – well drained, warm climate, long season but amelioration is always possible and it is worth exploring the options remember that Kees' goal of small berries and minimal shoot growth. We are also shooting for a balanced vine canopy with a leaf area index of about 1.5m^2/kg of fruit, just to make sure we aren't killing ourselves trying to get small berries on a monster vine. If you start with a balanced vine then the fine tuning becomes easier.

Water stress can be just as harmful to wine quality as too much water. It almost seems ridiculous to suggest to a grower that a site with fine drainage needs to be supplemented with drip irrigation. But a non-functioning canopy will not ripen fruit and compromise countless other important physiological processes important to vine health, fruitfulness and fruit quality. It is so much easier to meter in water as our colleagues in California and Australia do so skillfully than to remove it, especially in measured amounts. A typical vinifera vine on a single canopy system will use 4-5 gallons of water per day which translates to about 2.8 acre-inch per month[2]. That's actually pretty close to what we get from the sky each month during the growing

[1] Leeuwen, C. v., et. al. 2004. Influence of Soil, Climate and Cultivar on Terroir. Am. J. Enol. Vitic. 53:3, 207-217.

[2] Lakso, A. Robert Pool. 2005. The Effects of Water Stress on Vineyards and Wine Quality in Eastern Vineyards. Wine East. 12-20.

season. But in order to run our deficit – early (just after bloom) to limit berry size and after set through veraison to limit shoot growth, we need less than this amount in the soil. Available water will be determined by the soil's physical properties and this is the magic of Bordeaux and Burgundy were soils drain well in wet years but have enough water retention at lower depths to avoid severe stress.

It's probably a good idea for every grower to have a good sense of the soils out in the vineyard. There are three key components – the chemical, physical and biological. Most of us are pretty familiar with the chemistry and should be testing our soils every 3-5 years. Even if you didn't dig backhoe pits before you picked the site or planted vines it is an interesting exercise if not a good management tool to understand the physical properties of your soil. You should be testing below 18" anyway and this is how you get below that level. Maybe once you see and feel he true nature of your soils, you'll understand why your vines behave the way they do or what you can do to bring them into balance. Of course, a hole is just a hole unless you know what you are looking at so you'll have to get a soils person to help you or read Robert White's *Soils for Fine Wines.*

Remove excess run-off before it can penetrate. Ask a hydro-engineer from NRCS to do a drainage survey of your vineyard and take advantage of any topo features that will encourage drainage. The result of such a survey may be the installation of drain tile, an easy step prior to planting but much more difficult with vines in the ground. This is a job for experts both for the design and installation. As a general rule – anything that will be buried has to be done absolutely right. I am not an expert on the use of drain tile but growers and consultants in Ontario are very familiar with the use of tile in vineyard applications. It would be worth seeking their advice. I have explored the idea of using vacuum-assisted drain tile such as those used in site reclamation projects to remove water from the root zone. The general idea here is to create an artificially arid condition by removing water to the point of requiring irrigation.

Cover crops are common in vineyards and used for multiple purposes such as erosion and compaction control, soil fertility and organic matter, plant biodiversity, weed suppression and, at times, to slow down vine vigor. They can certainly achieve the latter. The most competitive grasses include orchard grasses, pasture grasses like perennial rye and tall fescues. At Virginia Tech, Dr. Tony Wolf and Gill Giese (Surrey CC) are experimenting with different covers as well as the use of root pruning and root bags to restrict root development.

A number of artificial diversion methods have been tried from simply covering the ground with plastic to various covering materials in the vine row and rather complicated overhead structures that act as umbrellas that shed water away from vine roots.

Oddly, I think that it may be the most artificial method, like an umbrella over the vineyard that offers the best results. Whether this is an acceptable treatment will be for each grower to decide, the viticulture foil to the wine concentrator or spinning cone. I still like the idea of returning to the fundamentals of ideal site selection and giving soils like Arendtsville a true test to see if it can shed enough water in a year like 2003 to still allow for a good wine to be made. Once we master the water issues, then all other viticultural

matters such as vine density, training/trellis, varieties, rootstocks and clones can be tweaked to perfection. But if we are ever to make consistently flavorful and concentrated wines in the East, we must find a practical, cost effective answer to the soil-water problem during the growing season.

Reference Resources:

1. White, Robert. *Soils for Fine Wines*. 2003. Oxford University Press.
2. Nicholas, Phil. *Soil, Irrigation and Nutrition*. 2004. Hyde Park Press.

