Jeff Zick, vineyard manager at Waltz Vineyard with Daniel Roberts

Daniel Roberts was in Lancaster to give a lecture he called "Climate, Soil and Vineyard Management" (what else is there?). I get some flak for bringing in experts like Daniel, Jeff Newton, Andy Erickson and other dry climate viticulturists and wine makers but based on what I have been able to learn even from this visit but also over the years I do not plan to stop this practice. If, as the saying goes, success is 10% hard work and 90% inspiration (or something near this proportion), then listening to these folks talk about their particular skill, knowledge and experience is what it takes to get a nascent wine industry in the Eastern U.S. to the next level. It may be their attitude that inspires the most – the simply expect to make great wines and they want to help others to do it, too. When Daniel was speaking I was thinking to myself, "you just can't get this kind of information anywhere else" but also "why wasn't I smart enough to videotape this amazing lecture so it could be available to a wider audience." In my mind what sets these outstanding practitioners apart from the crowd is their willingness to share what they know with others. They are educators as well as innovators. I am grateful to the audience who attended the lecture: I am viticulturally curious to a fault and I appreciate others who share this character flaw. If there is any doubt that these practices and technologies work, the skeptic need only taste wines like RdV, Linden, Barboursville, Black Ankle, Allegro, Karamoor, Blair, Pinnacle Ridge to name but a few regional producers who are using them. For certain cooler and wetter regions like Bordeaux, New Zealand, Burgundy have their own lessons to offer and we need to tap their resources too. But it is how well we are able to analyze and assimilate knowledge and data that matters more than its origin.

I have known Daniel for about 25 years since he first wandered onto Temperance Hill, the vineyard I managed in Oregon. We grew accustomed to the curious from California coming up to see what the innocent and naïve in the northwest were doing but he was a soil scientist who understood viticulture and was interested in Pinot Noir and also drank Chateau Petrus. I'm not a complete dunce so I decided to stick with him. Over the years I have learned as much about fine wine viticulture from Daniel as I ever could have hoped to, even from a UC Davis education. Riding shotgun with Daniel through his vineyards in the north coast is a profoundly stimulating and rewarding experience. Here you see ideas in action, always on the precarious edge of great wine and doom. You learn quickly that it takes deep pockets and nerves of steel to extend the reach of wine quality. As someone in the research and extension community, I learned that with rare exceptions innovation occurs in the fields and the explanations arrive later in journal articles.

I learned from Daniel the specificity of wine varieties and climate conditions, and the necessity of correctly matching rootstock to soil to achieve balance and harmony between all the terroir elements, including viticulture management. It is a delicate balance that results from the most skillful analysis of conditions down to finest minutiae and nuance of the site. He stresses the need for clear and precise information to correctly plant a vineyard. To place a vineyard at a particular location on Mt Veeder so the nighttime cold air will push warm air into the vineyard to get within a 20^{o}F diurnal temperature range is a work of art. I cannot say that I am skillful enough to discern the difference in wine quality but I assume

there are those who are. Daniel has told me numerous times that you place a variety on its outer edge of ripening for the best wine and his **Integrated Winegrowing** team is well equipped to find these special places. Perhaps the most amazing examples are the Sonoma Coast vineyards that play with temperature and fog to tweak the finest flavors from Pinot Noir and Chardonnay. Daniel is completely committed to a team approach to vineyard selection, evaluation, design and management and has gathered a team of soil, climate, technology and equipment specialists that is rather frightening in their abilities.

