CFAES

OHIO GRAPE-WINE ELECTRONIC NEWSLETTER

Edited by: Dr. Maria Smith

April / 2020

Photo: Early bud break variety 'Marquette', Georgetown, OH on 08 Apr 2020. Photo credit: Phil Weber

IN THIS ISSUE:

2020 Spring Freeze

The 2020 growing season commenced at the end of March for southern Ohio and late April for northern Ohio. Due to a major cold snap in mid-April, many growers experienced freeze injury to emerging shoots in the South. We have provided a recap of those events and a guide on how to proceed in this issue of OGEN.

For wineries, Todd Steiner has provided guidance towards managing wine oxygen during bottling.

Lastly, if you grow grapes and have not yet responded to the 2019 Grape Production and Pricing survey, please do so. It will be open until **May 15, 2020**.

-Maria and the OSU V&E team

Vineyard management following the April 2020 spring freeze events

By: Imed Dami and Maria Smith, HCS-OSU

Following a mild winter, early bud break grape varieties across southern Ohio suffered shoot injury following several days of below freezing temperatures during the week of April 12, 2020.

April freeze events across the state

Several days of below freezing (32°F) temperatures arrived during the week of April 12, with the coldest temperatures occurring on the morning of April 16, 2020 (**Table 1**; **Fig. 1**). On April 16, temperatures across the state ranged between 25.3°F at Piketon in south-central Ohio to 29.5°F in the northeastern Lake Erie region (**Table 1**). These below freezing events were the result of temperature inversions (i.e., temperatures increasing with height from the ground) formed during consecutive **radiative freeze events.** These events are characterized by calm, clear overnight conditions, thus differentiating them from wind-driven advective freeze events. Early budding varieties that had surpassed bud break or were at a more advanced in shoot development sustained the most severe damage.

Statewide, the probability (50%) for the last date of spring freeze is not until mid-May. Although the likelihood of freeze diminishes as we get closer to that date, we are not out of the woods yet.

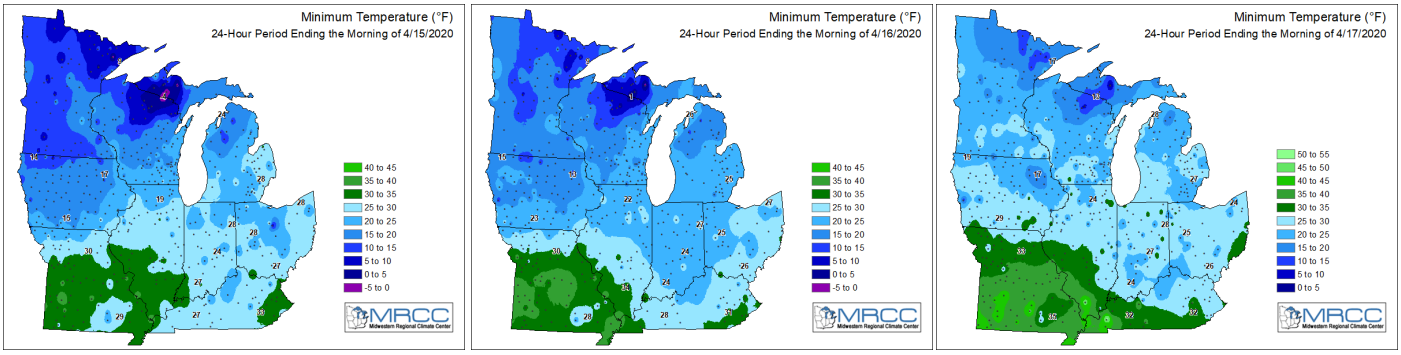


***Figure 1**. Minimum temperatures for Ohio and the Midwest region from 15 Apr 2020 (left), 16 Apr 2020 (center), and 17 Apr 2020 (right). Maps obtained from https://mrcc.illinois.edu/cliwatch/DLY_LT_MAPS.htm#*

***Table 1**. Ohio regional minimum temperatures for 15 Apr through 17 Apr 2020.*

		Date		
Region	Location[1]	15 Apr	16 Apr	17 Apr
Southwest	Cincinnati	26.0[2]	26.0	43.0
South-central	Piketon	24.1	25.3	38.8
Southeast	Caldwell	25.7	27.5	31.8
West	South Charleston	28.8	26.2	25.7
Central	Columbus	27.3	27.1	25.7
Northeast	Wooster	24.6	25.9	28.6
North-central	Berlin Heights	28.4	25.9	30.2
Northwest	Defiance	27.0	26.0	33.0
Northeast	Geneva	29.6	28.5	26.9
Northeast	Kingsville	30.9	29.5	29.1

[1]Temperatures retrieved from https://newa.cornell.edu
[2]Temperatures are in °F

April 2020 spring freeze (cont.)

Factors affecting freeze injury

Phenological (developmental) stage: during deacclimation in March and April, grapevines become increasingly sensitive to below freezing (32°F) temperatures. **Critical temperatures** (CT), defined as the air temperature that causes 50% damage after exposure for 30 minutes, vary with the stage of bud development (**Table 2**). As buds grow during early spring, they become more susceptible to injury at increasing temperatures.

