Virginia Cooperative Extension
Virginia Tech • Virginia State University
www.ext.vt.edu

Viticulture Notes…..... Special issue. April 2020

Tony K. Wolf, Viticulture Extension Specialist, AHS Jr. Agricultural Research and Extension Center, Winchester, Virginia
vitis@vt.edu https://www.arec.vaes.vt.edu/arec/alson-h-smith.html

Spring frost.

While April is arguably one of the prettiest months in Virginia, it can also be one of the most disappointing for grape growers and other fruit producers who have to contend with spring frosts. April of 2020 has provided an abundance of frosty morning, particularly over the last 7 days. In many respects, the problems started well back in March; March 2020 was the 4th warmest March on record for many locations in central Virginia and the southern piedmont. We had a high temperature of 80°F at the AREC in Winchester on March 20th, while at the bottom of the state, Danville reach 85°F. While daily temperatures have fallen below normal into April, early budding varieties such as Chardonnay, Viognier and Cabernet franc were already out of the gate. Low temperature events occurred on April 11th, 16th, 17th and 19th. The morning of 22 April may see additional frost in some locations, although most of the lows appear to be in the mid- to upper 30s at this point. Low temperatures ranged from 26F to around 28F on the coldest mornings. Dew points in many locations were several degrees colder due to the dry air, and in some cases tender shoots escaped injury, even at air temperatures of 27 or 28°F.

It will take some time to fully gauge the impact of the April frosts, but here's a preliminary assessment of what we've seen, in bulleted form:

- The incursion of cold, Arctic air was far-reaching: major frost events occurred as far south as northern Georgia. Vineyards in North Carolina and Tennessee were also severely impacted, particularly on the mornings of 15-17 April.
- Sunday 19 April was the coldest event in many locations in Virginia. Many vineyards that had dodged frost on the earlier mornings suffered on the 19th.
- Most of the freeze conditions were classic radiational cooling events, with lower elevations sustaining lower minimum temperatures and greater frost injury than higher elevations. Slight winds, some cloud cover, and low dewpoints mitigated frost injury in some locations.
- Central and southern piedmont locations appeared to suffer greatest damage, with strong elevational effects. One Albemarle County vineyard, for example, noted severe injury below 900' asl, while no injury was observed in vineyard blocks above that elevation.

- Owing to differences in phenological development, Chardonnay, Cab franc, and Viognier were among the most severely affected vines, while Cabernet Sauvignon was generally unaffected.
- Similarly, the advanced phenological development of young vines (1st and 2nd year vines) often led to greater frost injury than observed on older vines in the same vineyard.

What's next? We've dredged back through past issues of Viticulture Notes for a narrative on how to deal with frosted vineyards. Here I freely self-plagiarize articles published in May 2002 and May 2010 Viticulture Notes. You can find these old Viticulture Notes here: https://www.sites.ext.vt.edu/newsletter-archive/viticulture/

What can be expected with frost-injured vines? Frost will produce variable levels of injury to vines, depending upon the degree and extent of injury, as well as the variety. Longer shoots might only be affected near their distal ends, and regrowth by lateral shoots can, in time, compensate for the loss of the primary shoot tip. There is no guarantee, however, that the flower clusters on such shoots are undamaged, or that they will set a normal complement of berries. But if the clusters remain turgid and are well below the point of apparent shoot damage, there's cause for optimism that some of this crop will ripen. In other cases, some shoots are damaged while others escape. Secondary buds will develop from frosted canes or cordons, but the net effect is two or more populations of shoots, each ripening their crop at different rates. Much of the variability in cluster development that is apparent now will translate into variability in fruit maturation. Unfortunately, the solution to this problem is to sequentially harvest the grapes as they ripen, meaning two or more harvest dates in the affected blocks, with pickers who are trained to visually recognize the differences in stage of fruit maturity.

Even when all shoots are completely frosted, vines will normally produce a second canopy from latent buds (this includes vines that were planted this spring). Depending upon variety, the secondary shoots may bear a partial crop, but rarely more than 25% of what the primary crop would have been. Varieties with extremely fruitful secondary buds, such as Seyval, may do a bit better.

Management of the vines during the course of the growing season may need to be adjusted in response to frost injury. The loss of crop is demoralizing of course and one might be disinclined to exercise the same level of pest management and canopy management that he/she would expend with fruitful vines. Remember though that the light environment and carbohydrate status of this year's shoots will determine bud fruitfulness in the following year. Shoot thinning and shoot positioning may still be necessary. The pest management schedule can be modified, depending upon the presence or absence of crop. Lacking crop, one could justifiable cut back on black rot and botrytis fungicides, as well as the grape berry moth sprays. It would still be important, however, to keep foliage free of the mildews and to avoid excessive Japanese beetle feeding. Unfortunately, a partial crop, if you wish to harvest it, will still require a full pest management program [see my comments near the end of the newsletter about "moth-balling" vineyard block(s)]. New growers, experiencing their first episode of frost, may be concerned about the long-term welfare of the frosted vine. There is no point in attempting to remove frost-damaged tissues from vines; the affected tissues will be

shed in time. And, unless the temperatures were very cold, it is unlikely that damage to the canes or cordons will have occurred.

