



Short Season Viticulture in Cool to Cold Climates

The cooler the climate, the better job of vineyard planning, design, viticulture and management, and wine making are all necessary to make a high quality wine, compared to warm, arid wine regions. The vigneron just has to be better, smarter, more patient, creative and flexible, and able to cope with heartbreak.

There is a commonly held belief among wine lovers that the more delicate wines that demonstrate a terroir-effect are grown in cool wine regions such as Germany, Burgundy, Austria and others. Pinot Noir and Riesling are often noted for their amazing capacity to highlight the nuances of site in the wines they make.

With new viticulture technology in the form of cold hardy and disease resistant hybrid grape varieties the possibility of growing fine wines has expanded into cool and cold areas that were previously thought to be inaccessible to wine production. Ontario has a phenomenal 12,000 acres of *vinifera* vineyards. The Minnesota Grape Growers Association annual meeting regularly attracts over 500 participants. Anywhere there are people who like to drink wine, there are folks who want to grow it, whether it really makes sense or not.

My viticultural travels have taken me to some of these places including Nova Scotia, Ontario, Quebec, Vancouver Island (British Columbia), the Finger Lakes, northern Vermont and the Endless Mountains in Northeast Pennsylvania. These areas range from cool to downright cold and offer special challenges in the growing and making of fine wines.

Extension educators try to have answers for their growers. On a recent trip to the Endless Mountains in northeast Pennsylvania I found myself shrugging my shoulders so much they got sore. That's not a good feeling. Between the effects of climate change, growing grapes on the threshold of survival, the availability of new hybrid varieties for which little is known about their best cultural practices, and yet another bizarre growing season, it's very hard to explain everything that is happening in the vineyard. The growers I encounter always have many questions and I, unfortunately, have few answers for them.

Vineyards, as general rule, are filled with conundrums and compromises. At Sugar Hollow Vineyard, wine grower Paul Milnes wondered about the relative necessity of hilling up, which creates serious erosion channels on his hillside site. Do you protect the vine or the soil? Another question asked was with vineyard soils saturated from heavy rains and tractor access limited should the cover crop be mowed for frost avoidance?

Cool and cold can be defined as a cool growing season that limits fruit ripening and cold winters which threaten the vine with winter injury. In this relationship, cool areas may not necessarily be cold but cold areas are always cool. But when does warm turn to cool and cool become cold?

I'm not sure the differences can be exactly quantified and the growing degree day system seems inadequate to the task, suffice to say that some benchmarks may offer hints. Germany, Champagne, Burgundy, and northwest Spain are cool. Bordeaux, Piedmont and Tuscany are warm. Parts of southern France, southern Italy and Spain are warm to hot. In between these seasons is the danger of frost in the spring and fall. None of these regions have the regular risk of winter injury that exists above the Mason-Dixon line. Frost and freeze injury are the often induced by similar climate, site and viticultural conditions, and also avoided by the same strategies, such as avoiding low spots where cold air pool and cause damage, and excess soil moisture can delay proper vine acclimation. I'll use frost and freeze interchangeably throughout this article, although they are physiologically very different events to the vine.

A recent trip to the Endless Mountains persuaded me that an attempt to catalog my knowledge of viticulture in cool/cold conditions was necessary according to what I have seen and growers have encountered. That's what I'll try to do in this article.

People often ask me what effect climate change is having on vineyards in Pennsylvania. My unscientific perspective tells me that we are having longer frost seasons and more dramatic frost events like the Easter freeze in 2007. Seasons and weather events appear to be more extreme, such as the difference between 2009 and 2010 vintages. All of this further complicates the challenge of growing grapes in areas with marginal climate characteristics.