Site analysis begins with climate data, usually an Adcon telemetry system(s) placed on a potential site that will monitor its conditions over a period of years. Adcon collects telemetry every 15 minutes and delivers the data to a central location allowing him to monitor many sites, including RdV, from his laptop. Hobo-type data loggers are not adequate to provide this constant stream of data necessary for the climate profiles they develop for a site. The critical period is April through October when temperature exceeds 50^{o}F and vines are active (enzymes, proteins and other metabolic compounds) and the sap is moving. In our region, we also care about winter low temperatures. The temperature data allow for the proper assignment of variety to the site. In the north coast counties (Napa, Sonoma, Mendocino, Lake) the terrain and climate vary dramatically, even though it is generally Mediterranean (dry summers, wet winters). The great San Joaquin Valley draws cool air from the ocean and relative location to the coast and gaps in the coastal mountains determine the significance of fog, wind, cool air intrusion. In the case of Sonoma Coast vineyards, local elevation relative to the daily position of fog is one of the keys to vineyard location. I believe we have the same local effects of climate and topography but have not taken the time to understand it at the level of detail that Daniel does in his region. Once we do, then variety choice will be much less haphazard and dictated by the physiological properties of vine and grape, not by our guess of what might work in a particular location. Daniel consistently referred to the different climate requirements of Pinot Noir, Syrah, Grenache and Cabernet Sauvignon. Each has its own specific niche that it plugs into for optimal performance. It's a tight niche. As a general guide Daniel uses the traditional growing degree days for grapes with Pinot Noir and Chardonnay on the low end (1800) and Cabernet Sauvignon and Grenache (>3200) on the high end.

The data has practical value. In 2010, as a very cool season developed at only 65% of average heat accumulation the decision was made to drop fruit in June, much earlier than the typical pre-veraison yield adjustment, to give the grapes a better chance to fully ripen.

Daniel was complimentary but realistic about our viticulture and wines – it's a work in progress but the wines are on the right track. He compared us to New Zealand, another wine region with a damp climate and vine vigor issues but demonstrating fine wine potential. This observation is verified by Dr. Greg Jones, the viticulture climatologist who says that the Mid-Atlantic conditions are most similar to Hawke's Bay. As we know, NZ makes a pretty decent sauvy and pinot with an international reputation for quality. He used the data he collected over the years at RdV to clearly illustrate the difference in precipitation between his climate and ours – dry summers vs. 3-4" of rain per month. Using Adcon data GDD was well within the range necessary to get red varieties ripe (3600 in an average year like 2006 to 4000 in a warm vintage like 2007). So if heat is not the issue for wine quality, what are the other concerns? Ripe fruit isn't only about heat but also a myriad of management decisions, key among them is crop load. FYI – we are coming up fast on the time to estimate and, if necessary, adjust yields.

It is pretty commonly recognized that heat summation is a useful measure but not the most practical tool in predicting or achieving wine quality. GDD is the common currency that viticulturists can use around the globe to compare regions so it is a useful communication tool. It tells how much heat is accumulated by not how it is accumulated. We mostly think of ripening during the day when the sun is out but a lot can happen at night if conditions are right. The change in diurnal temperature – the difference between the day time high and night time low temperature, is more useful. Daniel monitors temperature profiles during the ripening period. In the East, with warm day and night temperatures, the diurnal range is narrow which encourages night respiration, lowering acids but gaining tannins. In the north coast region, the sweet zone for diurnal shift is between 20^{o}F for Pinot Noir and 40^{o}F for Cabernet Sauvignon. In Napa

Valley, the cool air on that develops on valley floor pushes warm air upwards, narrowing the diurnal window even further from the already cooler air at higher elevation. There will be distinct wine profiles with subtle differences in pH, phenolics and acidity between the valley floor and into the hills. The trick is to find a developable vineyard site in the hills that resides in this optimal diurnal range. On the coast elevation and fog will influence the diurnal shift. In very warm areas like Paso Robles, where daytime temperatures are typically over 100^{o}F, only varieties like Zinfandel and Grenache can be grown. If a variety is planted out of its ideal zone it will not perform well, either too cool and will not fully ripen or too warm and will have too high alcohol and suboptimal fruit flavors and texture. As a region gets warmer, the number of suitable variety choices decreases. Daniel's graphs showed the diurnal zone for RdV to be very similar to the mid-mountain area of Napa, not a bad place to be.

