Veraison to Harvest Vineyard and Winery Considerations

A brief review of reminders and considerations in the vineyard and winery as the vine transitions from the vegetative growth stage to the fruit ripening period.

What is happening within the vine after veraison?

Carbon and nutrients (henceforth "resources") move through the vine in different ways throughout the season. Growing tissues are called "sinks" because resources are allocated to them as they grow; these "sinks" are timely repositories for resources as the season progresses. Thus, the growing shoots and leaves are the sinks before bloom. Then, the inflorescences and setting clusters become sinks along with growing shoot tips; developing berries, primary and lateral shoots, and leaves are the sinks from fruit set through veraison. From veraison to harvest, the primary sinks become the ripening berries; perennial vine parts (e.g., trunk, cordons, roots) also become sinks during this timeframe and after harvest. From an ecological perspective, the coloration, softening, and sweetening of the berries is a means to attract animals to consume the berries - now containing viable seeds that can germinate when excreted by the animals. Who said plants can't move...? Nonetheless, this marked shift in resource allocation has some practical implications for vineyard owners and managers… the first of which is opportunity to scout vines for markers of perennial health.

Scouting

Early in the season, soil moisture is often ample coming out of winter and early spring; vine mineral nutrient uptake is generally not limited by mass flow. Further, the canopy is relatively small and shoots are being supported by resource reserves within perennial vine parts. With few exceptions (e.g., young vines with shallow roots systems) mineral nutrient imbalances are not often observed in the canopies early in the season. However, as veraison starts, vegetative tissues become weaker sinks and berries become stronger sinks. Further, temperatures are often warmer and soils can be drier than earlier in the season during bloom and berry development. Likely due to both a change in sinks and environmental conditions, markers of vine health are often observed in vegetation during and after veraison.

These visual foliar symptoms are often the result of nutrient imbalances or systemic diseases (e.g., viruses, phytoplasmas). The only way to know for certain what is causing symptoms is to submit tissues for analyses. However, scouting and observing the patterns of symptoms within the vineyard could help investigate the possible issue. For example, are leaves curled under? If so, leafroll is a possible cause. Is only a small section of vines in rocky soil at the top of the slope showing symptoms? If so, soils could be nutrient deficient and dry, thus limiting nutrient uptake. Are trunks displaying extensive crown gall? If so, then the foliar symptoms could be the result of restricted xylem flow (read more about crown gall).
Methods to assess nutrient imbalances are discussed below. Tissue testing should be done to confirm or refute a suspected systemic disease. There are no retroactive treatments for systemic diseases, so removing vines is a good measure to limit the spread of systemic diseases. If time is limited, flagging vines will allow for vine identification and removal during the dormant season or future evaluation in the forthcoming season.

Scouting for late-season insect and disease pests is always recommended. Fruit fly, mealybugs, grape berry moth, and spotted lanternfly are all common late-season vineyard insect pests. Downy mildew and the suite of cluster rots (Botrytis, sour, ripe) can be pervasive disease pests throughout the veraison-to-harvest period.

Several producers (within and beyond Pennsylvania borders) have also noted shriveled or discolored/pink berries (in reds). These symptoms do not appear to be caused by biotic factors; read more about these issues.

**Nutrition**

There are two growth stages for which grapevine nutrient sufficiency ranges have been developed – bloom and veraison (berry softening and color change; sugar accumulation). Thus, for tissue mineral nutrient results to be placed in the context of vine health, tissue samples should be collected at either or both of these growth stages. Grapevine tissues can be submitted to the Penn State Ag Analytical Services Lab for analysis. Common questions are "how should I sample tissues?" and "what tissues should I sample?" These questions are addressed in a recent fact sheet published by the Penn State Wine and Grape Team. In short, sampling at veraison may be more revealing of imbalances for some of the macronutrients (N, P, K). Relative to petiole sampling, leaf blade sampling may be more reflective of nutritional status as related to vine health and physiology, but we have a relatively less robust data set for interpreting sufficiency ranges for leaf blade nutrient levels. Hopefully, in time, we will learn more about how to interpret leaf nutrient levels in our region. Note that it is important to objectively validate a nutrient imbalance before taking corrective measures; those red leaves could be red blotch or another systemic disease; in these cases, magnesium or potassium fertilizer would not be the remedy. Here is a recent publication about grapevine nutrition principles that may help put into context its importance. If suspected nutrition issues will not be addressed in the current season, flagging vines or rows will allow symptomology and health status to be re-evaluated in the next season.