Question from the field: [This was published in the May 2010 issue of Viticulture Notes] *Question. The lower portion of my 'Norton' vineyard was frosted twice this spring; once in late April, and again, more severely, on the morning of May 10th. What can I expect in terms of crop yield and crop maturation? Should I have rubbed off the damaged shoots?*

My condolences to you on the frost injury. To answer your second question first, No, I don't believe that you should have rubbed off injured shoots, although there could be a justification for this under specific conditions. Vineyardists have dealt with the consequences of frost since weather and vineyards have existed, so it's not surprising that someone took a methodical approach to looking at various vine management strategies following a frost event. Frost is rarely even-handed in the injury it causes, especially when air temperatures are at, or just below, the critical temperature required to initiate freeze events. Some shoots are totally scorched. Others are unscathed. Still other shoots may have their tips or only a portion of leaf area frosted, with the basal portions of the shoot, including inflorescences escaping injury. To simplify the response discussion here, let's just consider these three scenarios: A) totally destroyed shoots; B) healthy shoots, and C) shoots with injury to the tips and/or some degree of leaf area, but with apparently unaffected flower clusters. A first course of action would be to survey the frosted vineyard and determine the classification of injury and the pattern of injury within the vineyard. As you illustrated in your question, topography would obviously affect the pattern or incidence of injury within the vineyard, but also the severity of injury on a given vine.

In areas where a significant portion of the shoots are "A" (totally destroyed), most (possibly 75% or more, but varies by variety) of the current season's crop potential of these vines will have been lost. New shoots will emerge in time from base buds on cordons or from secondary buds in the compound bud of cane-pruned vines. Some of these new shoots will bear some crop. The amount of crop will depend on (i) variety, (ii) training system, (iii), exposure of the buds during their development, and (iv) general management of the vines in the previous year. Certain hybrid varieties, for example, can have very fruitful base buds. High training systems (such as GDC) tend to have somewhat more fruitful base buds than do low-trained (such as VSP) vines owing to the greater sunlight exposure of buds on high training systems. Canopies that were relatively thin and well exposed to sunlight in 2009 will likely have more fruitful base buds in 2010 than would canopies that were heavily shaded in 2009. Growers understandably feel a compelling need to do something, anything, to help vines that are totally scorched ("A"). Would the stripping of damaged shoots benefit the vine? With vines that have total loss of shoots ("A"), there would likely be no benefit to this strategy. Work in California (Winkler, 1933; Lider, 1965; Kasimatis and Kissler, 1974) suggests that while a positive response (slight crop increase) to stripping damaged shoots might occasionally be observed with some varieties (such as 'Tokay' in the Winkler study), the overriding result was no significant increase in yields. Furthermore, if the shoots were partially lignified at their point of attachment to older wood when the stripping was done (18- to 24-inch shoots), the manual breaking out of damaged shoots often damaged the base buds.

What about vines that have long shoots (24 inches or longer) that had their tops/tips frosted, but which appear to have unaffected flower clusters (what I called scenario "C", above). The consequence of this damage is difficult to accurately predict, but let's try. A damaged shoot will initiate one or more lateral shoots at nodes proximal (below) to the point of frost injury. We've all seen this response with shoots that were decapitated from grape cane girdlers, periodical cicada egg-laying, hedging, wind damage, or from a host of other reasons. The new leaf area of the lateral shoot(s) will compensate in time for the primary shoot leaf area lost to frost. However, the lateral leaf area may not develop rapidly enough to ensure good fruit set on the subtending clusters. We know from leaf pulling research that pulling leaves prior to bloom can cause small reductions in fruit set by depriving the vine of a source of carbohydrates at a critical time (bloom and fruit set). This can be good if we're simply trying to reduce cluster compactness. If the leaf area to flower ratio is greatly depressed, however, the reductions in set may be much greater than desired. There's not a lot you can do here – it simply takes time for the vine to re-foliate after a frost. But don't expect full set on shoots that are damaged in this ("C") fashion.

Vines that bear largely unaffected shoots ("B") will generally set and mature a normal crop. One could do some shoot-thinning (or cluster thinning) of these vines if/as fruitful secondary shoots appear in order to standardize the crop to primary crop only (see following discussion).

The above discussion focuses primarily on the **yield response** of frosted vines. What can you expect in regards to **fruit ripening**? It's easier to predict the ripening pattern of vines that have completely destroyed shoots ("A") than it is for vines that have partially destroyed shoots ("C"), or those that have a mix of healthy ("B") and damaged shoots. The clock is reset for vines that have lost all shoots to frost. Base and secondary buds will eventually produce a full canopy of leaf area, assuming that temperatures were not so cold as to cause vascular injury. This "second" flush of canopy will have some crop, depending on variety, etc., and this crop will ripen in a generally predictable fashion. It will, however, reach commercial maturity somewhat later than a normal crop owing to the fact that budbreak of the second canopy was more than a month later than the original budbreak. On the positive side, it will be a lighter than normal crop and this will accelerate ripening to a point.