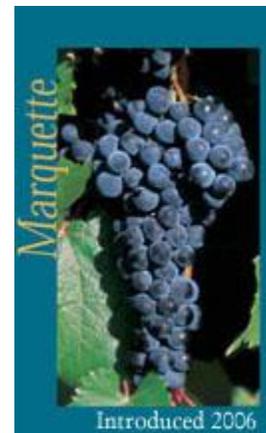
In cool/cold wine regions there are two primary viticultural goals: to get fruit to full maturity so it can make the best possible wine, and to have the vines survive the winter so they have a chance to make wine. We begin with the elemental truth in wine that the best wines are made from fully mature grapes, truest for reds but also applicable to whites. Thoughtful planning, expert viticulture and a lot of luck are necessary to achieve consistently high quality wines under these conditions. It begins by making every effort to compress the vegetative cycle of the vine which increases the chances that the fruit will fully ripen and, hopefully, be less exposed to harvest hazards such as rain, frost, birds, bunch rots, etc. Fortunately, all of the design and viticulture that promotes fruit ripening also enhances cold hardiness in vines, such as creating a balanced vine, not over-cropping, removing crop with enough time before the first hard frost for the wood to achieve maximum cold hardiness, etc. In most cases, I would argue for a balanced vine of small to medium size to achieve these objectives. Smaller vines carry less fruit and tend to ripen their grapes earlier than bigger vines with more substantial crops. High density wine growing in Germany, Austria, Burgundy, Champagne and Ontario seem to bear out this truth but with little evidence of any impact on cold hardiness.

Cool and cold climate viticulture is all about matching variety to climate. In order to do so, accurate knowledge of the climate of the vineyard site is needed. 30 year climate data can be interpolated from weather stations to give an accurate account of the climate history of a property almost anywhere. The key variables are length of growing season from last spring frost to first fall frost, growing degree days and low winter temperature where it is a threat to vine health and survival. Since everything is done in the service of the wine, knowing what type and style of wine the grapes are intended to make is essential. A \$10 bottle of Concord has very different requirement from a \$25 Riesling. Once climate and wine are identified, a process of risk assessment must occur. Cool-cold viticulture is always on the razor's edge and it never

takes much to push a vintage into the gutter. To be quite frank, the easiest and most prudent vineyard decision is to plant varieties that are fully adaptable to the local climate conditions: those that will survive the winter and ripen in the fall. But many new growers want to make classic European wines, even at great peril. Most do not fully comprehend the dangers those vines will face and the extra effort and expense that will be necessary for them to thrive, if in fact, that is a possibility. For the risk averse, the traditional and new cold hardy hybrids are the wise and safe choice. Their names are not easily recognizable to the consumers, but they can make very high quality wines. During the planning process consider the effects of climatic hazards on quality, economics and the sustainability of the vineyard.

If at all possible find other growers in your area who understand the local climate conditions. Unless you are in a well-developed vineyard region like the Niagara Peninsula, North Fork of Long Island or Finger Lakes you may not be able to find a nearby grape grower so look for a crusty orchard grower who has an intimate understanding of the local conditions and can tell you every frost event in the past 50 years. This kind of information, while anecdotal, can be extremely valuable. There are also excellent viticulture consultants that can help you to determine the climate conditions of your site and assist you with the assignment of proper varieties, vineyard design, prevention strategies, etc.