Phenological (developmental) stage	Estimated critical temperatures (CT)	
	°F	°C
Dormant	6.8	-14
Swollen bud stage	25.9	-3.4
Bud break	28.0	-2.2
First leaf unfolded	28.4	-2.0
Second leaf unfolded	28.9	-1.7
Third leaf unfolded	29.8	-1.2

Table 2*. Estimated critical temperatures for Pinot noir at different stages of bud/shoot development (Gardea, 1987)*

Weather conditions: 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.

Variety: early budding varieties are more susceptible to spring freeze damage. For example, Marquette, La Crescent, Concord, Chardonnay break buds early in Ohio and thus tend to be sensitive to spring frost. Late budding varieties such as Vidal rarely sustain frost damage. Varieties bear the highest fruit yields on shoots originating from primary buds. However, some bear fruit from secondary and base buds. Secondary and base buds of Vinifera and Native grapes are not as fruitful and may sustain more crop loss than Hybrids. In general, secondary buds may produce 30-50% of the crop potential, but this may be higher or lower depending on the variety (**Fig. 2**). Tertiary buds typically are not fruitful.

What to do after a freeze event?

- ***First, do not give up!*** Grapevines have an amazing way of recovering and compensating for yield. Also, the percent of damage does not equate to the percent of crop loss.
- Regardless of the damage severity, you **should not discontinue your disease and insect management program**. You need to keep the vine canopy healthy.
- ***Fertilization***: if the damage is severe and only fruitless shoots recover, this situation may lead to excessive shoot growth and vigor. **You should avoid nitrogen**

Figure 2*. Frosted shoot and new shoot emergence from the spur base bud. Photo credit: archive from Imed Dami.*

April 2020 spring freeze (cont.)

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. This practice will vary with the level of freeze damage and variety. Like any other vineyard operation, it comes down to practice cost and the "well-being" of the grapevine. Sometime, the two factors do not go together. It is up to the grower to decide which way to proceed. Since there are many scenarios to consider that are dependent on the type of freeze damage (partial or complete) and variety,

  Provided below are two specific examples of canopy management based on reported research in Indiana and California.

  1. ***Our colleague, Dr. Bruce Bordelon at Purdue University, conducted a trial to manage several hybrids after a freeze event that caused partial freeze damage. Damaged shoots were either pruned (shoot or spur) or left intact (untreated control). With Marquette, pruning damaged shoots resulted in increased yield and better cane quality (size) the following year.***
  2. ***Glenn McGourty, a past OGWC speaker and viticulturist at UC Davis, conducted a similar trial with Chardonnay. He also found that removal of damaged shoots resulted in higher yield. Fruit ripening was delayed, but fruit quality was unaffected. In both situations, there was added labor to remove damaged shoots (20 to 30 hrs/acre). However, the extra cost in the year of frost damage was justified with less labor for pruning the following season and better cane quality. Basically, a severe frost year was a good year to "clean up" old cordons for new spur development.***

  If you have a specific situation and undecided how to proceed, please do not hesitate to contact us.

- ***Disaster assistance***: **contact your local USDA-FSA** (Farm Service Agency; https://www.fsa.usda.gov/state-offices/Ohio/index) and report your crop loss. It is important that you record the extent of damage you have, in case some assistance program becomes available.

REMINDER! 2019 Ohio grape production and pricing survey.

By: Maria Smith, HCS-OSU

Reasons to establish a grape price index for the Ohio wine grape industry

Generating an aggregated pricing index for Ohio-grown wine grape varieties can help towards guiding profitability, and here's how:

- Ensure growers are not missing out on profits compared to regional and national pricing trends
- Provide accurately estimated revenue loss for vineyard insurance claims
- Understand long-term trends in Ohio grape production and value
- More precisely estimate how grape prices might change with various vineyard management practice use

Updates regarding the 2019 survey

Once again, we are seeking your participation in the 2019 Ohio grape pricing and production survey. This survey will be used to provide a state-wide perspective on the size, diversity, and value of the Ohio grape industry following the 2019 growing season.

We have updated the 2018 survey (https://ohiograpeweb.cfaes.ohio-state.edu/grape-growing/2018-ohio-wine-grape-production-and-pricing-index) to reflect industry feedback. Please see the following information for answers to common questions in 2018 and updates to the 2019 survey below:

- No vineyard is too small to participate and all growers provide a valuable contribution
- Yes, please fill out the survey regardless if your fruit was sold. Your production information alone is meaningful to our data set
- If you ***did not sell fruit***, please leave the price category as "$0"
- Please calculate your yield in ***tons***
- We have included categories for prices of juice and bulk wine, if fruit was processed prior to selling

The 2019 survey will be open from **April 6 through May 15, 2020**, with distribution provided through our Ohio grape producer contacts list. For any questions or a link to the survey, please contact Maria Smith at smith.12720@osu.edu.

