Grapes 101

Will effects of the 2016 drought carry over into 2017?

By Tim Martinson, Alan Lakso, and Alex Koeberle

Editor's Note: This article is based on Alan Lakso's presentation at the recent BEV conference entitled "Vineyard Water Relations: Implications of the 2016 Drought."

The 2016 growing season was notable for a drought that started in April and continued through September. A more typical pattern in drought years is for mid- to late-season drought stress that starts well after grapevine canopies are fully developed. Will the early timing of the 2016 drought cause carryover effects on vines in 2017? Our previous Grapes 101 article How Grapevines Respond to Water Stress covered in-season effects of the 2016 drought. In this article, we will address potential vine impacts in 2017 resulting from early-season vine stress in 2016.

2016 drought. In 2016, weather conditions varied widely across New York State, but rainfall in the Finger Lakes was well below the historical average from April to September. At Geneva, 4.5 inches of rain was recorded from April to July, with only 0.65 inches of rain for all of June. By the end of July, the rainfall deficit reached -8 inches, and this moisture deficit continued through September. Ample rains in October, including a 4.5 inch rainfall on October 21, almost eliminated the deficit. In contrast, note that in 1991 there was ample moisture through the end of June, with more severe water stress starting in July and continuing through the end of the growing season.

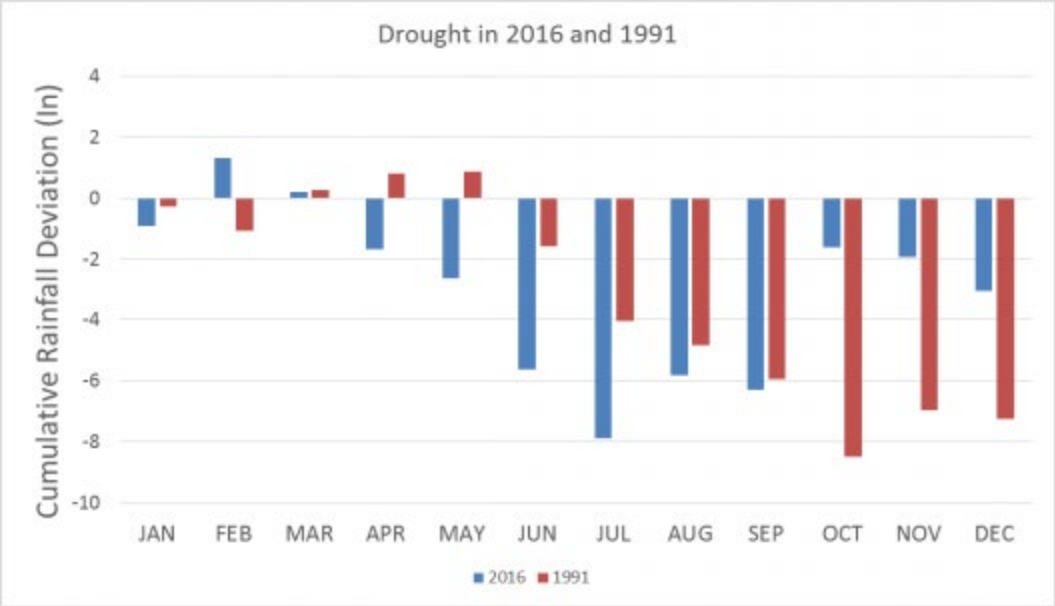

Figure 1. Deviation of cumulative rainfall in 2016 and 1991 from long-term average.

Potential carryover effects. Drought stress can affect bud and cane hardiness, limit root growth, and result in lower carbohydrate reserves, leading to weak growth in the spring and reduced budbreak and bud fruitfulness. The likelihood of significant carryover effects depends upon how early and how long the vines experienced drought stress. Extreme variability of sites and soils in the Finger Lakes means that effects are likely to be spotty and site-specific.

Soil water holding capacity and timing of stress. Our vineyard soils vary greatly in their water holding capacity. Both the soil's depth and texture (Table 1) determine water-holding capacity. Those sites (shallow and/or coarse-textured soils) with limiting water holding capacity will run out of water and experience stress much earlier than soils with high water-holding capacity. For example, if vines use one acre-inch of water per week, then a site with coarse sand at field capacity may run out of water in 5 days, but a site with silt-loam soils could last for 6 weeks before running out of water. This difference in storage capacity affects how early vines experience stress, and which tissues and processes may be affected.

Table 1. Water Holding Capacity of Different Soils.

SOIL TYPE	INCHES OF WATER PER INCH OF SOIL	ACRE-INCHES OF WATER IN 24 INCHES OF SOIL
Clay or Silty Loam	0.25	6.0
Sandy or Gravelly Loam	0.15	3.6

Loamy Sand	0.10	2.4
Sand	As low as 0.03	0.7

Tissue sensitivity to water stress. Different tissues respond differently to increasing water stress. Bud development and shoot growth are among the most sensitive, while post-veraison fruit development indicators (brix, berry growth) are less sensitive.

