Last Week's Frost Damage Update

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Current situation: The month-long stretch between mid-April to mid-May is the typical frost threat period from southern to northern Ohio, respectively. Vineyards almost dodged the bullet without frost injury this year until last week. On May 8th and 9th, minimum temperatures hovered around or dropped below 32°F in several locations in Ohio. At that time, all grapevines had already broken buds and/or reached shoot growth of more than 12" long. Since the new growth is sensitive to temperatures just below freezing, several varieties, exposed to those temperatures, sustained injury. Table 1 shows the lowest temperatures (27.7°F to 36.9°F) recorded on May 8th at OARDC stations throughout the state. It appears that the northeast and southwest regions experienced the coldest temperatures. Reports of injury to grapevines also corresponded to those areas. Since the May 8th event was a radiative frost, its impact was sporadic and localized rather than widespread.

Table 1.

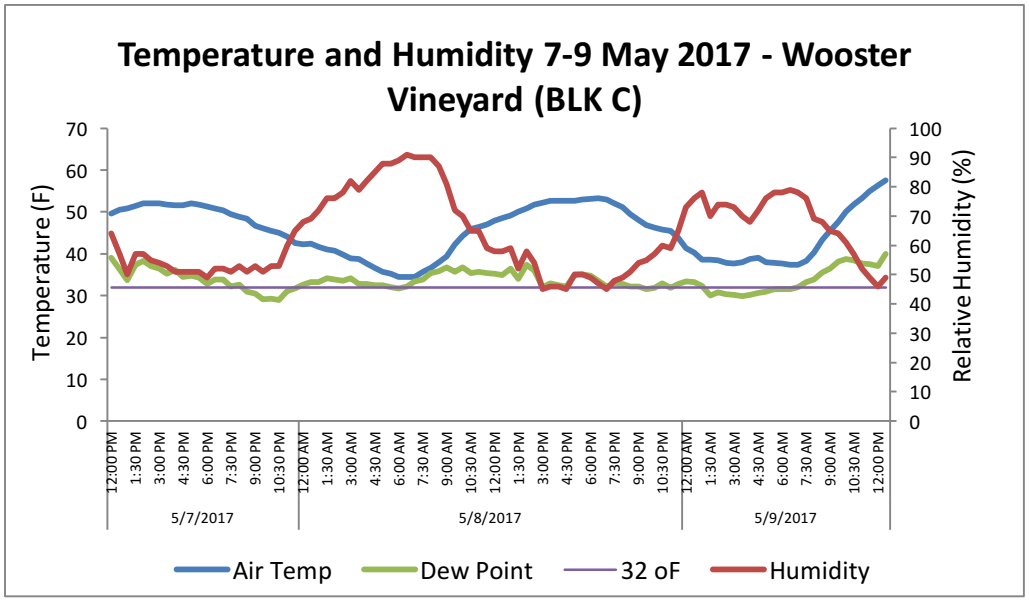
Region/County (City)	Station Name	Date	Min. Temp. (°F)	Date	RH (%)	Dew Point (°F)	GDD (1 Jan to 7 May)
North East							
Ashtabula (Kingsville)	Ashtabula ARS	5/8/17	30.6	5/8/17	94.7	23.9	206
Lake (Perry)	Perry Station	5/8/17	32.3	5/8/17	92.4	30.3	266
Wayne (Wooster)	OARDC – Wooster	5/8/17	29.7	5/8/17	96.5	28.8	314
Lorain (Avon)	Avon Station	5/8/17	34.7	5/8/17	96.1	33.7	278
North West							
Huron (Willard)	Muck Crops ARS	5/8/17	31.3	5/8/17	93.6	29.7	290
Sandusky (Fremont)	North Central ARS	5/8/17	35.8	5/8/17	72.5	27.8	261
Wood (Custar)	Northwest ARS	5/8/17	33.4	5/8/17	78.7	27.5	258
Central							
Franklin (Columbus)	OSU Campus	5/8/17	36.9	5/8/17	68.6	27.6	469
South East							
Jackson (Jackson)	Jackson ARS	5/8/17	30.5	5/8/17	94.5	29.1	510
South West							
Clark (Charleston)	Western ARS	5/8/17	27.7	5/8/17	88.7	24.8	354
Pike (Piketon)	OSU South Centers	5/8/17	29.7	5/8/17	96.5	28.8	527

At the research vineyard in Wooster, the temperature logger recorded 34.4°F on May 8 and 37.7°F on May 9. Hence, none of the varieties sustained any damage (white frost was observed on the ground though). I would like to use this moment to revisit some concepts and facts about frost, injury, factors impacting injury, and post-injury management practices.