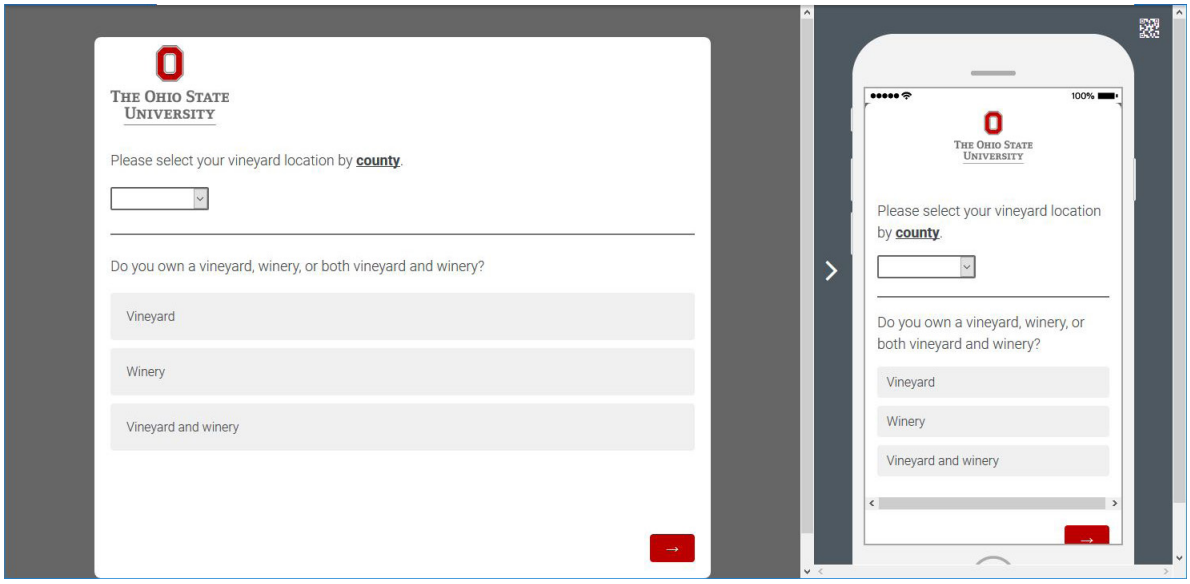


Photo: 2019 Ohio Grape Production and Pricing Survey preview, desktop version (left), mobile (right)

OARDC-Wooster April vineyard update

By: Diane Kinney and Imed Dami, HCS-OSU

Due to the COVID-19 pandemic and for the safety of employees, on-site work restrictions have been imposed by the state of Ohio and our university. As a result, field work has been limited unless approved by the Dean of our college. Under these circumstances, our field activities have been restricted with some delays on vineyard practices (such as pruning, see below). 2020 season.

Spring freeze

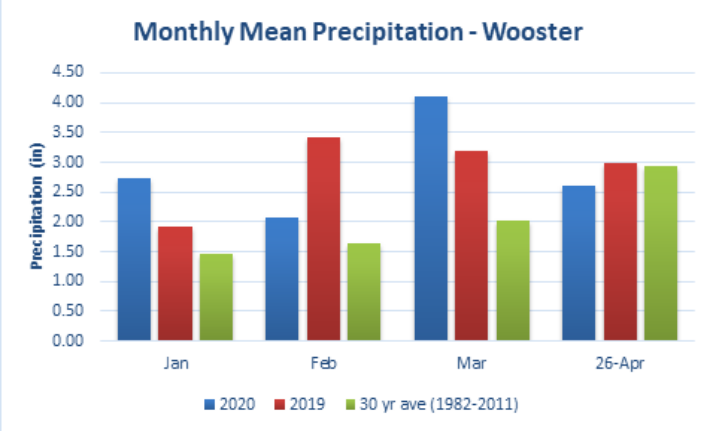
As published in the April 17th Special Edition, southern Ohio suffered a severe spring freeze on April 15-16th. Our Wooster vineyard experienced a low temperature of 24.6 °F. Fortunately, we had no bud break at that time and thus no injury was sustained even with our earliest budding varieties. Check this link for the full article with suggestions on frost protection mitigation methods: https://ohiograpeweb.cfaes.ohio-state.edu/sites/grapeweb/files/imce/pdf_newsletters/Frost%20event%20Apr%202020_special%20issue%20OGEN_2.pdf. Please contact Dr. Imed Dami (dami.1@osu.edu) or Dr. Maria Smith (smith.12720@osu.edu) for more information on spring freeze protection.

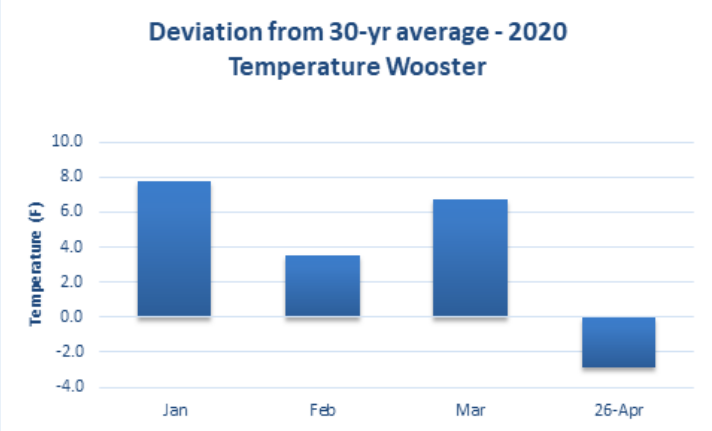
Grape Phenology

As of April 26th, only 75 GDD accumulated (half of normal) over the month due to cooler than normal conditions. This resulted in no bud break among all varieties grown at the research vineyard in Wooster. At this time in 2019, nearly all Minnesota varieties had reached 50% bud break. This delay of bud break has provided a double relief for us: no freeze injury and time to catch up with pruning.