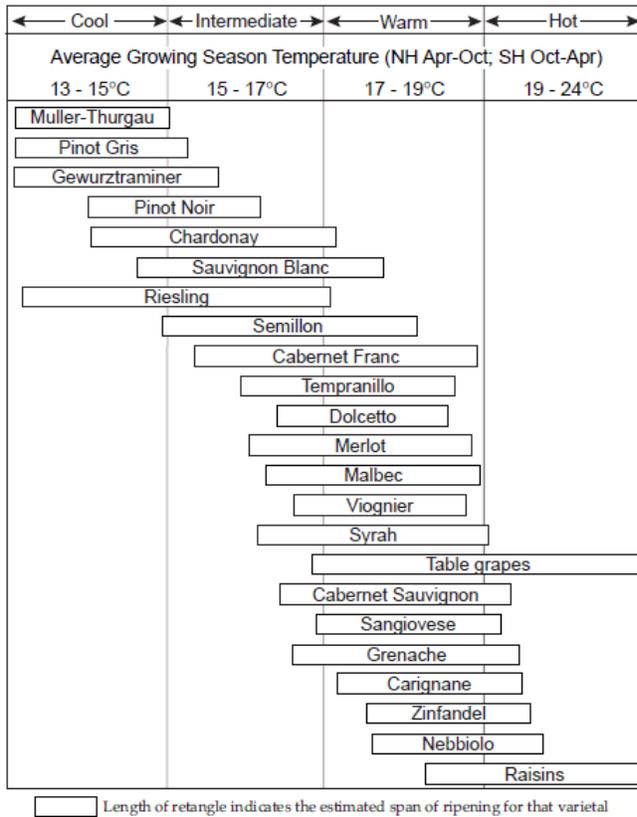
I have a general belief that as a wine consumer I would almost always prefer a ripe hybrid wine over an unripe *vinifera* wine. In many areas where both are planted, wine growers and consumers are confronted with this choice. Cold hardy hybrid varieties developed at Cornell, University of Minnesota, Elmer Swenson in Wisconsin and other adventurous and talented grape breeders usually have a shorter growing season and are more disease resistant, in addition to their cold hardiness. As a group, and especially the red wines, have a tendency towards high to very high acidity and often some level of what I describe as a “grapey” or native flavor, anywhere from overt to subtle. At UM, Peter Hemstad is breeding red varieties away from high acid and for more *vinifera*-like character, Marquette being the most recent and notable example. The technology keeps improving and who knows if we will eventually have a dead-ringer for Cabernet Sauvignon that ripens in 120 days and withstands -30F or more.



The cold, hard truth is that cool-cold areas are best suited for white wine production for a variety of reasons. Whites generally ripen earlier and they are more forgiving, flexible and adaptable in the hands of a talented winemaker to make a good wine over a wider range of maturity than reds.



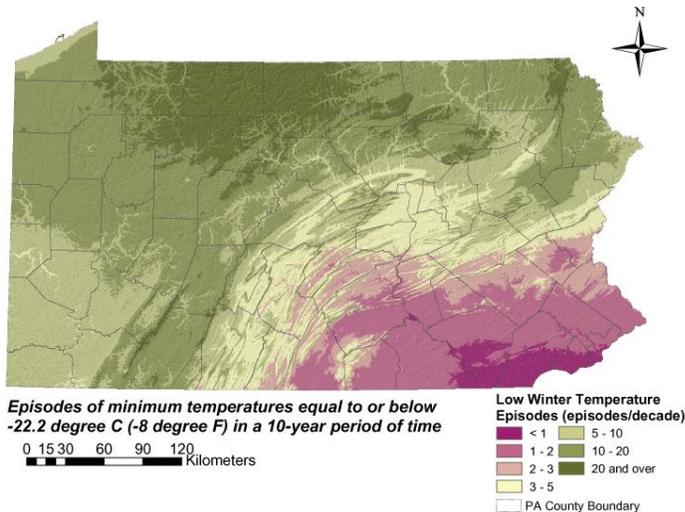
Grapevine Climate/Maturity Groupings



Range of climate requirements for varieties to reach full maturity. Gregory Jones, Southern Oregon State University.

