Shaulis Viticulture and the Eastern U. S. Grape Industry

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When I was hired by Cornell University in 1998 to provide research support to the Western, NY grape industry, I knew relatively little about Nelson Shaulis and his history in viticulture research. After all, Nelson had supposedly retired from Cornell twenty years earlier in 1978 (when I was 10-years-old and concerned more with Terry Bradshaw taking the Pittsburgh Steelers to another Super bowl than with the production of Concord grape juice). Unfortunately, I did not have the chance to spend much instructional time with Dr. Shaulis before he passed away in 2000. Most of our conversations took place in his nursing home room in-between my trips to Fredonia to set up new research plots. Dr. Shaulis was intelligent, dedicated to his research, and deeply concerned with the health of the N.Y. grape industry.

In Dr. Shaulis' obituary, he was characterized by colleagues as "one of the truly great scientists of the world in the field of viticulture." What did Dr. Shaulis do to be classified as a "great" scientist? Did he bring in multi-million dollar research grants, have an army of graduate students, or pump out an extraordinarily large number of publications? Compared to other research areas agricultural funding is not particularly lucrative, he had few graduate students, and critics argue he completed much more research than what he actually published.

Did Dr. Shaulis revolutionize the way viticulture research was conducted, develop complex experimental designs, or make major breakthroughs in viticulture? His body of research is made up of a series (albeit an extensive series) of straightforward projects with well defined questions and the appropriate experimental designs to address the questions. The way Dr. Shaulis approached science certainly indicates that he was a "good" scientist. I would argue there are currently many good scientists in viticulture with a similar mastery of the scientific method. The proposals and reports submitted to the Eastern Viticulture Consortium each year exhibit many examples of good science with clear questions and sound experimental designs.

Geneva Double Curtain Training! Dr. Shaulis is so well know for the Geneva Double Curtain (GDC) that it must have been the big breakthrough that elevated him to the status of "great scientist." Sure, GDC training had an impact on canopy management in NY and abroad but it was again a result of a series of methodical research projects – not a sudden breakthrough. In fact, I consider GDC one of those unique inventions created by accident, like chocolate chip cookies, penicillin, or "Post-it" notes. In his research efforts to increase vine size and productivity in Concord, Dr. Shaulis eventually produced vines with excessive vine size and leaf area for the allotted trellis space, a mistake leading to internal canopy shading and reduced bud fruitfulness. When faced with the issue of excessive vine size, Dr. Shaulis could either reduce the exposed leaf area (which he did with downward shoot positioning) or spread out the leaf area to decrease internal canopy shading (which he did with GDC training). GDC training was significant in the area of canopy management; however, there were many other outcomes from Dr. Shaulis' research having more widespread adoption in the NY grape industry: potassium and nitrogen fertilizer recommendations, various balanced pruning formulas, and the mechanical harvester to name just a few.

Measuring acceleration rate of a falling apple and inventing the reflecting telescope did not make Sir Isaac Newton a great scientist in the field of mathematics and physics. Rather,

Newton was a "great" scientist because he used experimentation and the scientific method to explain larger concepts such as universal gravitation and the three laws of motion, thereby laying the groundwork for classical mechanics. Granted, viticulture in New York can hardly be compared to the weight of Philosophiae Naturalis Principia Mathematica, (no matter how much Traminette you consume) but the grape world deserves great scientists as much as math and physics.

In my opinion, Dr. Shaulis was a "great" viticulturist because he used experimentation and the scientific method to explain important concepts viticulture that we use today, and will continue to use for the basis of research in the future. In a speech to grape growers in 1956, Dr. Shaulis stated, "Production efficiency and product quality are important components of grower profitability and industry success in New York." He went on to highlight four specific areas of research he was working on or going to be working on to support the future of the industry. However, the speech itself targeted the more general or conceptual areas of research. If you categorize Dr. Shaulis' research projects over the course of his career, his projects in general fall into one of four conceptual areas: 1.) Vine size for productivity, 2.) Crop load for fruit quality, 3.) Mechanization for efficiency, and 4.) Diversity for marketability (Table 1).