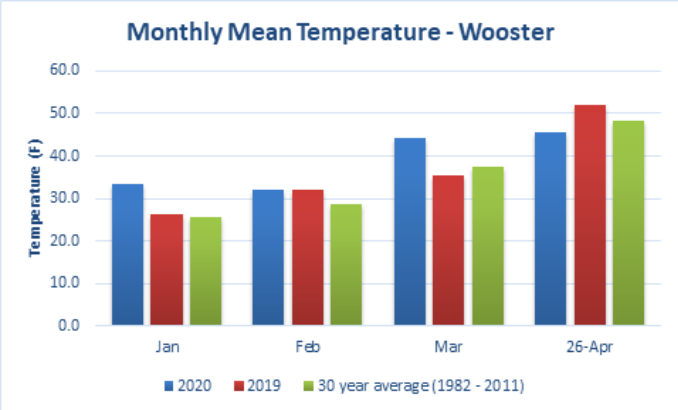
Weather

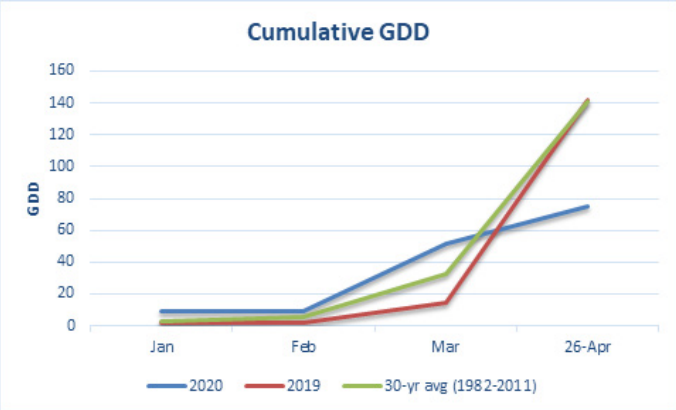
Precipitation for April has been a bit lower that the 30-yr average, but in late March, we experienced heavy rains, resulting in cumulative precipitation similar to 2019 (about 3.5" above normal). The warmth gained in March was negated by a cold April with several below freezing events, the latest at 29.6 °F on April 22nd. The cumulative GDD were only 75 vs 142 in 2019 and 141 for the 30-year average.





OARDC-Wooster update (cont.)





Cultural Practices

As mentioned above, our farm crew is continuing to prune and train vines. A second spay of Sulforix was applied in April. We are also ready to apply postemergence herbicide (e.g. glyphosate) before soil- dehilling of grafted vines.

TO: All Ohio Commercial Wineries

FROM: Todd Steiner, Enology Program Manager and Outreach Specialist

DATE: April 30, 2020

SUBJECT: **COVID 19 Response Update – Additional Cellar Practices**

This letter comes with the hope and prayers that each of you continue to be safe, healthy and able to cope during these challenging times we have been dealing with involving COVID 19 and its repercussions. I am simply providing an update from information sent nearly one month ago.

I am hopeful that the Ohio economy and travel restrictions will be able to open up shortly in a healthy way to help all wineries pick back up in retail sales in addition to continuing your focus on innovative and unique ideas of creative wine sales which many have applied during these troubling times. Hopefully, wholesale accounts will continue to increase for those moving in this direction and consumers will purchase Ohio wine to support our industry.

I am sure it will take some time to get back to a more “normal” reality and budget recovery for our industry. It is with high hopes that our wineries will be in a position soon to bring a majority of furloughed or laid off personnel back to work in our operations. We have a great industry with wonderful people and feel the need to get back to important vineyard and winery options in producing some of the high quality, premium wines we have been getting recognition for the past number of years.

The Ohio State University (OSU) is in a similar position as last indicated. We took a proactive early stance with COVID 19 by implementing practices with the goal of limiting the potential spread of this disease and continue our efforts in these areas. We continue to provide online/virtual classroom teaching with students being off campus. All OSU activities and events are cancelled through July 6, 2020 with none being scheduled until that time or further notice. All University travel that is not critical to COVID 19 is denied through at least June 30, 2020.

Other directives provided through President, Michael Drake, Dean, Cathann Kress and other Senior OSU Leadership continue to be in place in providing critical measures to further reduce the spread of COVID 19 to faculty, staff, students and citizens of Ohio. Faculty and staff continue to telework in performing new and innovative ways in handling research and extension functions during these challenging times.

In regards to the enology program, I am continuing to focus on the drafting of a wine production guide in addition to taking many phone calls, e-mails, texts and a few Zoom calls in providing support and consultation to wineries regarding winemaking activities and best practices during this time. Therefore, please reach out to me via cell at: (330) 464-2239 with any wine quality control issues or questions you may have during this time. These contact sources provide a great way to touch base since we are restricted in performing site visits at this time.

Last month I sent out an initial industry response to COVID 19 containing some essential aspects to monitor in the cellar to maintain wine quality while you are also dealing with many other important issues involving your business.

Some important procedures to monitor and maintain that were mentioned included proper monitoring of sulfur dioxide levels, visual inspection of tanks and barrels for headspace and microbial activity, sensory evaluation and cellar temperatures. These are still critical procedures to follow currently through bottling.

