Results

1. Mean budburst and leaf out dates?
   1. Comparison with RMI and GH budburst and leafout data
2. Thicker spurs meant flower more likely to have inflorescence and flower
   1. Logistical model
   2. Figure in supp
3. Middling temperatures seemed to allow for greater stem and leaf growth
   1. Mostly visual, based on plot
   2. Tendency, no directional relationship
4. No directional relationship between temp and soil moisture
5. Temp did not affect days to 10/50% flowering
6. Higher temperatures increased flower bud loss
7. P=0.05 (categorical) or P=0.01 (continuous)
8. Plot showing trend
   * 1. Loss barely happened at two coolest treatments

Introduction

1. Viticulture
   1. 1100 commercial varieties V. vinifera(P-X Wolkovich et al 2017 SEE SUPPLEMENT)
   2. 6000 varieties cultivated worldwide(Lacombe, T. Contribution al’etude de l’histoire evolutive de la vigne cultive 2012)
   3. Climate change and impact on viticulture industry
      1. Wine regions likely to change by 0.2-0.6 degrees C per decade 2000-2049 (Schultz and Jones 2010) (Schultz and Jones)
      2. Concerns about loss of viticultural lands/shifts to currently conserved areas (Hannah et al 2013)
         1. Shift towards poles🡪less land for winegrowing in the Southern Hemisphere (Shcultz and jones 2010)
      3. Introduce new varieties better suited to changed climate (Wolkovich et al 2017)
         1. Need to know phenologies of other varieties to find where they would be able to thrive
2. Phenology as tool to learn to adapt
   1. Phenology very temp driven (Jones or Chienne)
      1. Advance in timing of leafout/flowering in plant species = 4-6 days/degrees C (Wolkovich 2012)—2-5 days per decade in last 30-40 years (Root et al 2003, Menzel et al 2006)
      2. Warmer temps🡪early harvests (-6 days/ degree C) (Cook and Wolkovich 2016)
   2. Differs greatly across varieties
      1. 3-6 weeks across different varieties (Wolkovich et al 2017)
      2. <= 100 varieties have phenology data beyond harvest dates (Parker et al, 2011, 2013)
3. Flowering, harvest, and heat
   1. Successful flowers become berries, so harvest yield depends on flower numbers
   2. Climate change effects on flowering
      1. Reduction in flower number of 32.6-24.2 flowers per degree C (14 day treatments before bb, 13 day treatments just after bb)(Petrie and Clingeleffer 2004)
      2. Plants exposed to 40/25 degrees C temps for four days at flowering lost all flowers (Greer and Weston 2010)
   3. Phenocurve

i. insert image

* + 1. Phenological rate expected to increase to a point as temp increases, and then decline, slightly faster than it increased

1. Experimental goals
   1. Collect phenological data for a large number of winegrape varieties
   2. What happens at high temp end of phenocurve for flowering?
      1. Does flowering speed up?
      2. At what point do higher temperatures no longer increase pheno rate?
   3. Vegetative response to higher temperatures?
      1. Increased or decreased rate of growth?

Discussion

* + - 1. Quick overview of results (1 paragraph usually)
      2. Interpretation of results
         1. Phenocurve not seen in results

Heat effects vary by phenophase; plants less susceptible to elevated temperature effects on phenology during flowering?

I know one study saw less effect of heat after budburst than before (Petrie and Clingeleffer)

Plants subject to heat before budburst had significantly fewer flowers (p<0.01), while p<0.05 flower loss due to heat after budburst

Heat created by enclosing some buds in containers while leaving other open

Fruit set and veraison heat treatments saw fewer and less intense negative effects on winegrapes (bunch length, berry size, ripening; Greer and Weston 2010)

Slow-down of phenology for flowering may occur at higher temperatures than we studied

* + - * 1. Plants at higher temperatures lost most flower buds

Heat stress may not have significantly affected phenology, but it is evident in the loss of otherwise healthy flower buds

* + - 1. Possible weaknesses
         1. Sample sizes small due to majority of plants stalling before flowering stage

Too few plants to study varietal differences

We tried to get more varieties, but would need more plants of each variety – very important

Most varieties only in one chamber

* + - * 1. Chamber v field

Plants behave differently in controlled environments

Accelerated phenology

* 1. Importance/validity of experiment still stands
     1. genetic diversity allows for better replication and more holistic viewpoint
     2. Relationship with RMI data
        1. Importance of using lab experiments along with field experiments to build better models
        2. Broader context
           1. Connection with other literature

Plants exposed to extreme heat during flowering lost all flowers, inflor growth impeded (Greer and Weston 2010)

* + - * 1. Climate change and viticulture

Decreased yield at higher temperatures simply because fewer flowers to turn into berries

Modeling may need more than just phenology to capture future effects

* 1. Need more research on greater number of varieties

Petrie, Paul R., and Peter R. Clingeleffer. "Effects of Temperature and Light (before and after Budburst) on Inflorescence Morphology and Flower Number of Chardonnay Grapevines (Vitis Vinifera L." *Australian Journal of Grape and Wine Research* 11.1 (2005): 59-65. Print.

Schultz, Hans R., and Gregory V. Jones. "Climate Induced Historic and Future Changes in Viticulture." *Journal of Wine Research* 21.2-3 (2010): 137-45. Print.