**Crop weight estimation**

Crop weight estimation can be an important tool in situations where harvest logistics could result in space limitations in the winery, tanks, barrels, etc., as well as for independent growers selling their crop. There are a couple of primary ways to estimate crop weight at harvest, and these are highlighted in a publication from the University of Maryland. One method is by knowing the percent harvest weight that berries possess at a given stage of the season; historically, the stage of choice for crop weight estimation has been the "lag phase" of berry development as this is when some cultivars (e.g. Concord) are at an estimated 50% of their harvested weight. It is important to note that cultivars vary in berry weight development curves throughout the season; thus, the estimation formula that works for one cultivar will not necessarily work for another cultivar. To complicate matters, rainfall, site, and cultural practices can affect berry weight and therefore cluster weight and total crop weight at harvest.

A good alternative method to estimate crop weight at harvest is by using historical cluster weights at harvest from your own blocks—this method could reduce the variability that may be experienced when using a "general formula" developed from other sites, cultivars, or regions. If historical weather patterns are recorded in addition to historical cluster weights, then crop yield estimations can be accordingly refined for "wet" or "dry" vintages. Knowing historical berry and cluster weights at harvest would allow the estimation of crop yield any time.
clusters can be counted, for example between pea-sized berries and pre-harvest periods. To solely rely on historical average cluster weights to estimate crop yield, cluster number per vine and vine number would need to be determined. It may also be helpful to quantify berry number per cluster and berry weight in case of weather patterns at bloom, or physiological disorders, altered "typical" fruit set; historical data on berry number per cluster and berry weight would be necessary to determine "atypical" trends in a given season. Any crop yield estimation method will be optimized with extensive historical datasets, accurate assessment of cluster numbers per vine (and/or berries per cluster and berry weights), and an accurate assessment of actual vine number in the block of interest. Cluster thinning after cluster numbers have been counted will reduce the accuracy of the crop estimation... speaking of cluster thinning...

Figure 3. Chambourcin (left) and Traminette (right). The berry and cluster weights of these cultivars will differ, necessitating unique crop estimation protocols—especially given the condition that caused low berry numbers per cluster in Traminette.

Crop thinning

Crop load (the ratio of crop weight to pruning weight) and the leaf area-to-crop weight ratio, are metrics that have been researched by academics over the years; these metrics can be taken out of context in practical settings. The "ideal" crop load is one that results in fiscally sustainable amounts of crop that produces consumer-preferred wines and does not limit perennial vine health and sustainability. Thinning crop (at any time of the season) does not guarantee the improved quality of the retained crop. The only way to know if crop thinning will register a response in the vine is by understanding when your vines are over-cropped; the only way to know if your vines are over-cropped is to conduct a multi-year experiment to determine the effect of various crop levels on your response(s) of interest (e.g. fruit composition, wine preference, bud cold hardiness, pruning weight, etc.).

Too many factors change the "ideal" crop load, including site, cultivar, training system, vintage, winemaking goals, etc. For example, the ideal crop load will differ between Concord and Cabernet franc – for many reasons, including differences in training systems (and thus exposed leaf area), the intended use of the crop, and the performance and sustainability of varying genetic backgrounds in our climate. However, crop thinning during the first few weeks post-veraison could indirectly impact the quality of the retained crop by way of removing fruit that could have deleterious effects on the quality of the must. For example, dropping clusters, or parts of clusters, that appear to be lagging behind in maturation could limit the amount of unripe fruit in the must; this is most obvious in situations where green or pink berries remain in red-berried cultivars several weeks into the ripening period. Further, removing clusters from areas of high cluster density could limit the amount of potential fruit rots (from cluster overlap) and could increase radiation penetration to the remaining clusters; this could be particularly important in relatively rot-sensitive cultivars. The take-homes are: (1) cluster thinning (at any time of the season) is not guaranteed to improve the quality of fruit or wine – it may only be wise to crop thin when a measurable and positive impact on fruit composition, wine quality, and/or vine health can be measured and achieved; and (2) some refined cluster thinning after veraison may exclude unripe and/or rotten fruit in the must.