As we get further into spring it would be good to investigate blending and fining for further quality improvement. It is important to fine tune our wines through blending and fining in the development of the final product and allow enough time for both chemical and microbial stabilization after these applications. Planning enough time for finishing operations prior to bottling in late spring or summer provides available tank space for the upcoming vintage.

With the hope that Ohio will be opening again soon in different phases, we need to make sure our wines are sound in terms of quality and express excellent sensory attributes. Several components are listed below which will be important to address at this time prior to bottling.

Fining: The term "fining" of wine is used to describe several different additives/procedures to add an adsorptive or reactive substance to reduce or remove the concentration of one or more undesirable components. Essentially, it can be employed to remove unwanted juice/wine components that affect clarification, astringency, color, bitterness, and aroma. It can work for both red and white wines. Although blending can be a wonderful tool for improving wine quality, many fining techniques are designed to go beyond the expected benefits of blending. Fining can represent those extra techniques that can make the difference between commercially acceptable and wines of premium quality or remedy a faulty wine to commercial acceptance. If observed on a consistent basis across vintages, it can also represent an indicator that there may be a problem in the vineyard or cellar.

It is critical to perform sensory evaluation in terms of identifying any perceived improvements to clarity/color, aroma, flavor and texture that can be made via fining products. The categories listed in (Table 1) below include several fining agents and additives which may offer a good starting approach to help correct or fine-tune your wine for improved consumer acceptance. As an example, in case of harsh or excessive tannins in red wine, it may be worthwhile to perform fining trials with egg albumins or Gelatins to help soften the wine in making it more approachable on the palate. The addition of tannins may also help increased mouthfeel from wines that lack both body and intensity on the palate. For wines containing excess H_2S concentrations, copper sulfate may be required for reduction of these compounds.

Table 1. Potential Fining Agents or Additives for Wine Improvement

Color/Clarity	Aroma	Flavor	Texture
Casein	Copper	Acid	Tannins
PVPP	Casein	Sugar	Egg Albumins
Gelatin	Isinglass	Concentrate	Gelatins
Yeast	Yeast	Carbon	Isinglass
Carbon	Carbon		Yeast
			PVPP
			Carbon

Any time fining of wine is recommended or practiced, fining trials should always be performed first prior to cellar applications. These trials should make every effort to make sure preparation methods, temperature, mixing and timing should all be like cellar applications. Significant reduction in fining agent effectiveness can be the result of improper preparation. Many fining agents react quickly in wine depending on the mixing procedure, recommended contact time or reason to fine. Fining agents may be removed from the wine through racking and filtration. In some cases, counter-fining will help provide the quickest removal and clarity of certain fining agents. Contact time can vary from a couple of hours to several weeks depending on the type of fining agent, procedure and expected result.

Blending: No matter what procedures we perform in the cellar to help achieve desirable varietal flavor and aroma expression it would be expected that blending will play an important role in the production of a quality wine.

Blending or Assemblage can be a powerful tool that can pull together strengths and weaknesses from each variety or lot with the goal of increasing wine quality in the final blend. It is also important to create a wine which will fit your market, image or define your winery style.

Some of the main reasons to blend are to create premium wines such as: Bordeaux and Meritage-type blends, Champagne cuvées, Rhone-type blends, Tuscan blends, proprietary and Eastern blends. It is also useful for enhancing neutral, non-descript wine in aroma, taste, mouthfeel, balance, finish or color. Blending is a tool that can also offer an option in correcting slight deficiencies or flaws present in addition to making commercially average wines better in terms of quality and sensory appeal. Blending may also be important in developing consistency from vintage to vintage in providing consumer acceptance and recognition.

In performing both fining and blending techniques for further improvement of our wines, it is vital to make sure our wines are stable in terms of both protein and cold stabilization prior to bottling. Wines should also be adjusted for sulfur dioxide content based on wine pH and wine style as well prior to bottling.

Oxygen Management: Although dissolved oxygen has beneficial aspects associated with essential yeast propagation, healthy fermentations and some potential benefits from cellar practices like hyper-oxidation and micro-oxygenation, generally the presence of excess dissolved oxygen after primary fermentation causes a reduction in table wine quality.

Excess oxygen can dissolve into our wine during key winemaking processes becoming a real concern for chemical oxidation in addition to microbial and shelf life stability issues. Critical cellar practices involving movement of wine include racking, filtration and pumping all pose a threat of excess oxygen entraining in our wine. The use of an inert gas is essential in purging hoses, tanks and blanketing headspace lowering the amount of oxygen from dissolving into our wines during these procedures.

Cold stabilization also provides a threat for higher amounts of oxygen dissolving into our wine due to lower temperatures. Oxygen will dissolve more readily at lower temperatures with the rate of chemical oxidation occurring faster at higher temperatures. This makes it important to have the correct sulfur dioxide concentration in our wine based on wine pH to help bind excess oxygen in addition to having no headspace going into this process.
Bottling is another extremely important time for excess oxygen dissolving in our wine causing a real concern for chemical and microbial instability in the bottle and lessening aging potential. Areas of concern for oxygen absorption during the bottling process include filtration, bottling

tank and filler headspace levels, the filler (filling of wine) and bottle headspace. The proper handling and use of inert gas involved with these key components are vital to keep the dissolved oxygen (DO) level low and ultimately the total package oxygen (TPO) as low as possible which will help preserve wine quality and shelf life potential.