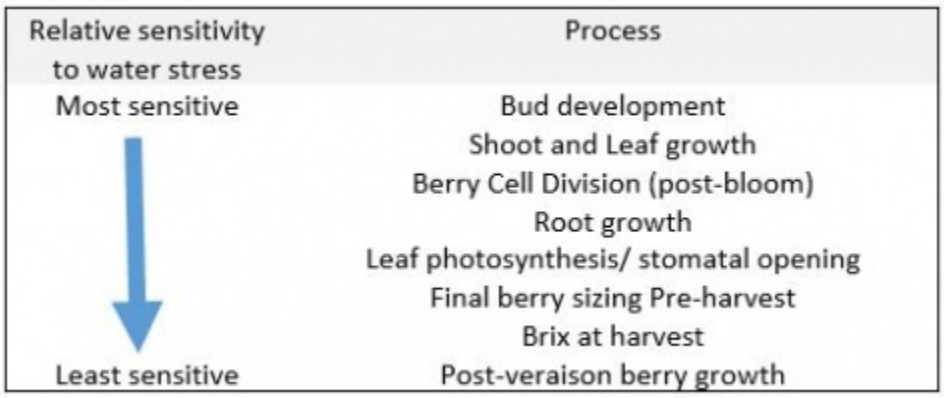

Figure 2. How drought stress affects vine processes.

Early vine stress at bloom/fruit set. A lot of important processes are taking place around bloom. This is the time when reserves are at their minimum. Competition between shoots, flower clusters, and newly-developing buds for a limited amount of photosynthates produced by leaves is intense. Early drought stress will stop shoot growth early, limiting vine capacity - and it may also impact bud development and fruitfulness for the coming season. Fine root production and nutrient uptake may be reduced, further limiting vine size – and potentially vine capacity in the coming season.

Mid-season vine stress. By 2-3 weeks after bloom, shoots of VSP-trained vines should have reached the top of the trellis for complete 'trellis fill'. Water stress at this point may still affect berry size during the late cell division stage, and will still limit vine size – but that may not be a bad thing, particularly with fertile soils that normally grow huge vines. Also our colleagues in Bordeaux stress that the Cabernet family of varieties do best with some mid-season water stress. However, stress severe enough to cause stomates to close during the middle of the day will reduce photosynthesis – and result in less net carbon accumulation by the vine.

Veraison to Harvest: After veraison, the vine places a high priority on supplying soluble solids (sugars) to ripen the fruit – and also allocating some to replenishing starch reserves in canes, trunks, and roots. Vines that are defoliated at veraison will still see increase in Brix in the grape clusters in part due to dehydration. If leaves aren't functioning to supply the sugar, then it can be mobilized from starch reserves – potentially reducing bud and cane hardiness and resulting in weak

growth in the following spring. However, the evidence for this is somewhat weaker. Studies measuring cane starch reserves following drought in 1991 showed little difference in starch reserve concentration in irrigated versus non-irrigated plots (Lakso et al 1991). Vines grew shorter shoots, but maintained similar concentrations of starch reserves in the tissues that could grow.

Implications for 2017. Finger Lakes vineyard sites are highly variable. Older vines with well-established root systems on deep soils that produced full canopies should likely see few carryover effects. Vines that showed weak growth last year on shallower soils (e.g. where growth stopped at 2-3ft or shorter shoots) may see some unusual carryover effects:

Reduced bud fruitfulness. At the lowest 6-8 nodes, buds for the next season form in the two to three weeks following bloom. If drought stressed, they may form fewer clusters, or the proportion of fruitless shoots may increase. Within the buds, the basal cluster develops first, before the second and third clusters. So the extent of cluster differentiation within the bud – particularly for the 2nd or 3rd cluster – may be reduced, resulting in smaller and fewer clusters.

Variable bud condition at different node positions. With prolonged and intensifying drought stress, buds at the lower node positions (eg. 1-6) that developed earlier in the season may be more developed than buds at higher node positions farther out the cane that developed later during more stress. These higher bud positions may be less fruitful and may be less likely to push in the spring than buds at the lower nodes. Spur pruning might have an advantage over cane pruning as it uses only the more basal buds.

Reduced vine capacity. Less shoot growth typically means less root growth – and potentially weaker early season growth that is fueled by vine reserves. Uneven bud burst and weak shoot growth may be symptoms of either reduced reserves to fuel growth, or vascular injury that prevents it from being mobilized.

What to watch for. The early start to the 2016 drought, and its duration through the entire growing season is a new experience for Finger Lakes growers, and it's hard to know what exactly to expect. We expect carryover effects in some vineyards that showed incomplete canopy development, but also expect that many sites will see no carryover effects. Growers should look for weak early growth, unusually uneven budburst, and particularly look at how the 2nd and 3rd clusters are developing. This may be a good year for leaving an extra cane or longer spurs and adjusting shoot number after bud burst when the potential yield (cluster number and size) is more apparent. And note that the nodes farther out toward the shoot tip may be less fruitful than normal. This may be important for those who use cluster thinning to adjust their crop. In any case, careful observations of the vines will be valuable.

Figure 3. Extreme soil variation in our glacially-deposited soils can lead to significant differences in drought stress within a few yards. Photo by Alan Lakso.

References:

Keller, M. 2010. *The Science of Grapevines: Anatomy and Physiology*. Chapter 6.1. Yield Formation.

Martinson, T. and A. Lakso. AC#26 Grapes 101. How Grapevines Respond to Water Stress

Walter-Peterson, H. Morning Ag Clips. How will drought affect grape size, yield?

Walter-Peterson, H. Finger Lakes Times. Vintage 2016: The only Finger Lakes constant is change

Tim Martinson is a senior extension associate in the Section of Horticulture, based at the NYS Agricultural Experiment Station in Geneva, NY. Alan Lakso is Emeritus in the Section of Horticulture. Alex Koeberle '13 is a program aid, Section of Horticulture, based at the NYS Agricultural Experiment Station in Geneva, NY.