Vine size for productivity: There is a positive relationship between vine size (measured as pounds of dormant cane pruning weight) and potential vine productivity. Growers often comment, "You can't get a big crop from a small vine." For example, when comparing a one-pound and a three-pound vine pruned to the same bud number (say 100 buds), the bigger vine will have more total leaf area and have a larger crop size because the 100 retained buds will also have higher average fruitfulness. Dr. Shaulis commented in 1956, "vigor of the grape vines in many if not most of New York's vineyards is too low" and "a grower should apply the cultural techniques now at hand so that all of his vines produce at least two pounds of cane prunings." Therefore, he focused one area of research on below ground management to improve root function and vine size. Mechanical and chemical weed control, potassium and nitrogen fertilizers, and the use of phylloxera resistant rootstocks were all studied to improve water and nutrient uptake and reduce root pest pressure - the target being the all important 0.35 pounds of dormant cane prunings per foot of canopy.

Crop load for fruit quality: Dr. Shaulis started to evaluate different balanced pruning formulas in the late 1940's and reported how vine size and retained node number changed the balance between vegetative and reproductive vine growth and in some cases changed final fruit quality. Evaluation of training systems, trellis height, shoot positioning, and vine spacing looked to increase the amount of sunlight interception per unit land area. Ultimately, in trials where root management produced excessively large vines, Dr. Shaulis developed horizontally divided training systems (Geneva Double Curtain training is the most famous but did you know there was also a *triple* curtain system?). Today, viticulturists refer to crop load as a central concept in manipulating the rate and extent of fruit maturation in a given region. In these cases, crop load is defined as the exposed leaf area to fresh fruit weight ratio – a concept originating from Shaulis' research.

Shaulis Viticulture in Western, NY

Year	Vine Size root and soil biology to optimize vegetation	Fruit Quality pruning and training to optimize crop load	Efficiency mechanization to reduce production costs	Diversity new varieties to complement Concord
1948		Introduction of Concord balanced pruning in Western, NY 30+10		
1950	Weed management with oil sprays	Pruning severity and fruit quality in Concord. 20+10, 30+10, 40+10		Comparison of Concord fruit with Fredonia and Van Buren
1955	Vine nutrition - Potash deficiency Petiole nutrient analysis	Training systems (umbrella, 4-arm Kniffin, Keuka) Trellis height (introduction to 6' trellis)		Catawba fruit quality
1960	Weed control with Karmex herbicide Grape pomace in floor management More research on Potassium deficiency and petiole analysis	Row and Vine spacing (64 square/feet/vine most profitable) Shoot Positioning **Geneva Double Curtain Training**	↑ Development of a mechanical grape harvester	
1965	Introduction of phylloxera resistant rootstocks (C3309)		↓	
1970	**The West Tier Factorial** Interaction of nitrogen, weed control, rootstock pruning severity, training, and shoot positioning in Concord	Crop Load in Sultana		Growing cold-tender grape varieties in New York New York site selection for wine grapes
	Ozone injury and nitrogen fertilization	Crop size and juice acidity in Concord	↑ Development of a mechanical pruner	Minimizing the hazard of cold in New York vineyards
1975		Summary research on Canopy management Divided trellis systems and	↓	
1978		Canopy microclimate		

Table 1: Timeline highlighting Dr. Shaulis' viticulture research projects and focus areas in Western, N.Y.

Mechanization for efficiency: Grape production is a business influenced by the laws of supply and demand, cash flow, and market competition. Improving operation efficiency will help the NY grape industry stay competitive and profitable. However, any mechanization introduced into the vineyard should also be developed and evaluated to ensure sound viticulture; such as vine size and crop load. For example, the mechanical pruning system developed by Shaulis and cooperators employed select pruning, shoot positioning, and shoot thinning to maintain an open canopy structure and adequate bud fruitfulness.