Closure becomes the last line of defense against oxygen absorption into our bottled wine. Past research has shown a large difference in the type of closure when it comes to their effectiveness in preventing oxygen ingress into our bottled wine. There is also a fairly large difference within each grade of each closure relating to dissolved oxygen levels. The choice of a closure can also be associated with a certain variety or wine type being bottled.

Further information identifying the sources of the bottling line for excess oxygen entry into wine can be found within this OGEN issue.

It is of utmost importance to follow through with sterile bottling practices which involves cleaning and sterilizing the bottling line/operation and performing sterile bottling techniques including sterile filtration of white wines to 0.45 micron and 0.60 micron for red wines. If a winery is unsure of their sterile bottling practices, there are also several alternatives such as sorbic acid and Velcorin (DMDC) that can be utilized at the correct concentrations in combination with sulfur dioxide and sterile filtration procedure's. The use of Velcorin is highly effective and much better than potassium sorbate but costly to purchase the required dosing machine. However, there are more mobile dosing and bottling units on the market today to explore which may be more practical for a smaller to mid-sized winery. It may also be possible of working together with a group of wineries in sharing the cost.

It is our goal as winemakers to work with what we have been dealt with regarding the current vintage conditions and produce the best quality wine showcasing both varietal character and overall balance. It is important to utilize every resource possible to us in the cellar in addition to outsourcing expertise from those around us in addition to contacting the OARDC Enology program in helping achieve better wine quality and meeting our desired goals for both the winery and consumer.

Again, our thoughts and prayers are with everyone within the grape and wine industry and all citizens in the state of Ohio. I am hopeful and optimistic that we will pull through this and in many ways become a better nation, state and industry by managing these difficult issues.

Please let me know if you have any winemaking questions or concerns for further discussion.

Sincerely,

Todd Steiner

Todd Steiner
Enology Program Manager & Outreach Specialist
College of Food, Agriculture, and Environmental Sciences
Department of HCS
118 Gourley Hall, 1680 Madison Avenue, Wooster, OH 44691
330-263-3881 Office / 330-464-2239 Mobile / 330-263-3685 Fax

Sources in the bottling line operation responsible for dissolved oxygen entry in wine

By: Todd Steiner, HCS-OSU

Introduction

The benefits and drawbacks of dissolved oxygen in wine can be discussed at great length. However, to extend the aging potential and prevent undesirable changes in the wine due to oxidation, a winemaker must recognize that in most cases oxygen is considered to be detrimental in the production of a high quality product.

Benefits of limited oxygen

In some cases, oxygen exposure in the must/juice otherwise known as hyperoxidation has been associated with stabilizing white wines from further browning oxidation during the vinification process. This enzymatic oxidation occurs in must/juice absent of sulfur dioxide (SO_2). During enzymatic oxidation, certain phenol groups react with oxygen to produce yellow quinones. These compounds in turn react with more oxygen to yield brown colored products. This process stabilizes further browning reactions in wine from this source [**1**]. Although, the author of this text considers grape juice oxidation as being detrimental to producing wines of high quality, this oxidative process is not implicated for the most part in oxidative reactions occurring in wine.

Oxygen is also essential during the initial stages of alcoholic fermentation for healthy yeast propagation and fermentation. Residual oxygen is then completely removed by the increased production of carbon dioxide (CO_2) during the fermentation process.

Some controlled oxygen exposure may be beneficial in red wines during barrel aging. This increases phenol polymerization and improves color stability and softening of the palate in red wines [**2**]. A cellar procedure for controlled oxygen addition accomplished in red table wines known as micro-oxygenation is reported to reduce harshness and softens the palate. It is important to understand that micro-oxygenation is intended to avoid excessive accumulation of dissolved molecular oxygen in the must or wine that causes oxidation [3]. However, the advantages of micro-oxygenation needs further research performed and should be performed by trained personnel only in recommending this technique.

Oxygen elimination prior to bottling

Generally, oxygen is detrimental to wine quality especially from the end of fermentation through wine storage and bottling. The presence of oxygen during the latter stages of wine production can increase browning reactions, chemical and microbiological instability and the production of off aromas such as acetaldehyde.

Attention must be given during the vinification process to avoid those potential sources for oxygen pickup and prevent excess oxygen from dissolving into the wine. Key sources for oxygen pickup include: racking, excess headspace, pumping, filtration and bottling. Depending on temperature, dissolved oxygen levels can range from 6 to 9 mg/L in wine. Higher levels are expected at lower temperatures [**4**]. Since the rate of oxidation increases with temperature, it is critical to add the appropriate amount of SO_2 based on wine pH. Furthermore, when kept at low temperatures, such as during cold stabilization, protecting the wine from air and keeping tanks full is essential to minimize oxygen absorption in wines [**5**]. Other practices such as filling tanks from the bottom, inspecting for leaky pump seals and securing any loose hose connections on the inlet side are necessary to lowering oxygen pickup. Prior to bottling,

Dissolved oxygen (cont.)

excess oxygen in wines can be removed by using an inline sparger. This introduces an inert gas like nitrogen (N_2) or CO_2 through a porous stainless steel cylinder suspended in the wine. As the wine passes around the sparger, gas bubbles enter the product and displace the dissolved oxygen. The bubbles will rise to the top of the tank releasing the inert gas and oxygen. For this procedure, the use of CO_2 as an inert gas is less effective and may excessively carbonate (saturate) the wine prior to bottling; therefore, N_2 is preferred [**1**].