This touches on a couple of key ripening parameters in the East that I feel are inadequately understood – the effects of humidity and a very narrow diurnal shift (most importantly, very warm nights). Daniel mentioned humidity as an important consideration for fending off dehydration during the occasional severe heat spikes experienced in arid wine regions. Vineyards with microjet irrigation are able to cool/humidify the berries and prevent shriveling. In 2010, the infamous heat spikes over 3 days in late August cause rachises to decompose and certain varieties, like Malbec, sustained significant crop loss, up to 30% in some vineyards. Another topic we talked about was the impact of diffuse vs. direct light on vine functions and fruit ripening. He didn't have a clear answer but suggested a book that might, and one I plan to read as soon as possible…

You know you are a viticulture nerd if you have read *Viticulture and the Environment* by John Gladstones. As far as I know this is the definitive tome on the subject of climate effects on grapevines and grapes. Mr. Gladstones has been in poor health recently but he has published a sequel called ***Wine, Terroir and Climate Change*** (Wakefield Press, 2011) that, hopefully, fills in some of the gaps left by his first book. Daniel showed us his personal copy of the book sent to him by Mr. Gladstones. I am always trying to tease out the relative importance of light and temperature, which affects what physiological processes in the vine and how, or if, conditions can be altered to improve wine quality. I hope the new book will offer more insight into these delicate relationships.

Row direction has become increasingly important in California to avoid sunburn and high alcohol. Day of the year, time of day, vine spacing, vine height, fruit wire height, slope and aspect are all considerations for the row direction decision. They are seeking the optimal row direction for fruit ripening without crop loss. In general, variations on a north-south orientation are favored on all sites, flat or sloped. East-west rows provide uneven exposure of the north and south sides of the vine. E-W is only recommended for white wines. Daniel's ideal vineyard would be planted on a turntable that could follow the sun through the day. Heat spikes are a reality in arid, warm wine regions and vineyards must be prepared to protect their fruit, especially after fruit set. On the valley floor, rows are planted up to 45 off N-S. He emphasized the need to understand the difference between true north and magnetic north to achieve proper orientation.

Wind is a big factor in some areas such as the Salinas Valley in Monterey. Sustained winds over 17 mph can affect shoot growth and fruit set. Willow trees and tall grasses are used to buffer winds.

Daniel made it clear that soil is not dirt. Dirt is something you get on your clothes. Soil is the combination of crushed rock with water, oxygen, carbon dioxide and time. The surface soil (A horizon) is usually less than 5000 years old. Geology is rarely relevant to vineyard development or performance since soils move about readily by wind and water. Only when a soil remains on top of its parent rock is the geology revealing. Soil factors influence vine survival and growth, berry quality and help to determine rootstock, variety, vine spacing and how deep to rip, which in turn determine vine balance, berry quality, wine flavors and quality characteristics and ultimately, the price of the wine. Top soil (A horizon) is important for soil structure, organic matter, nutrients and rooting. The B horizon is typically higher in clay content, lower organic matter and acidity. Whether the soil is friable or firm will determine

horizon differentiation and the effective rooting depth. Roots can only penetrate soils up to 300 psi. Layer depth, texture, rock and total available water are among the soil components that are evaluated and rated for grapevine suitability. Possible impediments to root and vine health or negative factors include soil salinity, sodicity, choloride, alkalinity/acidity, aluminum, boron, calcium and magnesium ratio and heavy metals. Rootstocks are first and foremost for phylloxera resistance. They were originally developed in France to promote lime tolerance. Daniel uses a lot of 420A and Riparia Gloire, mainly for vigor reduction in fertile soils. 1103P is the only rootstock to use in high magnesium soils. Soil pits and mapping were the mainstays of his work for decades, during which he has visited over 20,000 soil pits. He prefers pits over cores to get a clearer impression of texture and structure, which is so important to evaluating available water.

All of this soil work is done to promote uniformity in the vineyard and vines. The IW team talks a lot about uniformity and synchronicity in vine dimension, behavior and fruit quality. He showed a slide of a five acre block that had a brix range of 21 to 26. Fruit of this varied maturity when blended together made a mediocre wine. Soil differences were largely responsible for the uneven fruit quality. By defining ripening zones in the soil and designing the vineyard towards uniformity, they have been able to improve wine quality. Uniformity is a great challenge to Eastern vineyards, especially those who suffer from vine decline, winter injury and other chronic ailments.