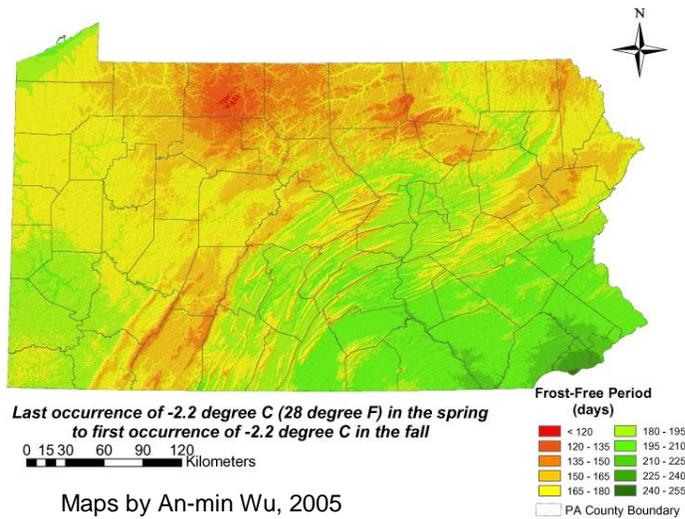
for the crowd pleasers. On that note I was told that the secret to the balance of a friendly red was a portion of California grown wine (what I refer to as “sunny” wines) that helped to fill in the middle and give the wine lift. It made the wine complete. My opinion about this is that as long as there is truth in labeling and adherence to the local wine laws, wine makers should use blending as a tool to make wines better, especially red wines. Most wine makers now know that a portion of ripe Merlot or Cabernet Franc can improve almost any Frontenac or Marquette. But the focus of any cool-cold wine region should be on white wines such as Riesling, Gewurztraminer, Pinot Gris, Chardonnay, Gruner Veltliner, Albarino and the legion of hybrids. Chardonnay is troublesome because of its early bud break and no one really knows how cold hardy varieties like Albarino and many other exotic aromatic *vinifera* white varieties really are. I have been told by some growers that Sauvignon Blanc is very hardy and others say it very tender. As a rule, cold hardiness in any variety is very hard to pin down and fluctuates from one winter to the next, although generalizations abound. I am always scratching my head about the relative hardiness of Merlot vs. Cabernet Sauvignon. One thing we know for sure is that among the Bordeaux red varieties Cabernet Franc is the most hardy and it has become the default classic *vinifera* red wine in regions like the Finger Lakes and Niagara Peninsula largely due to its cold hardiness, but can it really make consistently good wines, and is it worth the effort to try to find out? Returning to white varieties, the cold hardy hybrids such as La Crescent, Frontenac Gris, Louise Swenson, Prairie Star and others offer viticultural and wine features that make them outstanding choices in almost any cool to cold climate. Nor should the traditional hybrids such

Many white varieties, such as Gruner Veltliner, make very different styles of wine at low to higher brix levels but both are attractive and have their supporters. Of the reds, only Pinot Noir is a classic international variety that is suitable for cool climates and even then it is extremely fickle and challenging to make consistently high quality wines. However, other red varieties such as a Zweigelt, Blaufrankish (Lemberger), or even Dornfelder, can make interesting if not charming wines. At Nimble Hill Vineyards in Tunkhannock I tasted their basic red wine made from a blend of St Croix and Cabernet Franc and declared it the perfect entry red wine with just a touch of sweetness that says “hug me” to the consumer. In Nova Scotia I asked why the wineries insist on making red wines and they told me frankly that at least half of the people who come to the winery want red wines. Okay. But let’s forget about snobby reds and go



as Vidal, Seyval, Traminette, Marechal Foch, Baco Noir and others be ignored since they are very viable wine candidates. Vidal, in particular, is a variety that has great wine potential, from unctuous ice wines in Ontario to zesty, dry white wines on the New England coast. Areas such Quebec (Michurinetz, Vandal Cliche), and Nova Scotia (L'Acadie, Lucie Kuhlman, Cabernet Foch) have hybrids peculiar to their own region that make them unique and interesting. Whether these varieties will ever receive wider recognition for their

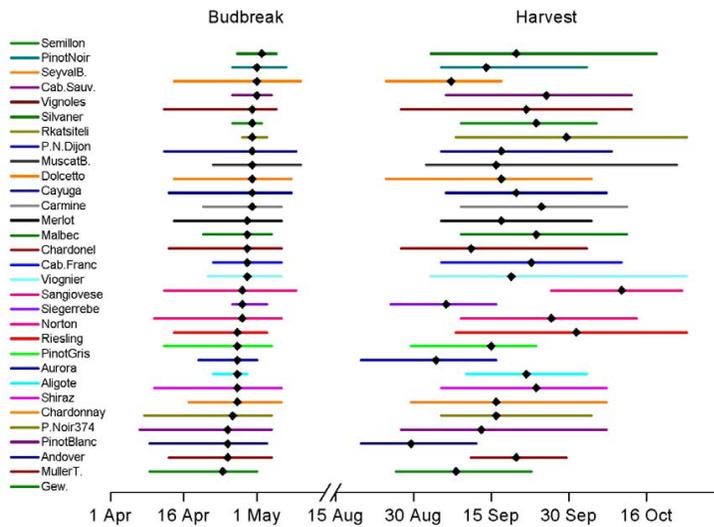
wine prowess is another matter, but on a local and regional level they have tremendous ability to please and sustain a winery enterprise.



