Climate Limitations and Vineyards in Arizona

An Exchange on Climate and Viticulture in Yavapai County
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6/12/2018
dormancy  
winter  

bud break  
spring  

leaf fall  
autumn  

flowering  
spring/summer  

carbohydrate accumulation  

30-60% pollination rate  

harvest  
summer/autumn  

fruit set  
spring/summer  

veraison  
summer  

aroma and flavor development of berries  

rapid initial growth of berries  

rapid sugar influx to and expansion of berries  

slow growth, or the lag phase, of berries  
Temperature drives vine phenology.

- **dormancy**: winter
- **bud break**: spring
- **leaf fall**: autumn
- **flowering**: spring/summer
- **fruit set**: spring/summer
- **harvest**: summer/autumn
- **veraison**: summer

- Carbohydrate accumulation
- 30-60% pollination rate
- Rapid initial growth of berries
- Slow growth, or the lag phase, of berries
- Rapid sugar influx to and expansion of berries
- Aroma and flavor development of berries

Temperature drives vine phenology. Growth rates and conditions affect pollination and berry development.
Except for January and May, above-average temperatures occurred during the first six months of 2017.
January-June average temperatures have been above normal in most years since 1990 in Yavapai and Cochise counties.

Relative to 1981-2010 normal

So far in 2018, temperatures were well above normal in January and April, and about or above normal in February, March, and May.

Relative to 1981-2010 normal
Warmer temperatures can advance early growth stages of the vine, like bud break, flowering, and fruit set.

- **bud break**
  - spring
  - warmer temperatures can advance bud break

- **flowering**
  - spring/summer
  - 30-60% pollination rate
  - warmer temperatures can advance flowering

- **harvest**
  - summer/autumn
  - rapid initial growth of berries
  - aroma and flavor development of berries

- **fruit set**
  - spring/summer
  - slow growth, or the lag phase, of berries
  - rapid sugar influx to and expansion of berries

- **veraison**
  - summer

- **leaf fall**
  - autumn

- **dormancy**
  - winter

- **carbohydrate accumulation**

- **slow growth, or the lag phase, of berries**
warmer temperatures can advance bud break

Is this an issue for winegrape growing?

warmer temperatures can accelerate growth

warmer temperatures can advance flowering

warmer temperatures can advance fruit set

30-60% pollination rate

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rapid initial growth of berries

Is this an issue for winegrape growing?
What’s a common worry for growers during spring?

- Bud break: Warmer temperatures can advance bud break.
- Flowering: Warmer temperatures can advance flowering.
- Fruit set: Warmer temperatures can advance fruit set.
- Veraison: Warmer temperatures can advance veraison.
- Harvest: Aroma and flavor development of berries.
- Carbohydrate accumulation: Rapid sugar influx to and expansion of berries.

- Leaf fall: Freezing temperatures can reduce vineyard yield.
- Dormancy: Freezing temperatures can reduce vineyard yield.
- Harvest: 30-60% pollination rate.

- Spring: Warmer temperatures can accelerate growth.
- Summer: Warmer temperatures can accelerate growth.
- Autumn: Warmer temperatures can accelerate growth.
- Winter: Warmer temperatures can accelerate growth.
On average, the date of the last spring freeze occurs in late March and early April for almost all of the Verde Valley AVA.

The goal during spring is to not have sub-freezing temperatures negatively affect the vineyard.
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For existing vineyards:
- delay bud break
  - late pruning
  - sprayable products
- frost protection
  - wind machines, irrigation, vineyard floor management

For prospective vineyards:
- site selection
  - avoid locations prone to pooling of cold air
- variety selection
  - later bud break, flowering, and fruit set
Has phenology or have freezing temperatures changed more quickly?
Since 1948, last dates of sub-freezing temperatures range from early February to late April at the Yavapai College vineyard.
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Is there increasing or decreasing risk of freezing temperatures?

For homework:
- climate data
- Jeremy Weiss
- phenological data
- winegrape growers
Anthocyanins, which aid in tannin retention, wine color, and wine aging, are lower at grape maturity under warmer ripening temperatures.

The amount of heat during the ripening period is important.

www.nydailynews.com/life-style/eats/experts-french-heatwave-killing-wine-production-article-1.2322896
Temperatures were about average in 2017 for the months of July, August, and September.

July-September average temperatures have been above normal in most years since the mid-1990s in Yavapai and Cochise counties.
The seasonal outlook shows 50-60% probability of above-normal temperatures July-September.

The goal at this time of the year is to not have excessively warm temperatures negatively affect grape quality at harvest.
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**For existing vineyards:**
- delay bud break
  - *late pruning, sprays*
- canopy management
  - *lower leaf-area-to-fruit ratio*
- early harvest
  - *prevent acid-sugar imbalance, undesirable pH*

**For prospective vineyards:**
- site selection
  - *avoid southerly and westerly aspects*
- variety selection
  - *later ripening*
Will advanced and accelerated growth stages move ripening to a hotter time of year?
The earlier the harvest, the warmer the temperatures during the ripening period.

<table>
<thead>
<tr>
<th>harvest date</th>
<th>previous 30-day average temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yavapai College vineyard</td>
</tr>
<tr>
<td>August 1</td>
<td>82.0</td>
</tr>
<tr>
<td>August 15</td>
<td>80.9</td>
</tr>
<tr>
<td>September 1</td>
<td>78.6</td>
</tr>
<tr>
<td>September 15</td>
<td>74.2</td>
</tr>
<tr>
<td>October 1</td>
<td>70.9</td>
</tr>
</tbody>
</table>

1987-2016 averages

data: TopoWx (Oyler et al. 2014)

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*Is there increasing risk of impacts during ripening from warmer temperatures?*
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**Is there increasing risk of impacts during ripening from warmer temperatures?**

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**Phenological Events:**
- **Dormancy** (winter): extreme cold can damage or kill vines
- **Bud Break** (spring): warmer temperatures can advance bud break
- **Leaf Fall** (autumn): freezing temperatures can reduce vineyard yield
- **Flowering** (spring/summer): warmer temperatures can advance flowering
- **Harvest** (summer/autumn): excessive heat can reduce enzyme activity and skin-derived aroma, color, and flavor components, especially with red varietals
- **Veraison** (summer): rapid sugar influx to and expansion of berries
- **Fruit Set** (spring/summer): warm temperatures can advance fruit set, slow growth, or the lag phase of berries

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**Carbohydrate Accumulation:**
- 30-60% pollination rate

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**Excessive Heat:**
- can reduce acid and increase sugar to levels that negatively affect the balance of table wines
How are variations and changes in climate impacting vineyards in Arizona?

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