Resource Assimilation and Vineyard Productivity

GRAPES 101

Grapes 101 is a series of brief articles highlighting the fundamentals of cool climate grape and wine production.

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Sunlight streaming through Cabernet Sauvignon grape canopy at Fredonia, NY.

Grapes have been cultivated for over 7,000 years with deliberate and sometimes not-so-deliberate changes in production practices to improve vineyard productivity and grape quality. Today's viticulture and enology research can use advanced laboratory techniques to focus on the most subtle environmental, chemical, or biological factors affecting final product quality. It is important for

researchers and practitioners alike to revisit grapevine fundamentals and establish or re-establish the framework in which we all work.

Nutrient assimilation.

What is more fundamental than identifying the characteristics of our organism of choice—the grapevine? Grapevines are photoautotrophs (from the Greek photos = light, auto = self, troph = nourishment) and carry out the process of photosynthesis, during which energy from sunlight is used to convert carbon dioxide and water into organic compounds. Carbohydrates from photosynthesis are then used as stored chemical energy for cellular respiration and as carbon skeletons for the biosynthesis of other organic compounds, i.e., used for fuel and growth. Inorganic mineral nutrients are also assimilated into plants (primarily through the roots) and into anabolic biochemical pathways to synthesize the compounds needed for plant growth and function.

Sunlight interception and nutrient assimilation.

Why is this fundamental concept important to a vineyard manager in New York? One of the primary objectives for the vineyard manager is to be able to control (or at least influence) carbon, water, and mineral nutrient assimilation. Total potential vineyard productivity depends on the amount of seasonal sunlight (photosynthetically active radiation) which can be intercepted by functioning grapevines over some unit land area. Although there is little you can do to increase available solar radiation (unless you want to move your vineyard to a better location) or carbon dioxide (aside from the global climate change discussion), a vineyard manager can do something about sunlight interception as well as water and nutrient availability and uptake.

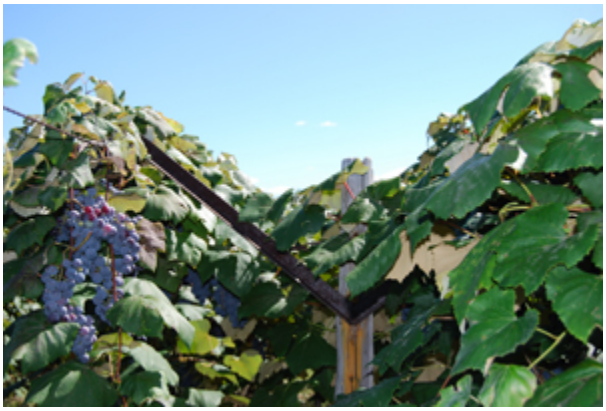
Vine size.

The first and quite obvious requirement for light interception and vine production is the ability to grow leaf area. Vine size, traditionally measured as the weight of dormant cane prunings per row or canopy distance, is an indicator of potential leaf area growth—and therefore potential light interception and vine productivity. Research and vineyard management practices to control vine size almost always investigate soil physical, chemical, or biological factors leading to water and nutrient availability (i.e., soil depth, nutrient availability, phylloxera, etc.) or measure water and nutrient uptake by the root system (i.e., rootstocks).

Canopy deployment.

The second objective is to extend the leaf area to maximize light interception and minimize canopy shading. Viticulturists refer to the vine canopy as all of the above

ground vine organs—trunk, leaves, shoots, and fruit. Canopy management therefore aims to manipulate vine leaf area through changes in vine structure, pruning, training, shoot number, and shoot positioning. Third, exposed leaf photosynthesis needs to remain high for optimum carbon assimilation. Leaf gas exchange rates can be influenced by light and temperature as well as stresses imposed by inadequate water or nutrient availability or diseases and insect pests.



Geneva Double Curtain (GDC) as an example.

The best example of vine size and canopy management working together is in GDC vineyards. Increasing water and nutrient availability or using rootstocks which increase water and nutrient uptake can lead to vines too large for the allotted trellis space. Excessive leaf area on single wire training can be spread out on two trellis wires to intercept more sunlight per unit land area. True GDC systems use additional canopy management techniques, such as canopy separation and shoot positioning to further optimize light interception. In addition, because GDC vines have an increased amount of exposed leaf area, the vines require more water to maintain adequate gas exchange. This brief article highlights the importance of growing and managing vine leaf area for vineyard productivity. Crop size and crop load management, also important in the production of quality fruit, deals with carbon partitioning and will be covered in a future article.

Suggested reading:

- *Keller, M. 2010. The Science of Grapevines: Anatomy and Physiology. Burlington, MA: Academic Press.*
- *Smart, R.E. and M. Robinson. 1991. Sunlight into Wine: A Handbook for Winegrape Canopy Management. Adelaide: Winetitles.*
- *Wolf, T. 2008. Wine Grape Production Guide for Eastern North America. Ithaca, NY: Natural Resource, Agriculture, and Engineering Service.*