In cold areas winter injury gets the most attention because of the threat of vine injury or death. This is a well-placed concern but frost damage should be hard on its heels. Frost risk should be accurately assessed and every possible passive prevention measure employed, most related to site characteristics. As frost becomes a greater concern so does the date of bud break for all varieties. If frost is a regular threat, varieties with later bud break become more the obvious choice. Chardonnay, for example, is frequently implicated by growers to be at high risk for frost damage.

The economic, viticultural and wine quality complications raised by the loss of primary shoots are very significant and the cause for much anxiety, not to mention loss of sleep. While nature has designed a vine with multiple safeguards (the compound bud) against the hazards of frost and freeze, growers face yet another viticultural conundrum: early bud break and risk of frost vs. the benefits of a longer growing season.

Active frost prevention measures such as overhead sprinklers and wind machines are, quite frankly, too expensive for most of our small vineyards and even when they are available only work effectively under certain conditions. Recent research in Ontario has demonstrated the ability of wind machines to prevent both frost and freeze damage and they have become the active protection measure of choice. Helicopters utilize the same principle of mixing warm air with cold but growers have told me that it is hard to find pilots who are reliable and willing to fly at night. However, if a skilled and reliable service can be found, this can be a great tool against



Bud break and harvest dates for 31 varieties in Colorado.
Colorado State University Western Colorado Research Station

frost and freeze events. When considering the expense of active measures use the value of the grapes and/or wine against the cost of the equipment or service. From this perspective, it may make the costs appear more reasonable. Areas of California are coping with a string of awful frost seasons that include multiple frost events. We are lucky in our region that we usually only have one or two serious frost nights and likewise for winter freeze events. Of course, it only takes one to ruin a season.

Avoiding excess soil moisture (i.e. rainfall) at critical times of the growing season such a shortly before and after veraison can be as important as dodging frost and freeze conditions. Areas that receive less rainfall are highly desirable and it may be possible to find these by careful study of historical climate data and examination of physiographic features. It's not a science yet in the wine industry but hopefully improvements in mapping ideal wine growing climate areas is in our future.

Two growers in NE PA have experimented with dormant oils to delay bud break, following recommendations from the University of Nebraska. One said he had good results, the other negligible but number of applications appears to matter to the results. Growers also claim that prophylactic applications of copper have helped. In California, products such as Frostgard are used. It is difficult to quantify the efficacy of many of these measure, suffice to say the "feel good because I'm doing something" effect is probably at work here. Double pruning is another traditional method for gaining a few days of delayed bud break. It is important to note that anything you do to delay bud break will exact a price at the end of the season with likely a later harvest date as a result, with its inherent risks and concerns - yet another compromise.

The necessities of the marketplace cannot be ignored either. Who is the customer base and what wines will they buy? There is no sense making a wine if no one wants it. Market and viticultural realities are often at odds and must somehow find a balance. In frost and freeze prone areas grape sourcing is a key ingredient to winery survival. In discussions with wine makers in Pennsylvania there is almost unanimous agreement that most customers in our tasting rooms care little about the origin of grapes. I believe this is mostly a rural phenomenon. People just want a wine that tastes good to them. The more sophisticated (city) wine consumer will eventually demand a local source of grapes but that moment has not yet arrived. It is up to each winery owner to decide how and where to source their raw materials. I prefer a strict emphasis on local sources with outside materials used only as a blending tool to fill in gaps in a wine profile.