Figure 4. Merlot clusters overlap in a fruit zone trained to vertical shoot positioning (VSP).

Canopy management

Most canopy management practices are finished by veraison; shoots have been thinned and trained, hedging has mostly been finished, and the first round or two of fruit zone leaf removal has been implemented. However, some re-implementation of fruit zone leaf thinning can aid in fungicide spray penetration, cluster drying, and radiation infiltration through the fruit zone. The drawbacks of leaf thinning at or after veraison are the time and labor required and the resultant exposure of ripening clusters to vertebrate pests (including birds, raccoons, turkeys, etc.). Thus, exclusion measures like canopy netting are often necessitated... but not without the investment of more time and labor. The benefit of an exposed fruit zone can be a more efficient harvest as clusters are easily seen by pickers.
Late-season disease management

As weather conditions continue to be conducive for downy mildew development, scouting susceptible varieties is essential to maintaining good control. The pathogen that causes downy mildew is dependent on wet conditions; without a wet plant surface through which spores need to swim to reach infection sites (stomates), no infection takes place. At this time of year, we are only concerned about leaves, and young leaves on the ends of shoots are especially susceptible. In places that have received a lot of rain through these first 3 weeks of August, the abundant water is like a shot of nitrogen, spurring continued new growth that’s like "candy" to the downy mildew pathogen. Do your best to maintain a tight grip on this disease or it can strip vines of their leaves when they need them most; to ripen the crop and lignify canes/prepare wood for winter survival.

How can you differentiate between downy mildew and powdery mildew on leaves? Among all three photos (below) of Niagara leaves, the upper left is infected with powdery mildew; the upper right with downy; and the lower center is healthy. Note that downy mildew lesions are more clearly defined, more vivid, with sharper edges. Underneath downy infected leaves, you’ll see the "downy" white sporulation of the pathogen, corresponding to the lesions on top. Powdery mildew lesions have “blurry” or more diffuse edges, with sporulation on the top or bottom of the leaf.

Growers of susceptible cultivars do well to keep closely monitoring their vineyards for active sporulation and use that information in combination with the DMCast model on NEWA to determine if and when infection periods have occurred or will occur.

Leaves will remain susceptible all season, though they do become less susceptible as they age. For this reason, the limiting or elimination of new shoot growth by veraison, through good nutrient and/or canopy management, can help to reduce the supply of susceptible tissue in the vineyard during ripening and make post veraison control of this disease more manageable. Downy mildew was observed on new shoot growth, but not on mature leaves at older nodes, in late August-early September. There were at least two reasons for this: i) new shoot growth is more susceptible than older, mature growth, and ii) new shoot growth, unless just sprayed,
is unprotected or less protected by previous fungicide applications. Symptoms on mature leaves in late summer may appear different from those on young leaves in early spring.

The sight of active, white sporulation on green vine tissues means the downy mildew pathogen is capable of spreading quickly under wet conditions, and that sprays for downy mildew should continue, especially for susceptible varieties. Even humid nights that result in heavy dews by morning, can continue to fuel downy mildew development, generating fresh sporulation that can spread the disease rapidly when plant surfaces are wet. If you let downy mildew get out of control, it can strip vines of their leaves and in the worst cases, effectively end fruit ripening for the year, and shoot ripening for next year’s crop. Your grapevines go into winter dormancy in poor condition, and are more vulnerable to damage by severe cold, leading to crown gall and expensive trunk renewal the following season, with little or no crop to pay for it; all that stuff is connected, so you want to keep downy mildew under very tight control, especially on *Vitis vinifera*.