Oxygen elimination at bottling

Bottling is the last process where added dissolved oxygen can have a significant negative impact on the aging potential and quality of the wine being released directly to the consumer. Thus, extreme care must be employed in minimizing the amount of oxygen entry at bottling.

Oxygen has the potential to dissolve into the wine at every stage of the bottling process. A recommended level for total dissolved oxygen in bottled red wines should be below 1.25 mg/L and 0.6 mg/L for white, blush and rose wines [**6**]. Major sources of oxygen diffusion into wine at bottling occur during wine transfer, filtration, filling and headspace levels of the bottling tank, filler and bottle. Each process will be described in further detail below.

When transferring wine to the bottling tank, it is advisable to purge the tank and transfer lines with N_2 or CO_2 prior to filling. If any headspace is present after filling, it is important to use an inert gas on the surface to prevent oxygen from dissolving into the wine. Often, a mixture of N_2 and CO_2 can be beneficial especially for white wines. Maintaining a slight but constant pressure over the headspace is recommended. Although CO_2 levels ranging from 300 – 600 mg/L can enhance a young white or light red wine [**7**], caution must be used that excessive pressure may cause too much CO2 absorption providing a noticeable tactile sensory perception and possible bubble formation. In addition, excessive CO_2 levels can cause an increase in pressure possibly pushing the cork out after bottling. Therefore, the use and monitoring of CO_2 in the wine prior to bottling by Carbodoser is beneficial in adjusting concentrations up or down accordingly for these purposes. The Carbodoser is a relatively simple technique involving a glass tube measuring the amount of CO_2 out-gassed from a fixed volume of wine. Comparing actual results with a calibration curve provides the concentration of CO_2 in mg/L of wine.

Wine filtration prior to bottling is another source for oxygen pickup. During filtration, it is important to operate the filtration unit according to the manufacturer's directions making sure all connections and pads are tight to prevent oxygen entry. Purging of air from the filter pads and transfer lines is also a recommended practice.

Wine entering the filler bowl is typically one of the most problematic sources for oxygen pickup. The filler bowl should also be covered with an inert gas to reduce oxygen pickup. Depending on the type of filler used, filling of wine into bottles can increase the levels of dissolved oxygen by 0.5 to 2.0 mg/L [**7**]. The length of the fill spouts as well as the type and force of the jet may influence the amount of dissolved oxygen. Therefore, it is advisable that filling tubes be as long as possible depending on the bottle. Providing vacuum prior to filling and flushing with 2 to 3 volumes of N_2 has been reported to lower oxygen absorption at bottling [**4**].

After filling, bottle headspace is another source of oxygen absorption. This is due, in part, to the variability of the bottle headspace, which is influenced by such factors as, wine temperature, solubility of gases in the wine, bottle size and shape. To help reduce oxygen ingress at this stage, the injection of an inert gas such as N_2 or CO_2 can reduce the amount of oxygen in the headspace. According to Peynaud [**7**], a

Dissolved oxygen (cont.)

small amount of CO_2 supplied to the bottle headspace will help replace the oxygen and diffuse into the wine causing a depression which also helps prevent the problem of wine leakage due to expansion. In addition, a bottling line supplied with a vacuum filler is also effective in reducing the amount of oxygen in the headspace. Similarly, a controlled dosage of liquid N2 into the wine after filling flushes oxygen from bottle headspace for screw-cap operations [**8**].

The corking machine may vary on whether it supplies a vacuum or not prior to cork insertion. According to Crochiere [**8**], if set up properly supplying a vacuum at corking can help reduce the amount of oxygen absorption into the wine.

Whether using inert gas sparging, pulling a vacuum, liquid N_2 dosing or a combination of these procedures, it is advisable to keep the time and distance from the filler to the corking machine as short as possible. In addition, if there is an interruption in the bottling line process, down time may cause the inert gas to escape allowing oxygen to concentrate back into the headspace of the bottle. Therefore, if a bottling line stoppage has occurred, it is advisable to remove all bottles in question and dose them again or discard them from the bottling line.

The last important item of the bottling process that influences oxygen absorption in wine and ultimately affects aging potential is the closure. Today, there are many wine closures available each having different properties. Two major functions affecting oxygen pickup in bottled wine include closure recovery time from compression and the rate of oxygen permeation. Lopes *et al*., [**9**] indicated that the level of oxygen permeation is lowest for screw caps and "technical" corks, intermediate for conventional natural cork stoppers, and highest for synthetic closures. Further, they showed that differences in oxygen pickup varied among grades of each closure. This variability could then provide an explanation for bottle to bottle variation. This finding was in agreement with the results reported by Crochiere [**8**]. Both studies reported the need to be more consistent in production standards of each type of closure as it relates to compression recovery and oxygen ingress rates.