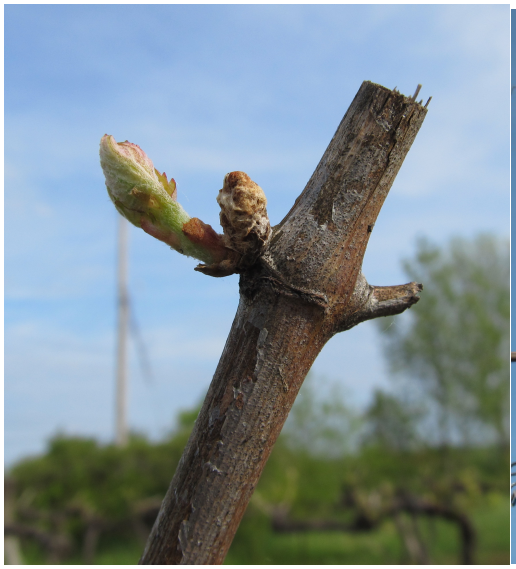
Critical temperature (CT): is defined as the temperature that causes damage after exposure for 30 minutes. Typically, CT is reported as the temperature that causes 10%, 50%, or 90% damage of buds or young shoots. During deacclimation, grapevines become increasingly sensitive to temperature below freezing (32°F) and CT varies with the stage of bud development. That is, buds become more sensitive as they grow in early spring. The following is an example of critical temperatures that cause 50% damage of grape buds and young shoots in Concord (

Stage of development:	Critical temperature:
Swollen bud stage	26°F
Bud burst (break)	28°F
First unfolded leaf	28°F
Second unfolded leaf	29°F
Fourth unfolded leaf	30°F

CT also varies with weather conditions including air relative humidity and corresponding dew point. Dew point (DP) is the temperature at which water condenses out of the air as dew or the temperature that corresponds to 100% relative humidity. Condensation releases heat and slows the drop of air temperature. Thus, if DP is higher than CT, heat will be released before reaching damaging temperatures and may provide some protection. If the air is dry, DP is low and temperature will drop rapidly and may reach CT and thus cause more damage. Last week's event is a white frost, characterized by a high relative humidity, which means that DP temperature was close to air temperature (see figure below). The wetness of grape shoot tissues may have worsened the extent of damage since wet conditions lead to ice nucleation at warmer than cooler temperature (by preventing supercooling).



Frost damage symptoms: If leaves are already apparent and they are damaged they first look water-soaked, oily, and droopy. In a day or two and when it warms up again, the small shoots turn brown and crispy. Swollen buds in a wooly stage are difficult to assess visually. However, by touching the buds you could feel they're crispy, crunchy, and brittle and fall off readily.



Shoots are frosted, what now?

I know it is human nature when we face a crisis or an issue like this, we are anxious and can't help it and want to do something, anything to remedy a situation. In this case, what to do with damaged shoots? I've read the very few reports on managing vines after frost damage and the information is mixed and not consistent. In other words, there is a need for more research on this topic (just like what we experienced with the polar vortex in 2014). I will summarize the different situations reported in California, Virginia, Australian, and New Zealand. In any case, growers need to decide on a strategy: 1) focus on getting any yield from frosted vines this year, or 2) sacrifice some/more yield this year for the benefit of next year's crop. Also, growers should weigh in the cost of labor involved to remove damaged shoots against the gain of crop salvaged (i.e. is the extra labor worth it?). Having said that, I know most of our growers do not conduct shoot thinning. This is the year to do it if you have damage so shot thinning will be done to remove damaged shoots and adjust shoot density at the same time.