### Chemical control

Your list of chemical control options will start to dwindle as we get within 66 (Mancozeb products, Ridomil MZ), 42 (Ridomil copper), 30 (Ranman, Reason), 21 (Ziram), and finally 14 (Revus, Revus Top, Zampro) days of harvest. There is also the list of strobilurin containing fungicides that control downy, mainly Abound (not in Erie county PA) and Pristine. However, be aware that widespread resistance to strobilurins by the downy mildew pathogen has been documented in many places in the Northeast, and so this class of fungicides may not be among your best options. In the end, you’ll be left with Captan, copper, and phosphorous acid products (0-day pre-harvest interval), which have their own shortcomings, discussed below.

Products like Ridomil (the mefanoxam component), Ranman, Reason, Revus/Revus Top, Phos acid products, and Zampro, are more rainfast than the ‘old standard’ surface protectants like copper, mancozeb, ziram, and captan, but contain chemistries that are prone to the development of resistance. Therefore, they should not be used to put down an epidemic, which will only speed up the resistance development process. Even phosphorous acid products can be lost to resistance through repeated applications on a diseased vineyard, so keep downy mildew well under control. The resistance-prone materials (Ridomil, Ranman, Reason, Revus/Revus Top, Zampro, Phos Acid products) are best used to maintain a clean vineyard, not to put down an epidemic. Conversely, the surface protectants would be the least risky in terms of the development of resistance and can be an effective means of controlling downy mildew late into the growing season. Just be aware of seasonal limits, so plan ahead as best you can.

Here is a searchable database of pesticides that are used in vineyards. These materials can be searched by target pathogen, pre-harvest interval (PHI), active ingredient, and FRAC code. The PHI may come in handy at this point in the season. A reminder that the label is the law – be sure to follow it and know federal and state regulations.

Here are some precautions to consider with the use of the ‘old standard’ surface protectants:

- **Captan** is toxic to plants, and for that reason, is formulated to remain on the surface of the plant as a protectant. Tank mix partners, like oils, solvent-based insecticides, and emulsifiable concentrates, may enable captan to penetrate into plant tissues which can lead to plant injury. Therefore, oils and some liquid insecticides should not be applied with Captan or within 14 days of a Captan application. Check out this link from Rutgers. Always read the label carefully.

- **Copper** is poisonous to yeasts and that excessive copper residues at harvest can interfere with fermentation, and wine stability and quality. Unfortunately, it’s impossible to predict how high residues will be on fruit at harvest; that’s going to depend on the copper formulation (some of the newer coppers utilize lower copper concentrations, but may also be more rainfast), rate of material used, number and timing of applications made, spray coverage, and amount of rainfall from application to harvest. I am not aware of any information that establishes a nice, clean cut-off date or pre-harvest interval for avoiding excessive copper residues at harvest, but I have heard that cutting off copper use about a month before harvest may be sufficient in most cases.

- **There is also evidence that late Captan sprays can delay fermentation and have negative effects on wine quality, but the consequences seem less severe and irreversible than those associated with copper use. For more on this, consider this online article from Michigan State University.**

If you are protecting a non-bearing, young vineyard from downy mildew (you’re not selling/harvesting a crop), you can continue to use mancozeb products to control downy mildew past the 66-day pre-harvest interval. You can also consider using mancozeb after harvest to keep canopies clean of downy mildew and ‘firing on all cylinders’ until that first frost. The longer your vines can continue to produce and store carbohydrates after harvest, the better prepared they’ll be to withstand winter cold without damage (and the crown gall that follows).

In wine cultivars, especially those that produce tight clusters, a _Botrytis_ specific fungicide spray at veraison and about 2-3 weeks later can help manage bunch rots but will only be effective on _Botrytis_. In warm, wet harvest seasons, we can also see some sour rot caused by non- _Botrytis_ microbes that
cannot be controlled with Botrytis-specific fungicides. Fruit zone leaf removal applied earlier around/shortly after bloom can significantly reduce bunch rot development now in these cultivars. However, research has shown that the benefits of leaf removal tend to diminish the later it’s applied.