In conclusion, oxygen incursion at bottling can have a significant negative impact on wine quality and aging potential. Therefore, the recognition and knowledge of how one can control or limit the amount of oxygen entry at bottling is critical.

References

[1] OUGH, C.S. 1992. Winemaking Basics. New York: Food Products Press.

[2] ZOECKLEIN, B.W., *et al.* 1995. Wine Analysis and Production. New York: Chapman & Hall.

[3] SMITH, C. 2002. Micro-oxygenation in extended maceration and early stages: immediate effects and early stages. Proc. of The Ohio Grape-Wine Short Course. HCS Department Series 726. Wooster, OH. pp. 54-63.

[4] BOULTON, R.B., *et al*. 1996. Principals and Practices of Winemaking. New York: Springer Science+Business Media, LLC.

[5] GALLANDER, J.F. (1991). "Wine oxygen level: how much is too much?" Proc. of The Ohio Grape-Wine Short Course. HCS Department Series 621. Wooster, OH. pp. 48-51.

[6] FUGELSANG, K.C. 2009. Personal communication.

[7] PEYNAUD, E. 1984. Knowing and Making Wine. New York: John Wiley and Sons.

[8] CROCHIERE, G.K. 2007. "Measuring oxygen ingress during bottling/storage." Practical Winery and Vineyard. (January/February): 74-84.

[9] LOPES P., *et al*. 2007. "Oxygen transmission through different closures into bottled wine." Practical Winery and Vineyard. (January/February): 65-71.

By: Diane Kinney and Imed Dami, HCS-OSU

Vine & Wine News continues to provide updates on grape growing and wine making in Ohio and elsewhere. These updates will be posted on the program website, *Buckeye Appellation* (BA) at: http://ohiograpeweb.cfaes.ohio-state.edu/. We would like to invite you to visit the website on a regular basis to help inform you of what our OSU Team has available to you through OGEN, TGE, research updates, events and news. Our hope is that it becomes a resource you look up periodically. So why not bookmark this site today?

In the past month (April), we have posted the following updates. Simply click on the blue link and the desired document will automatically open.

Educational Materials:

- Ohio Grape Electronic Newsletter (OGEN) on homepage and tab (Special Frost issue).
- The Grape Exchange (TGE) on the homepage and tab (latest posting on April 24).

News:

- Frost grips grapes in southern Ohio

Events:

- Agriculture and Natural Resources Madness

Ohio Agricultural Research and Development Center (OARDC)
1680 Madison Ave.
Wooster, OH 44691

go.osu.edu/grapes

Name & Address	Phone	Email	Area of Expertise & Assistance Provided
Dr. Imed Dami, Professor & Viticulture State Specialist Horticulture & Crop Science 216 Gourley Hall - OARDC	330-263-3882	email: dami.1@osu.edu	Viticulture research and statewide extension & outreach programs.
Dr. Doug Doohan, Professor Horticulture & Crop Science 116 Gourley Hall - OARDC	330-202-3593	email: doohan.1@osu.edu	Vineyard weeds and control. Recommendation on herbicides.
Dr. Gary Gao, Professor & Small Fruit Specialist OSU South Centers 1864 Shyville Rd., Piketon, OH 45661 OSU Main Campus, Rm 256B, Howlet Hall, 2001 Fyffe Ct., Columbus, OH 43210	740-289-2071 Ext. 123 Fax: 740-289-4591	email: gao.2@osu.edu	Viticulture research and outreach in Southern Ohio.
Dr. Melanie Lewis Ivey, Asst. Professor Plant Pathology 224 Selby Hall - OARDC	330-263-3849	email. ivey.14@osu.edu	Grape diseases, diagnostics, and management. Recommendation on grape fungicides and biocontrols. Good agricultural practices and food safety recommendations.
Diane Kinnney, Research Assistant Horticulture & Crop Science 218 Gourley Hall - OARDC	330-263-3814	email: kinney.63@osu.edu	Vineyard and lab manager - viticulture program. Website manager for Buckeye Appellation website.
Andrew Kirk, AARS Station Manager Astabula Agricultural Research Station 2625 South Ridge Rd. Kingsville, OH 44048	440-224-0273	email: kirk.197@osu.edu	Viticulture research and outreach in northeastern Ohio.
Dr. Erdal Ozkan, Professor Food Agriculture & Biological Engineering 590 Woody Haes Drive Colubmus, OH 43210	614-292-3006	email: ozkan.2@osu.edu	Pesticide application technology. Sprayer calibration.
Patrick Pierquet, Research Associate Horticulture & Crop Science 220 Gourley Hall - OARDC	330-263-3879	email: pierquet.1@osu.edu	Wine cellar master. Enology research, micro-vinification, sensory evaluation, and laboratory analysis.
Dr. Maria Smith, Viticulture Outreach Specialist Horticulture & Crop Science 205 Gourley Hall - OARDC	330-263-3825	email: smith.12720@osu.edu	Maria is the primary contact for viticulture extension and outreach. Evaluation of site suitability for vineyard establishment and all aspects of commercial grape production.
Todd Steiner, Enology Program Manager & Outreach Horticulture & Crop Science 118 Gourley Hall - OARDC	330-263-3881	email: steiner.4@osu.edu	Todd is the primary contact for enology research and extension. Commerical wine productoin, sensory evaluation, laboratory analysis/setup and winery establishment.