1. Damage at early stage of bud development (e.g. buds well to 1-leaf open): in this case, do nothing and young shoots should be left alone. Rubbing off injured swollen buds would risk damaging the remaining secondary buds. Remember grapevines have compounds buds. If the primary shoot is damaged, then the secondary will grow with 30-70-% crop potential.
2. Damage of more developed shoots with no visible clusters (inflorescences): work in CA showed that cutting (pruning) the damaged shoots at the base was better than rubbing off (removing by hand) the shoots or doing nothing. It appears that the benefits of this practice are variety-dependent since Chardonnay benefited more than Cabernet Sauvignon.
3. Shoot tips are damaged but clusters (inflorescences) on primary shoots are not damaged: clusters from primary shoots may survive and continue to grow. While vines are recovering, clusters may also be produced from laterals and secondary shoots. This creates the situation of two sets of clusters that may be different in development by 2-4 weeks. In Australia, at harvest time, the maturity difference between

the two sets of fruit was negligible. However, this may be tricky with late ripening varieties (e.g. Cab franc) in a short season in Ohio. On the other hand, removing all secondary clusters may promote a more vegetative growth thus undesirable vine balance and fruit quality. This is a situation where growers have to wait and observe fruit development of each variety and the warmth of the growing season and then adjust (or not) the crop accordingly.

Other tips to consider during the season:

- First, do not panic! Things may look worse now than few months from now. Grapevines have an amazing way of recovering and compensating for yield. Also, the percent of damage does not equate the percent of crop loss.
- The best way to **assess crop potential** in 2017 is **after fruit set** when the clusters are visible. Cluster number per vine should give you an idea about percent cluster number loss. Please check this link to estimate your crop: ohioline.osu.edu/hyg-fact/1000/pdf/1434.pdf.
- Whether the damage is severe or not, you **should not discontinue your disease and insect management program**. You need to keep the vine canopy (shoots, leaves, and fruit) healthy.
- Fertilization: if the damage is severe and only fruitless shoots recovered, this situation may lead to excessive shoot growth and vigor. You should **avoid nitrogen fertilization**. If the damage is minimum and a normal crop is expected, continue a normal fertilizer program. If you practice split application of nitrogen (N), skip the first one and then, based on the fruit to shoot growth, decide whether to apply the post-fruit set N application.
- Canopy management: due to excessive foliage and resulting shading you may need to be **more aggressive with your canopy management** practices.
- Disaster Assistance: **Contact your local USDA-FSA (Farm Service Agency)** and report to them your crop loss. It is important that you record the extent of damage you have, in case some assistance program becomes available.

Food for Thought - Things to keep in mind:

- Generally, varieties bear fruit on shoots originated from primary buds. Some bear fruit from secondary and base buds. Examples include hybrids such as Seyval, Vidal, Dechaunac, Chancellor, Foch, Baco noir, and Marquette. Secondary and base buds of Vinifera and juice grapes (e.g Concord) are not as fruitful and thus may sustain more crop loss than French Hybrids.
- Early frost can be advantageous for secondary clusters to develop larger. Even primary shoots can still develop and produce a crop. In 2016, we had a great summer with plenty of sunlight and heat. Those conditions are ideal for high fruitfulness of buds this year. You may be surprised by a normal crop.
- Some growers reported the use of oil (Stylet or Amigo) with different level of success. Some had bud break delay, others did not observe it. In any case, oils would not be effective in this situation since all varieties already broke buds by the time the frost event occurred on May 8th.
- Many also reported using KDL, just before (24-36hrs) the frost event. Unfortunately, all reported no impact of KDL on preventing or reducing frost injury. It is clear that KDL needs further research to investigate its effectiveness.
- Growers used various cultural practices to protect against the frost including high training system, double pruning, mowing the grass, and cultivation of row middles. The success was not as dramatic and obvious as with that observed in good sites or where wind machines were used.

References and additional resources on spring frost and management in grapes:

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"Devastating Frost Hits NE Ohio Vineyards": www.oardc.ohio-state.edu/grapeweb/images/OGEN_1_June_2010mbp.pdf

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