If vine size and balance is important to successful wine growing in cool and cold climates then soils, too, must be important. In my 30 years in viticulture I have noted that from the Mosel to Alsace, Burgundy, Bordeaux, Piedmont and on that small vine viticulture produces the best wines, reds in particular. This is a controversial topic but I would generally observe that if a terroir can be found that supports small and balanced vines, i.e. well-drained, low fertility soils and modest, timely rainfall (or lack of it), then lower yields per vine can help to promote and even accelerate fruit maturity. The key is soil moisture, however it is measured as plant available water or total available water. Getting the vine to change gears from vegetative growth to fruit ripening mode is the tremendously important in all climates, but much more difficult in cool and moist ones. Small to medium vines require soils that are well to excessively well-drained, having low to moderate nutrient levels, along with other size regulating features such as soil pH, CEC and organic matter. These are the same requirements for fine wine production in warm regions that, at least in theory, should impart similar affects on vine behavior and fruit quality in cool and cold areas. Many vineyards will be planted on soils that do not have optimal drainage or fertility so other means will be necessary to impose balance on the vines. These may include choice of rootstock, cover crops, vigor diversion methods, severe hedging, divided canopies, as just a few examples. In warm and dry years, vine performance will be manageable but in cool, wet years, wine quality and cold hardiness will be more difficult to achieve. In cool/cold vine cultivation growers should plan for the worst conditions and be grateful for the occasional fine vintages.

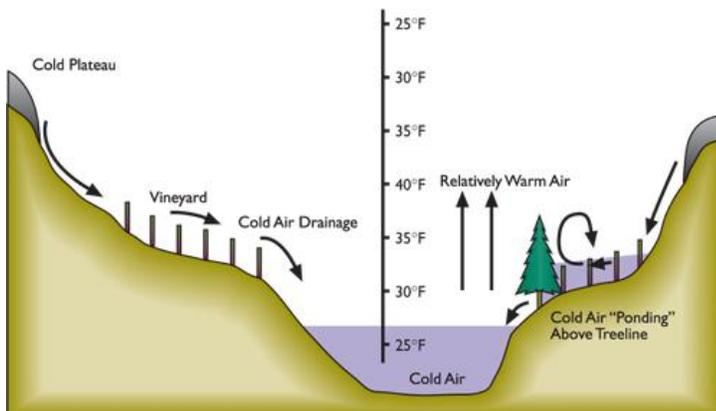


Illustration of local elevation effects on air drainage.
Tony Wolf, Virginia Tech.

Soil is always at the heart of site selection but there are many other important secondary considerations that comprise a good site. In selecting a site in a cool to cold region the grower is attempting to lower the risk of a frost or freeze event that will compromise wine quality in any given year, good or bad. If bare soils help with frost prevention, then it seems likely that stony soils will assist even further by gathering heat during the day and radiating it in the night. The

shale soils of the Lehigh Valley may offer this advantage. Other favorable site characteristics include convex land forms, slopes, correct aspect, and local and absolute elevation. Among these, local topography may be the single most important factor in avoiding frost/freeze if the risk exists. Avoiding low spots in the vineyard maybe the single most important feature a grower can seek when selecting a site. Cold air and water accumulate in low lying areas and both increase frost/freeze risk and hamper vine acclimation. Even virtually imperceptible depressions in a field can cause problems. I have seen so many cases where low lying vineyards sustain damage yet mid to upper slope sections are unharmed. If low spots should be avoided, placing vineyards on slopes should be encouraged. This motivates both air and water to flow away from the vineyard thus lowering frost/freeze risk and encouraging fruit ripening and vine acclimation. Some growers seek sites with up to 30% slope but almost any amount of slope will help. Absolute elevation will have an impact on the risk of frost and/or freeze events. Higher

elevations are generally cooler and will delay fruit ripening and possibly raise the risk of winter injury. In warm macroclimate regions, a higher and therefore cooler mesoclimate vineyard site may be preferable but increase frost and freeze danger – yet another compromise. For a host of reasons, avoid trees, and particularly anything that may impede the flow of air and water off of the vineyard site. Shrubs and brush at the bottom of slopes should be removed so a clear drainage path can be made. Aspect may be less important for frost and freeze, but in general a southeast to southwest orientation is preferred in cool/cold climate regions. In Europe the further north the vineyards are, the more highly prized a south aspect becomes. Row orientation is ideally up and down a slope and north-south to northeast-southwest. An important trellis design feature is fruit wire height. Lower encourages ripening in the growing season but increases frost and freeze risk. There are arguments over the relative virtue of single vs. multiple trunks. The latter is the traditional method in cold regions but some claim the additional stored carbohydrates may increase early season vine vigor. Winter injury is extremely random and it very possible that on a vine with multiple trunks that one may be damaged and the other(s) unharmed. Compromises abound and risk tolerance enters the decision making process. I encourage the use of multiple trunks in cold regions with the Mason-Dixon line being the border between safe and sorry.