The analysis work of sight and touch is being replaced by remarkable technology developed by Dan Rooney in Wisconsin. His surfer and diver equipment uses electro-conductivity to measure the essential soil chemical and physical parameters that Daniel can then process into rootstock, variety, spacing and other design features of the vineyard. Electro-magnetic imagery can be generated almost instantaneously and a continuous image of the soil is created. The penetrometer takes readings every centimeter with the tip measuring compaction, and the sleeve collecting moisture, texture and other key properties. Needless to say, like all data, it is only as good as the person who is interpreting it. **Soil and Topography Information** (STI) is the company that does the soil mapping and Daniel says they have compared pit vs. probe data for three years and much to his shock the STI data is better, and cheaper. They look at soils in three dimensions from top to bottom of a hill and laterally across all fields and below the surface through the horizons. Soil chemistry changes with depth and this can be very important for vine performance. Burgundy is a good example of the influence of soil changes on wine quality from top to bottom of the slope. It's very important to place the right variety and rootstock on the correct soil and position on a hill. Quality is mostly related to soil moisture. Research by Dr. Andy Reynolds at Brock University in Ontario clearly demonstrates the relationship between leaf water potential and soil moisture on wine quality (Riesling 198 on 101-14) – not surprisingly, less water promotes better wines. Daniel uses **Dalle Valle Labs** for his soil chemistry. He believes strongly in using a lab that understands local conditions and viticulture goals for the soil.

The only part of soil biology that is of real concern to Daniel is nematodes. There is great concern over the increasing impact of nematodes on vine health since they are vectors for disease and virus. Type and number of nematodes will influence rootstock choice, for example, there are only two rootstocks that are tolerant of *X.index*, which carries fanleaf virus. More and more exotic nematodes are being identified in vineyards and orchards and in addition to other pathogens and vectors, are a real concern to vine health and wine quality. However, once a vine reaches maturity it is less susceptible.

In low pH soils, which are common in the East, and in volcanic soils in the west, aluminum toxicity can be a danger. As pH decreases, solubility of aluminum increases and if it approaches 300 ppm vines and shoots will be stunted and may die. Adjusting pH is difficult since lime does not leach or last and stays at placement depth. They use gypsum which is much more soluble than lime, leaches and ties up aluminum. Their optimal pH range is 6-6.5. Soils samples should be taken every seven years to the base of rip depth, or more often if problems are evident.

Nitrogen (and other vine nutrients) is maintained at a low level to discourage excessive vine vigor and that is appropriate for the desired vine size, viticulture and wine goals. He is not afraid to hold N at 0.6 but the key is that he determines the nutrition levels, not the plant analysis lab. He did not have a firm opinion on the use of molybdenum for improving fruit set, they are into a multi-year experiment using moly. Boron and zinc are typically applied as foliar fertilizers prior to bloom.

Available water and roots is really what this is all about. The soil "bucket" under the vines where the roots reside contains the total available water that nourishes the vine. Roots do not seek out water, they will grow where there is water. It is a myth that roots plunge to great depths. While some do in certain soils, most roots on most vines reside in a 20" effective rooting depth, or to rip depth. Roots grow where the goodies are. Oxygen is limiting in at greater soil depth. In arid areas, soil moisture can be manipulated at key moments during the growing season to influence vine functions. It is necessary to have the soil moisture below field capacity to achieve the necessary water deficit to push fruit ripening. That is the fundamental challenge in the East, where soils, such as they are now, rarely dip below field capacity which encourages vegetative growth. Daniel mentioned the use of negative pressure evacuation systems, such as those used in soil remediation, to help remove excess soil moisture. If drain tile is used, gravel must extend from the tile to the surface for it to be fully effective. A soil with high rock content will promote drainage and should be sought for fine wine vineyards in the Mid-Atlantic region. The soil viticulturists at Integrated Winegrowing have a system for evaluating soils that results in a TAW score. To a large extent, soil texture and rock content will determine the TAW. Soils with a score below 1.5 are too coarse to support any plant life and any score 8 or above should be planted with corn. The sweet spot is between 2.5 and 3.5, where 420A is the best rootstock and deficit irrigation be practiced to full effect. I do not believe that they have rated TAWs for non-irrigated scenarios but 3.5 to 5 might be the proper range with 101-14 as the best rootstock. The boundaries between TAW zones are fuzzy. Soils above 5 require Riparia Gloire. RdV Vineyard in northern Virginia may be the best example I have seen on the ability of rock and slope to limit vine size and control vegetative growth in the summer. As a rule plant red varieties on rocky, low to moderate TAW sites but whites can do very well on deeper soils with higher TAWs.