Diversity for marketability: In his 1956 speech, Dr. Shaulis addressed the importance of "testing better varieties to complement Concord." I find it interesting he used the word "complement" and not "replace" in his statement about new varieties in New York. Dr. Shaulis focused part of his research efforts on testing new varieties for the Northeast and defining vineyard site selection criteria. Concord is the largest produced grape in the Eastern U.S. and primarily used for the fresh juice market. Promoting the color, flavor, aroma, and health benefits of Concord has helped keep it on top in juice and jelly products. Although Concord is also the largest produced grape for wine in the Eastern U.S., Concord and other *V. labrusca* wines have poor marketability compared to more well known wine varieties. Increasing the production success and fruit quality of varieties other than Concord through research will only add diversity and marketability to the Eastern U. S. wine and grape industry. How many small wineries draw consumers in with Riesling or Chardonnay and end up selling Concord, Catawba, or Delaware as well?

Dr. Shaulis was a great viticulturist because his research developed the concepts which became the foundation for future viticulture research in the Eastern, U.S. and abroad. If imitation is the sincerest form of flattery then I hope Dr. Shaulis would be pleased with the influence he has had on today's Eastern U.S. viticulturists, as well as on viticulturists around the World. It is difficult not to see "Shaulis Viticulture" in action when you look at the cold hardiness and site selection research by Tony Wolf in Virginia, the canopy management and fruit quality research by Andrew Reynolds in Canada, and the vineyard mechanization research by Keith Striegler in Missouri.

Bates Viticulture in Western, NY

Year	Vine Size root and soil biology to optimize vegetation	Fruit Quality pruning and training to optimize crop load	Efficiency mechanization to reduce production costs	Diversity new varieties to complement Concord
1998	-Effect of soil pH on Concord (potted vines)	-Effect of retained nodes, training, shoot positioning, and crop adjustment on Concord fruit maturation rate	-Evaluation of mechanical pruning systems in HRU and GDC Concord vineyards	-The interaction of soil pH and rootstock on the growth and fruit quality of Riesling, Cab Sauv, Traminette, and Noiret in the Lake Erie region.
2000	-Effect of phylloxera on Concord (potted vines) -Concord mineral nutrition and soil pH (field vines)	-Physiology of mid-season crop load adjustment in Concord	-Nitrogen fertilizer efficiency (amount and timing) -Development of mechanical thinning protocol	
2005	-Interaction of crop size, soil moisture, and K fertilizer on cation balance in Concord	-Effect of cane length on Concord and Niagara fruit quality	-Introduction of Precision Ag to Western, NY vineyards	

Table 2: Timeline highlighting current viticulture research projects in Western, N.Y. and how the projects follow Shaulis Viticulture.

At the Cornell Vineyard Lab in Fredonia, we have tried to continue with research (Table 2) in Dr. Shaulis' four areas of viticulture production. Inadequate vine size is still a major limitation to production in many Concord vineyards. Research continues to investigate the effect of soil pH and mineral nutrient availability on the vine size and productivity in the Lake Erie grape region. Although balanced pruning is rarely used in Western N.Y. vineyards, alternate crop load management research continues in the areas of crop estimation, mid-season crop adjustment, and Concord fruit quality. With the recent downturn in the Concord juice market, vineyard production efficiency is more important than ever for growers to stay profitable. Mechanical pruning and thinning evaluations and fertilizer efficiency research aims to decrease production costs while maintaining sound viticulture production. Finally, the Lake Erie grape belt is slowly looking towards the wine industry for diversity to complement juice grape production – similar to the Finger Lakes region in the 1970's and 1980's. Research is ongoing that investigates the interaction of soil nutrient availability and root stock selection on the health, productivity, and fruit quality of four wine grape varieties.

When Dr. Shaulis arrived at Cornell, the grape industry was in its infancy and New World viticulture was an unwritten book. Consequently, he was able to approach viticulture from the ground up, both figuratively and literally, and make large strides in improving New York grape production. When Dr. Shaulis departed, he left behind the basic concepts for understanding vineyard production and profitability. Concepts we can build upon and move viticulture research into the future.