The picture is muddied for vines that bear a mix of destroyed ("A"), damaged ("C") and perfectly healthy shoots ("B"). Here we have two or more discrete populations of fruit that differ in the onset of ripening, if not the rate of ripening. The populations may be mixed on the same vine, and will very likely differ within sections of the vineyard due to topographic impacts of the vineyard on frost incidence. What is the predicted outcome for such vines? Mardi Longbottom described such a situation that occurred in Coonawarra Australia following a frost in 1998. Her description can be read in the July/August 2007 Viticulture Notes. In sum, Mardi found that the two populations of fruit (primary shoots vs. secondary shoots) did indeed have large differences in Brix at veraison. Those differences tended to converge with ripening, however, and the crops were ultimately picked at the same point in time. They had decided not to drop one or the other crop in advance, which was a gamble, but it paid off for them (quantity-wise, anyway) to harvest the sum of the two crops. Lider (1965) reported a

similar pattern of Cabernet Sauvignon maturation in the Napa Valley, with the crop on primary shoots running about 3.0°Brix greater than that of the secondary crop in the week prior to harvest on differentially frosted vines. Lider's advice to differentially sample affected portions of the vineyard makes as much sense today as it did 45 years ago. Seasoned growers know that vineyard topography, variation in vine capacity, and soil characteristics can affect the rate of crop maturation and will stratify their vineyard sampling (and harvest) accordingly. Variable frost damage adds another layer of complexity to this sampling approach. What are your options? One potentially compelling reason to strip off both uninjured and partially injured shoots on frosted vines is that it resets the vine to a common crop ripening sequence, and avoids the asynchrony described above. The negatives are three-fold: (i) you will further reduce yield potential; (ii) you might push the ripening end-point beyond what your site/variety/season mix can adequately ripen; (iii) and it incurs a labor expense. In the case described with the leading question, you are starting with a very late-ripening variety (Norton) in a site that has shown its potential for frost damage. If, on the other hand, you had a variety such as Seyval, that has very fruitful base buds, and which ripens early, completely shoot-thinning a partially frosted vine would make more sense (if done immediately after the frost, not a month later!).

Fast-forward to April 2020: Some other general considerations of frosted vines: First, never give up. Even heavily frosted vines may bear a nominal – even "adequate" crop. Secondly, never say "never". What's that supposed to mean? Well, this year (2020) is decidedly different for many businesses due to the coronavirus pandemic. If there were a year when "moth-balling" a vineyard block to cut costs might make sense, this would probably be it. Not having crop on the vines would allow for a much lighter fungicide and insecticide program, as well as a "canopy management-lite" approach. More on that in a subsequent newsletter. Light crops on otherwise high-capacity vines can lead to overly vigorous growth, necessitating perhaps some added labor in shoot hedging. Go easy on the fertilizer if the crop is dramatically reduced.

I tell beginning grape producers that the best of growers in the best of sites should expect a weather- or disease-related loss of crop once in 10 years (drought, hail, excess rain, frost, winter injury, disease). If you beat those odds, consider yourself lucky. A final recommendation would be to reflect on this frost event and consider options for future episodes. If this is a once in a decade event for you, you're still doing well. Perhaps some revision of the vineyard layout should be part of the future strategy if portions of the vineyard are being routinely frosted (spring or early fall frost).

Again, it's too early to tell the full extent of these April frosts – and look, we're not completely out of the woods yet with respect to the potential for further frost events this spring. Preliminary indications are that a significant crop loss occurred throughout much of the state. In Virginia, mechanisms for dealing with meteorological disasters, including provisions for lessening the stringency of in-state grape purchase by Virginia farm wineries, may be enabled once the damage is locally assessed and collated by Farm Services Agency (USDA) and local authorities (including Virginia Cooperative Extension). I encourage you to document the extent of visual damage in blocks now, and also document crop loss assessed at harvest,

relative to benchmark years such as 2019. If you have crop insurance, you will need to communicate with your insurance policy writer to file a preliminary crop loss statement (https://www.rma.usda.gov/-/media/RMAweb/Publications/Risk-Management-Publications/how_to_file_a_claim.ashx?la=en)
I would also encourage you to communicate the extent of damage with your local Cooperative Extension office. This will be important as local governments assess the extent of damage to the fruit industry.

I thank a number of growers located throughout Virginia who are part of the nascent "sentinel vineyard project" for providing an early assessment of vine development and frost injury for this preliminary report.

Literature cited:

Kasimatis, A.N. and J.J. Kissler. 1974. Responses of grapevines to shoot break-out following injury by spring frost. Amer. J. Enol. Vitic. 25:17-20.
Lider, J.V. 1965. Some responses of grapevines to treatment for frost in Napa Valley. Amer. J. Enol. Vitic. 16: 231-6.
Winkler, A.J. 1933. The treatment of frosted grape vines. Proc. Amer. Soc. Hort. Sci. 30:253-7.