Ripping the soil is at the core of Integrated Winegrowing's vineyard development philosophy and effort to build uniformity into a vineyard site. A lot of the analysis work is directly targeted at determining how to rip the soil, especially the proper depth to rip. Ripping provides a friable soil for root development. Conventional field ripping occurs in one direction, or cross ripping but either where there is a lack of uniformity in the soil environment that each vine will encounter. The vibrating winged plow was developed to gently lift, fracture and lay down soil evenly so not a lot of disturbance of the soil occurs and every vine has the same soil depth. The wing is 20" wide and tilted at a 20^{o} angle. Ripping is done on the vine row so the vineyard must be laid out prior to ripping. According to Daniel, wing ripping results in friable soils that reduce young vine water needs by 20%. Daniel does not like a slip plow which he says alters or destroys soil chemistry and structure.

When to rip is an important decision. If the soil is too wet it is plastic and will not fracture. If it is too dry it simply breaks into large clods and soil structure will be damaged. In massive soils sudan grass can be planted to loosen the soil. Steve Groff, a farmer in Lancaster County, sells large turnip (carrot shaped) that can be use for the same purpose – they loosen the soil then can be disced as a mulch. Daniel determines the correct plasticity by using the ribbon test between his fingers. If the ribbon reaches 5" and begins to break into pieces the soil is ready.

Ripping builds uniformity into vine growth and, along with rootstocks, helps to determine vine size, which affects vineyard design decisions like vine density and spacing. Over the past three decades California has gone from 12' x 12' to 6'/5' x 4'. 4' x 4' is very tight. This kind of vine density is very tough on independent grower unless there is an acreage arrangement with the winery. The economics of high density are easier for estate wineries to justify. He likes the fruit wire at 24", which is a good zone for the field crews, and it allows the shoots to grow taller, possibly avoiding the need to hedge. He's

definitely trying to squeeze the vine into a smaller box, not wanting to grow leaves but ripen fruit, which he says small vines do better than big ones. More leaves also contribute to insect and disease problems.

Compaction can ruin soil. Daniel encourages all of his growers to use crawlers.

Decisions to do not end with design and proper management is critical to success, e.g. cordon vs. cane pruning, irrigation and fertilizers, etc.

Perhaps more than any other item, Daniel emphasized the need for clean and healthy plant materials. It made me think back to my visit with Dave Michul, who manages Andy Beckstoffer's Napa vineyards, when I asked Dave what his single biggest viticultural concern was he said the quality of plant materials for his new vineyards. It's a biggie. Virus, fungi, bacteria, and physical quality are all potential problems. As I have said before and he confirms, hiring James Stamp to order and monitor nursery stock is the only way to be sure you get the best and correct materials. James knows the source materials and the grafting and raising process. According to Daniel, there is crown gall in vineyards in California, usually initiated by some physical damage to a vine.

Tipping is done twice a year to remove the area of rapid mitosis. The first tipping is done to the shoot tip meristem only, just a pinch to the terminal growth point at 6-12" shoot length on vigorous shoots, usually at the apical end of canes or shoulder spurs on cordons. This stunts the tipped shoots and distributes growth more evenly along the cane or cordon. This tipping seems not to encourage a lot of lateral growth. The second tipping pass is done before bloom to improve fruit set, usually removing 2-3" from the shoot tip. This tipping can encourage more lateral growth but the benefits in set and yield are more important. This is distinct contrast to the trace bloom leaf removal practice to reduce fruit set in order to open clusters on compact cluster varieties like Chardonnay and Vignoles. On Pinot Noir and Chardonnay vines are tipped at pea stage.