2005 PA Vintage Notes, Bittersweet Harvest?

by Stephen Menke, PSU Extension Enology Educator

Although I have tasted only a limited amount of the 2005 vintage, I have received some interesting comments and inquiries form PA winemakers. Though the vineyard conditions were exceptional in most places last year, not everything turned out to be purely wonderful in the wines.

Most vineyards in PA had higher grape °Brix than usual, and most grapes looked and tasted physiologically riper at harvest than most years. However, some vineyards had high acids at seeming physiological ripeness, and a few places had both higher pH and high acids at ripeness. Some of these results can be explained in the context of variability in canopy management and yields. Some may be due to variability in sensory judgment of ripeness in an unusual year.

To make things even more complicated, some recent, and as yet unpublished, UC Davis/PSU research on root physiology points to previously unknown effects of rootstock on nutrient and water uptake and on °Brix vs. overall grape maturity. [See news link at http://www.sfgate.com/cgibin/article.cgi?f=/c/a/2006/04/20/WIGL0IB16F1.DTL&hw=wine&sn=006&sc=167]

Furthermore, some PA wines that had optimal pH, °Brix, acid, and sensory ripeness, the best in years, turned out to have some sour or bitter tastes upon completion, even though the underlying fruit aromas and flavors are very good. Since most of these reports involved wines that did not have high acid at harvest, and some even underwent malolactic, I am assuming that it is bitterness that is being noticed. This is most likely due to unripe tannins. It may be that winemakers were not ready for the level of phenolics and tannins in this years more heavily pigmented grapes, and the normal soak time on skins for whites or normal fermentation time with skins and seeds for reds resulted in greater extraction of unripe tannins and other bitter phenolic components than usual. Or it may be that even at seeming ripeness some of the phenolic components were not sufficiently mature. This underscores the positive role of judging skin and seed maturity by sensory evaluation, and then limiting settling times for crushed grapes and times for whole grape maceration, especially with traminette and gewürtztraminer. It also underscores the value of delestage for reds, to eliminate much of the main source of bitter tannins, the seeds. I would suggest that winemakers should read the

articles on delestage and on various tannin research that Bruce Zoecklein has on his Enology Notes and Vintner's Corner newsletters, available at
http://www.vtwines.info/
It is possible that these bitter components will mature into larger and softer complexes with age, or they may need to be resolved with fining. In any case, it may be that a series of test finings with protein is warranted (gelatin or casein or isinglass or albumin), followed by heat and cold stability tests. If indicated by stability tests, then do counter-fining tests (to remove unstable proteins) with colloidal silica or bentonite. Also, PVPP can directly remove small bitter tannins, as well as browning and pinking precursors. Any of these treatments must be tested first, as they can all affect flavor and complexity of the wine, and any fining treatments should be followed by filtration before bottling.

Whither Goes Pennsylvania Enology Research

by Stephen Menke. PSU Extension Enology Educator

One of the questions I get consistently is "How do we get enology research done at Penn State and who will do it?" This question is full of assumptions and complications, and I think I should take some time to explain enology research in general, and Pennsylvania enology research potential in particular.

University enology research requires several components. First, it requires faculty that have interest in doing enology research. Second, it almost invariably requires funding from outside the university. Third, the facilities infrastructure must be in place to aid in carrying out the research. Fourth, there must be a strong stimulus that prompts the research and sustains its completion. Let us look at each of these components in detail.

First, how is faculty interest generated? The key to university research faculty interest is that their output is journal articles and books and scholarly presentations. They are judged by the university and their peers on research that is mostly published in peer-reviewed journals, and most of these journals are looking for research that is more basic than applied. However, applied research that also addresses a basic question is a great combination for some researchers, and is also very publishable. I think most enology research fits well into this category. So the interest of a faculty researcher in a basic problem is the strongest motivation. If that basic problem can be addressed in part by applied enology research, then the interest is stronger and more focused. If the researcher also is personally interested in wine or grapes, the interest is further reinforced. That is the usual order of motivation. For example, most researchers are much less interested than the winemakers are, in which yeast gives the best selling wine. However, the researcher may be very interested in some part of how yeast lives or how it performs certain genetic and/or biochemical tasks, while it is making the wine. They tend to focus on very specific areas of this general interest, which specific area can be researched in a controlled and comprehensive manner, with the researcher's available infrastructure of labs, students, funding, and cooperators. So, for example, it might be possible to assess the genetic/biochemical ability of some cell membrane mechanisms of various yeasts strains to withstand alcohol stress (the researcher's basic interest variables), while under different conditions of fermentation (experimental research variables). These conditions of fermentation may then concurrently give information on the ability of the various yeasts to produce the wine aromas, flavors, and textures in which

the winemakers are interested (applied research variables).

