

Vineyard Variability and Wine Quality – Improving It with Irrigation

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Alan completed his PhD in Plant Physiology in the Viticulture and Enology Department of UC Davis in 1973. His research dealt with temperature effects on malic acid metabolism in winegrapes. In 1973 he moved to Cornell's NY State Agricultural Experiment Station in Geneva, New York to work on apple management and physiology. In the mid-1980's he was able to resume research on grapes. His current research emphasizes integrating vine developmental physiology with environmental and cultural influences as they affect yield and grape quality. Recently more emphasis has been placed on carbon and water relations, root dynamics and modeling of vine physiology. He is currently teaching the vineyard management courses at Cornell.

In viticulture in general and winegrape growing we generally deal with simplified concepts of yield and quality. Often we talk about the relationship of fruit or wine quality to simple vineyard averages such as yield/acre or perhaps average pounds yield per pound of pruning weight.

Effects of Vine-Vine Variability

Is this really a problem? Does it make much difference if vineyards with similar yields of perhaps 4 tons/acre have more or less variability? The answer is not intuitive, but simple spreadsheet calculations can help us.

Although the relationship between wine quality and yield has surprisingly not been well documented and is open to opinion, a reasonable relationship for the NE climate is likely to be high quality at yields up to about 4 tons/acre (assuming good healthy vines that all have the same crop) (Fig. 1). At higher yields the quality drops off. This relationship will be used to estimate how vineyard yield variability affects average wine quality since normally all the fruit of a variety from a vineyard is combined for wine-making.

Using this quality-yield relationship, we can see what the effects on wine quality of different amounts and types of vine-vine-variability. First, it is not of interest to consider a vineyard of very low yield as few can sell wine for high enough prices to sacrifice that much yield. Also, we will ignore the very heavily-cropped vineyards as the wine quality is very poor. So, we will examine vineyards with average yields near the shoulder of the yield-quality relationship as they are attempting to balance yield and quality.

The way of calculating the effects of variability is to develop a scenario of variation in the number of vines/acre that have different yields. The scenarios assume pretty uniform patterns (e.g. bell-shaped

curves) The number of pounds of fruit from each yield category is multiplied by the quality for that yield category. It is important to understand that although there may be equal number of vines with 5 or 30 pounds, the 30-pound vines will have a greater effect on the final crop as they contribute 6 times the fruit to the crop.

In the example, if all the vines were perfectly uniform and had exactly the same yield adding up to 4 tons/acre, the wine quality would be 9 out of 10. A 4-ton vineyard with 90% of the vines having between 3 and 5 tons/acre equivalent gives a wine score of 8.5 due to the few heavily cropped vines reducing total crop quality slightly. Another vineyard with a 4 tons/acre yield, but having only about 70% of the vines having between 3 and 5 tons/acre equivalent gives a wine score dropping to 7.7. Interestingly, many other distributions of yield from flatter bell curves to even bimodal distributions (having most vines either under or over cropped).

The main point is that average yields do not tell the whole story. It is noticeable that when I visited extremely respected producers such as Cheval Blanc in Bordeaux they put tremendous emphasis on making their vines as uniform as possible in both the vigor, canopy, and crop. Their management approach is worth emulating, even if not to the level they can afford. The key is to avoid the over-cropped vines that produce large amounts of poor quality fruit and to avoid the low-cropping vines that may produce good quality, but produce so little fruit.

Sources of Variability in Vineyards

There are several sources of variability within vineyards, especially in the East where we have few if any large consistent tracks of vineyard land. In the Finger Lakes we have additional variability due to the glaciation of the region, the topography and the variably cold winters giving varying cold injury to winegrapes.