Typical vineyard management is 6x4 spacing, double guyot without renewal spurs that crowd the head area of the vine (canes must be <2' long), thin to 3 shoot per foot when shoots are 6-8" long, narrow clean strip under the vine but no Roundup after the third year because of its propensity to create an impermeable crust on the soil surface over time. Cover crop is a blend of brome, zorro and fescue at 50 lb/ac. No leaf removal (clusters are too exposed), just laterals at pea stage on the morning side to the node above the apical cluster and, if necessary, interior leaves (Jeff called this tunneling) on more vigorous vines. Wings are removed pre-bloom on Pinot Noir and Cabernet Sauvignon, they are typically 2-3 brix behind the main cluster (just observe how much later wings bloom in the spring). Daniel uses pressure chambers (bombs) to determine stem water potential but relies more on his eyes to determine the level of stress in the vine. Regulated deficit irrigation is practiced and each variety has its particular stem water potential, e.g. -12 to -13 for Pinot Noir, -14 to -16 for Cabernet Sauvignon and Grenache is really tenacious at -18.

2010 and 11 have both had very cool and wet springs in the north coast. Daniel's description of "spring fever" is even more dramatic than what we experience here, stunting of shoots and even abscission of leaves due to a halt in the nitrogen cycle, hence the light green to yellow leaves. They have even gone as far as to use plastic wrap (like shrink wrap) to cover the fruit zone to raise the heat level, but much care has to be taken doing this to avoid heat spikes and excess moisture. If done properly, it improves both fruit set and shoot growth (see vine tenting and high tunnels in my previous articles).

Repeatedly, Daniel said the key to fine wine here is well-drained soil, slope and correct rootstock. This isn't news to us and it's more a matter of site selection that will push our wine quality dramatically forward. We can know and understand these principles but how to put them into action and make wine is where his experience really counts. They put so much effort into site selection, design and development, and we should too.

Because of travel glitches we were unable to do a planned tour of vineyards but we visited Waltz Vineyard and vineyard manager Jeff Zick gave us a great tour. Notably, fruit set has been uneven this spring, most likely due to bumpy weather conditions (see Tony Wolf's May-June Viticulture Notes for details), and vine vigor is evident (a 2-3 hedge year?) but vines were clean and very well managed. Daniel talked about a variety of topics from reducing shoot crowding in the heads of the vines to tipping to improve evenness in shoot growth and fruit set.

I would like to mention three very notable wines that we tasted during Daniel's visit which are reference points for our region: the 2008 Allegro Vineyards Cadenza, 2007 Black Ankle Vineyard Crumbling Rock and the 2009 Waltz Cabernet Sauvignon (barrel sample). If there is any doubt that many of the fundamental techniques for growing fine wine in California have cross-application value for Eastern wine, these wines provide the answer.

So far this year we have had Daniel, Jeff Newton and Mark Greenspan visit the region, three of the best practicing viticulturists in the world. Yes, they come from California, a different viticultural reality, but they bring with them a wealth of viticultural knowledge and experience that is far too impressive to ignore because of its origins. I hope wine growers in the East will view and use California as an essential place and people that can help us to hone our craft to a very fine edge. After all, they make pretty nice wines so they must be doing something right. The nifty thing is that when they talk about what they are doing there it isn't so foreign or different from what we are already doing here. They tend to have more money, professionals, technical resources and the sheer weight of 500,000 acres of grapes, but they are not light years ahead of us. We have different conditions but we take ideas and practices from the best around the world and apply them to our vineyards and our wines already reflect the assimilation of this knowledge.

Daniel's presentation will be available for viewing on the **Pennsylvania Wine Grape Network** website. I'll send a message via e-newsletter after it is posted on the site.

I would like to thank Daniel and Elizabeth for coming to Lancaster and Daniel for sharing his knowledge and experience with us. They endured great travel trauma trying to get here (hint: never ever fly through Chicago). Jeff Zick and Kim Waltz were gracious hosts for our visit to Waltz Vineyard. I am grateful to the Pennsylvania Wine Marketing and Research Program for partially funding this seminar.

Reference Resources:

- Daniel Roberts and Integrated Winegrowing - http://www.integratedwinegrowing.com/
- Dan Rooney and STI - http://www.soilinfo.com/

Mark L. Chien
Statewide Viticulture Educator
Penn State Cooperative Extension
http://pawinegrape.com/
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