Once the site has been selected and the vineyard designed and installed then the viticultural practices will have impact susceptibility to frost and freeze events. Anything that can be done to ripen the fruit faster and, to some extent encourage later bud break, will help to avoid injury. Can rootstocks help the cause? There are certainly indirect effects of rootstocks that may help a vine to resist cold injury, or delay bud break. A pioneer grower in the Endless Mountains is experimenting with Riparia R-39 (selected within the Arctic Circle) and ES1553 (an Elmer Swenson selection) that he hopes will directly impart cold hardiness to the scion. Certainly Riparia Gloire, Slate Quarry Riparia and other devigorating rootstocks may help the vine to ripen fruit earlier and acclimate better. More research would be very welcome in this area. Clean vine materials are important to cool and especially critical to cold climate wine growing. Crown gall is a serious problem in cold climate vineyards and every effort should be made to find certified crown gall tested nursery materials. Under marginal conditions, maintaining a healthy vine, free of viruses and the assortment of trunk diseases will greatly enhance the ability of vines to survive. Plant the best quality nursery stock possible.

In cold areas there is abhorrent (but very necessary) practice called “replacement viticulture” in recognition that vines and/or their parts come and go and the ability of the grower to replace them will determine the economic success of the vineyard. Needless to say, outstanding viticulture will help all aspects of fruit quality and vine survival. If it is accepted that vine and vineyard uniformity is an important contributor to wine quality, then replacement viticulture is not the route to fine wine but it is a reality of wine growing in the cold. Synchronicity is another virtuous feature of wine quality and that, too, is difficult to achieve in a vineyard with vines and parts of vines with different sizes, shape, ages, etc. In general, try as much as possible to be like a normal vineyard (see warmer regions). Vineyards on Long Island or the Niagara Peninsula are good examples of what wine growers should strive to achieve. Visit and examine them closely for their design and maintenance features and understand what makes them successful. Avoid injury to the vine such as grape hoes, string trimmers, large pruning wounds, etc. because they create portals for opportunistic bad guys such as crown gall. Even if I dislike replacement

viticulture I accept its necessity. The goal of every vineyard is to be sustainable and this includes profitable. Any open wire (i.e. missing vine or part(s) of a vine) detracts from a vineyard's ability to be profitable. A management strategy must include how to keep the trellis full as much as possible. Growers should have a good program for replants, which are neither easy to install or cultivate. For example, how will you maintain adequate weed control in a vineyard with numerous replants? Many cold climate growers have a regular program of replacing trunks, as they get beat up over the years. No one seems to know what impact this practice has on wine quality. If we believe that vine age has an impact on quality, what effect does the combination of older roots and renewed trunks have on the physiology of the vine and grape quality?

Part of the reason for trying to create a smaller vine is to limit yield per vine which, in theory at least, should help to promote earlier fruit maturity and help the vine's acclimation process. I have seen in many red wine vineyards the higher density vines ripening earlier than their wider spaced neighbors. The sooner the fruit is harvested, the sooner a vine can get on with the business of cold acclimation. This is one of the few win-win situations in viticulture. Regardless of vine density and size, growers should strive to create a balanced vine and not to over-crop their vines, which surely can compromise their ability to overwinter. Proper yields are unique to each vineyard, and even blocks or sections within a vineyard so only you can determine what the proper crop load should be. This must be done through yield trials that involve wine making to see what level makes the best wine and ideal vine balance (hopefully they are the same).