Soil/Water Variations. The geology of the glaciation of the Finger Lakes has led to extreme variability in the soils of the region. Soil fertility is variable but tissue analyses can guide appropriate fertilization to overcome these variations. The variations in soil water supply may not be manifested in all years, but in dry years tremendous variation can be seen. Overcoming the variation is not as easy as with nutrition since it is effectively impossible to change the water-holding capacity of soils except with large amounts of organic matter over many years. So irrigation is the logical approach. It is not easy to match the soil variation with variable irrigation but in most cases, irrigation is only applied in dry conditions, so some excessive irrigation is not a major problem except in poorly drained soils.

One of the greatest values of irrigation is to reduce variability in both the year of the drought, but also in many cases in the following year or two. This is especially the case if there are two back-to-back droughts as we experienced in 2001/2002. In a 3 year study at Prejean Vineyards with Lailiang Cheng, Tim Martinson, Thomas Henick-Kling and Terry Acree, we found that irrigation not only maintained Riesling yields over time, but also allowed full ripening, more varietal flavor development and less Atypical Aging.

At Fredonia we have done some long-term studies of irrigation on both newly planted Niagara vines as well as on mature Concord vines with normal and minimal pruning. In the new Niagara vineyard, our results showed that early-life supplemental (i.e. only when needed) irrigation years allowed for rapidly vine development, so that in the third year a full crop could be supported without hurting vine size. The first several crops were sustained at surprisingly high mature levels due to the avoidance of drought reductions on vine pruning weights. Control vines that had no irrigation grew well and produced good initial crops, but when there was a dry year, the vines could not support a full crop and also maintain vine size. The results indicate that the common observation that full crops will strongly inhibit vine size in young vineyards may be a result of drought stress combining with crop stress, not just crop stress alone. In the mature vines, the biggest effects were primarily to even out variations related to soil variations in water-holding capacity and evening out year-to-year variations due to different seasons.

Variability in Environment. In addition to the baseline variation in vineyards due to soil variation, there are also variations in the climate that may be greater than we may think. In the last year Bob Seem of Plant Pathology and I have begun to document small-scale variations in temperature within Finger Lakes vineyards. For example in a small 9-acre vineyard near Seneca Lake, we found up surprising differences in temperatures during ripening. On a sunny warm days, there were up to 9 °F differences in maximum daily temperatures across this small vineyard. Over the last month of ripening, the upper rows of the vineyard had about 18% more degree-hours of heat accumulation than the lower rows. Although this was over only a short distance, it appeared to demonstrate the effects of very local air circulation off the lake. The vineyard owner did not suspect that the environment differed that dramatically.

Another example during the coldest day of the year showed that along a transect down the slope at Hector, NY (a quite steep west-facing slope). The coldest temperature that day across that slope varied by 14°F. The warmest site was closest to the lake, but the coldest site was not due to elevation, but to

topography of air drainage. Such variation is not unexpected, but is critical to understand for site selection and matching of variety to site.

What to Do About Variation. There are basically two approaches to dealing with variation. Both depend on first actually finding out and documenting what variation there actually is. This may be done by yield and/or vine size mapping. Such data can be gained by detailed weighing of vine yields manually or with yield monitors on harvesters. Since this may not be feasible, it may be still very useful to walk the vineyard and make notes of vine size, apparent crop or stress symptoms in dry years by row and panel number. A lot of useful information can be gained by walking the vineyard with a map in hand.

One approach once variation is known, is to attempt to overcome variation by compensatory management such as cover cropping vs mulching, using divided canopies in vigorous sites, installing irrigation in dry sites, etc to make things more uniform. This is more difficult as it requires good information and very flexible management, but it has the advantage of more uniform crop quality and sustainability.

A second approach that is more historic is to identify variation in vineyards and use the variation to produce variable wines. This of course is fine for those few sites that are superior, as grand cru vineyards in Europe. This approach normally takes much experience over many years to identify. In extremely variable climates and limited vineyard sites, it may not be that desirable for most. Additionally, with variations in vineyard water relations from year to year, the superior site may move. In wet years, excessively-drained dry sites may be superior by draining away the water. However, in dry years the deeper soils with more water-holding capacity may be superior.