Second, how does the funding process work? Filling out grant applications is a tedious process for a researcher, and the amount of net outside funding needed to maintain a research program is large, usually from a minimum of about $25,000 for a single small project to $1 million or more for a major research effort. That net amount is what is left after university overhead is subtracted from the original grant. This overhead ranges from 20% to over 50%, depending on the category and funding source. This means that to net $25,000 after overhead, the grant must be anywhere from $31,250 to $50,000. So the researcher looks at the size of the grant, the time needed to write each grant, and the total grant money needed. It becomes quickly obvious that the most efficient use of time is to go for fewer larger grants and try to find grants with minimum overhead. The second funding constraint is that most grantors tend to use a selection process that favors researchers with track records in the area of research, favors research projects that have multiple funding sources, and favors projects that cooperate among several researchers with complementary research aims. So small grants, i.e., under $30,000, tend to be supplemental funding for larger grants, not primary funding sources. For these reasons, enology funding tends to be a supplemental part of grape research or food research or health research. Only grape research is likely to be directly interested in wine quality. Universities and federal funding sources, for political and historical reasons, tend to not want alcohol-related research on campuses, so usually grape research must shelter the wine research. This is why most enology research is limited to vineyard "quality" parameters, such as grape composition vs. overall wine quality, and not basic flavor research or consumer preference research, though this is done to limited amounts in some food science departments.

Third, facilities infrastructure is important. PSU has plenty of research labs at University Park, that could be used for wine analysis. However, the PSU system has no designated space for a pilot winery, only the shared space I use at the Biglerville Fruit Research and Extension Center (FREC), which is a very difficult space to use for winemaking and is minimally equipped. Some research wines were made in the past at University Park, but no suitable facility or grapes currently exist there for a pilot winery. The vineyard at FREC is not currently of a design or size that facilitates enology research. A new cultivar trial vineyard will soon be planted at FREC, if funds can be made available for its management, which would help enable enology research there. The vineyard at the Lake Erie Regional Grape Research and Extension Center (LEGREC), in North East, already has sufficient grapes to do enology research, though a cultivar trial vineyard must be put in, if funding is available for its management. It also has no space available specifically suitable for a pilot winery facility. An offer has been made by a PSU researcher to manage both the FREC and LEGREC cultivar trial vineyards, for about $10,000/year, preferably from industry sources. These cultivar trial vineyards and the trial vineyard manager would make it infinitely easier to get grants to do both viticulture and enology research at PSU, and could include acquiring funding for a pilot winery facility to do better enology research.

Fourth, the stimulus for getting research faculty interested, for supplying the list of research needs, for helping get proper test vineyard and pilot winery facilities, and for sustaining motivation for grant applications must come mostly from a united effort by the industry and by us as PSU Enology and Viticulture Educators. This includes creating an industry priority list of desired research areas, a commitment of time by the extension educators to make this list and the relevant facilities known to the appropriate researchers, and some supplementary funding by the industry to help with either facilities infrastructure or directly with research projects. Currently, the Pennsylvania Wine Marketing and Research Development Board supplies some supplemental monies for research projects in viticulture and enology,

but has trouble interesting PSU researchers in those monies. I think that this is primarily because, unlike Cornell or Virginia Tech, no suitable trial vineyards and pilot winery facilities exist and because large grants for viticulture and enology are currently minimal at PSU, which situation is partly caused by the lack of facilities infrastructure (chicken and egg problem).

My own opinion is that to simulate PSU viticulture and enology research, a good start is to help get the minimal facilities infrastructure set up. This includes helping apply already completed research, such as getting the clean vine production pilot project going, and providing the $10,000/year to allow for the management of the cultivar and rootstock trial vineyards at FREC and LEGREC, which can then serve as springboards for pursuit of larger grants.

Please let me know, and discuss among yourselves, the merits of the above ideas and courses of action.

This publication is available in alternative media upon request.