Canopy management is invariably complicated by replacement viticulture, especially if extra parts are involved, such as replacement spurs and-or canes. They can crowd a finely balanced canopy and exacerbate shading issues, which in turn hamper disease management and fruit ripening. The grower just has to manage this situation the best he can given the severity of the injury situation. There is certainly no prescription for this. The canopy is vitally important for wine quality and vine health. Ideally, a mild water stress is placed on the vine before veraison and the vine's attention is directed to fruit maturity and away from producing more leaves. This is where soil plays such a critical role in post-veraison viticulture. As new hybrid varieties come out of research programs and the barns of innovative growers there is a lag in vineyard design and management knowledge. For example, what is the best vine density and spacing, trellis and training system, yields, methods of canopy management, disease and pest management strategies, etc? A lot of what growers are doing now is based on intuition and tradition, which often works fine but may not offer the optimal design and management systems.

Finally, wine making is more challenging and important to making high quality wines in cool and cold areas where grape quality will have tremendous variability from one vintage to the next or even with a vintage. Getting balance into wines from grapes with high acidity, insufficient body, off-flavors, diseased grapes, or all of the above makes wine making a critical part of the production process. Proper extraction is necessary to elevate the mid-palate, particularly for red wines and tools such as concentrators and rotary fermenters, if skillfully used, can help to improve the quality of substandard fruit. Blending is another excellent tool for the winemaker to make both red and white wines better. Using warm climate "sunny" fruit/juice/wine as a blending tool to improve wine within legal limits is another option. The quality of wine is indeed determined in the vineyard but this can be good or poor quality and often it is the

creativity and knowledge of the wine maker that matters the most in fashioning a palatable wine in a difficult vintage. White wines require the preservation of freshness and acidity, also in balance, to produce the attractive aromatic qualities that consumers expect from varieties like Riesling and Vidal.

I have often said that the Eastern U.S. is the most challenging fine wine area in the world due to the combined threats of winter injury, fall hurricanes and low pressure systems, and often warm, humid summers. As conditions get cooler, viticulture and wine making become more difficult and with this come additional costs. I know from experience that the most expensive and least rewarding vintages are the cool and wet ones, where every task in the vineyard is a struggle and wine quality is often compromised. The occasional winter event can lead to varying degrees of vine loss resulting in lower production. It's all a tremendous gamble and not for the faint of heart or wallet. The vineyard and-or winery owner has to stare these risks square in the face and say I can take it. If you cannot, then my completely sincere suggestion is to use the money you would spend on the vineyard battlefield in a fine wine shop and other favorite past times, although none will be as thrilling as the annual vintage game we play.

Cool and Cold Climate Resources:

1. *Northern Winework: Grape Growing and Making Wine in Cold Climates*. Tom Plocher and Robert Parke. 2nd Ed. 2009.
2. Tom Plocher's Northern Winework website - <http://northernwinework.com/cms/index.php?page=home>
3. *Winter Injury and Methods of Protection*. Tom Zabadal, et al. Michigan State Extension Publication 2930. 2007. <http://www.migarden.msu.edu/uploads/files/8/e2930.pdf>
4. *Monographs in Cool Climate Viticulture No. 2*. David Jackson. 2001.
5. *Cold Climate Cultivars: A Review of Cold Climate Grape Varieties*. Lisa Smiley, Paul Domoto, Gail Nonnecke. Iowa State University. <http://viticulture.hort.iastate.edu/cultivars/cultivars.html>
6. *Cold Hardy Grapes*. University of Minnesota. <http://www.grapes.umn.edu/index.html>
7. *Cold Climate Grape Production*. Dr. Lorraine Berkett. University of Vermont. <http://www.uvm.edu/pss/grape/>
8. *American Society for Enology and Viticulture: Cold Hardiness Workshop*. Conference Proceedings. 2000.
9. *KCMS Applied Research and Consulting*. Dr. Kevin Ker. Ontario. <http://www.kcms.ca/default.asp>

Visit the Pennsylvania Wine Grape Network website at <http://pawinegrape.com/> for more information.

Mark L. Chien
Statewide Viticulture Educator
Penn State Cooperative Extension
May, 2011