Work by Megan Hall and Wayne Wilcox at Cornell University shows that controlling fruit flies (with insecticides) during the latter part of the ripening period (beginning around 15 Brix) can significantly reduce sour rot development. Applying insecticides with sterilants or antimicrobials like Oxidate or Fracture can further improve control over insecticides alone. However, always rotate insecticide chemical classes to delay the development of resistance. Here is a recent fact sheet on grape sour rot from the Penn State Grape and Wine Team.

Rots and winemaking

More than seventy fungal/bacteria species are associated with bunch rot. Primary pathogens invade via natural openings or intact tissue. Only fungi are present in the case of bunch rots but secondary pathogens can also infect fruit. Secondary pathogens need a wound or injury to infect fruit. These secondary pathogens include fungi (yeasts/molds) and bacteria. Botrytis cinerea is the most common bunch rot pathogen of mature berries.

In addition, the breakdown of grape skin allows native yeast and acetic acid bacteria to grow potentially leading to sour rot. Sour rot results in preharvest cluster decay with the production of acetic acid (vinegar). Acetic acid-forming bacteria include Acetobacter spp. and Gluconobacter spp. which can result in volatile acidity and ethyl acetate. Note that Botrytis can be linked with sour rot but is more commonly linked with other fungi.

How much bunch rot can be tolerated? This depends on a number of things. Red wine quality is impaired by >5% Botrytis. Other factors include the type of rot, winemaking processes, and extended skin maceration. Laccase enzymes break down anthocyanins and proanthocyanidins. This can result in both color and palate structure decreases. In white wines undesirable aromatics such as oxidized/earthy aromas are produced.

If late-season bunch rots exist, here is an article on winemaking considerations and implications with rotten fruit:

- Fermenting with Botrytis 101

Winery preparation

Harvest is fast approaching, like it or not. With some careful planning, harvest does not have to be chaotic. Now is the time to go back and look at the 2020 harvest and identify areas needing improvement. The article Preharvest Planning and Winery Sanitation discusses proper harvest preparation as well as winery sanitation.

When to harvest?

Well… the answer to this question could, and often does, change with vintage. The simple answers – (1) when the buyer wants the fruit; (2) when fruit is "ripe" and "mature" and will create your targeted wine style; or (3) before fruit is extensively rotting and cluster integrity is greatly diminished. Vintage complicates this, as do many other factors. Historical experience with the cultivars grown at your site likely provides the greatest advantage relative to other factors that direct harvest decisions. The decision of when to pick relies on multiple factors that walk the line between harvest capability (which can be limited by cultivar, weather, labor availability, winery preparation, tank space) and fruit maturity (objective and sensory-based measurements). But, with only one shot at harvest until next year, the goal is generally to pick fruit to optimize chances of making the targeted, consumer-preferred wine. What is the "consumer-preferred wine"?... we will leave that for enologists, winemakers, and tasting room managers to discuss at another time.

From the Penn State Grape and Wine Team—best of luck to producers in Pennsylvania and the greater region for dry weather for the rest of the 2021 vintage!

Authors

Cain Hickey
Extension Educator, Viticulturist
cch5027@psu.edu
814-440-5534

Michela Centinari, Ph.D.
Assistant Professor of Viticulture
mzc22@psu.edu
814-867-0514

Bryan Hed
Research Technologist
bxh38@psu.edu
814-725-4601
Molly Kelly
Enology Extension Educator
mxk1171@psu.edu
814-865-6840

Flor Edith Acevedo
Assistant Professor of Entomology/Arthropod Ecology
fea5007@psu.edu
814-898-6000

extension.psu.edu

Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.

Where trade names appear, no discrimination is intended, and no endorsement by Penn State Extension is implied.

This publication is available in alternative media on request.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability, or protected veteran status.

© The Pennsylvania State University 2023
Code: ART-7285