GRAPE RESEARCH NEWS

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Water Balance and Drought Stress in New York Vineyards

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The hot, dry weather experienced this year in New York has led to the development of drought stresses that vary considerably from vineyard to vineyard . To help understand the reasons for this variation in vineyard responses, let's review the important factors that control vineyard water balance and vine responses to drought.

An important point in determining how much stress occurs in the vineyard is that, much like economics: *Stress due to drought is not just the lack of rainfall, it is the imbalance between the demand of the vines and the supply of water available to them.* Many factors can affect this balance and must be considered in each case to help predict or understand the severity of drought effects.

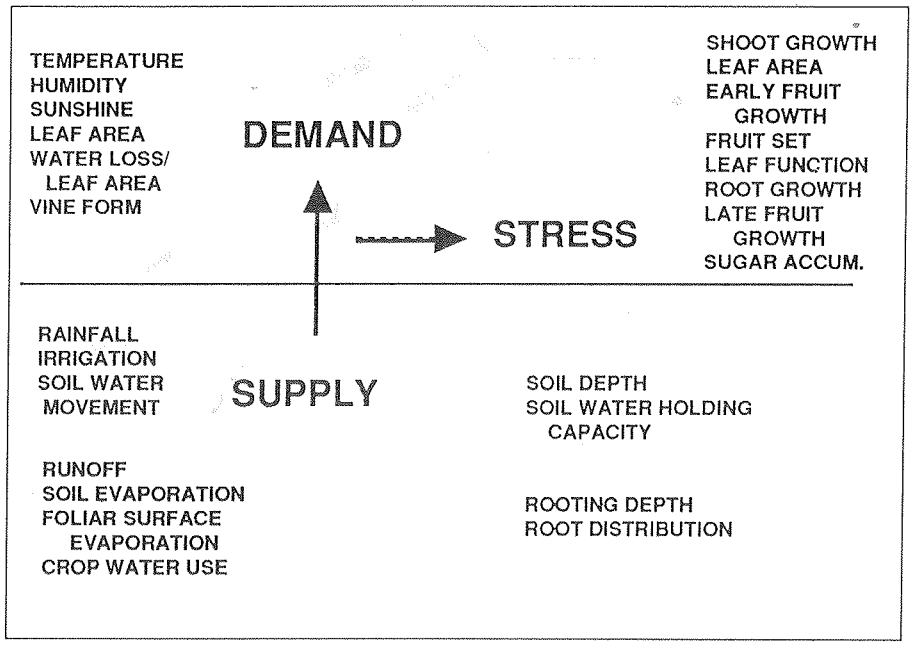


Figure 1. Diagram of factors involved in the water balance of a vineyard. The stress responses are listed in approximate order of increasing resistance to water stress (i.e. shoot growth rate is most sensitive).

SUPPLY

The supply of water available to vines depends on how much water is in the soil at the start of the season, how much is added during the season, and how much is lost to soil evaporation and competing plants (Fig. 1).

Soil Water Reserves. The amount of water available to the vines depends not only on the rainfall, but also on the amount of water held in the soil at the start of the season. This soil water reserve at the start of the season depends on winter and spring rains and snow, the soil depth, and the water holding capacity of the soil. Compared to a clay soil, the same volume of sandy loam will hold only 50 per cent as much water (0.2 inches water per inch of soil for clay vs 0.1 for the sandy loam). This difference can be overcome if the lighter soil allows a greater depth of rooting, such as the deep gravels of the Chatauqua belt which allow rooting to six feet or more. Many heavier soils may have restrictive layers that reduce the total rooting volume. Thus, the

Potential Available Water equals Rooting Volume times the Soil Water Holding Capacity. Dry winters and springs may reduce these reserves markedly before the season even begins.

Water Inputs. Clearly, rainfall is the most important factor, but there are other ways that water can move into the vineyard. Surface runoff and soil water movement (in heavier soils) can provide sections of a vineyard with more water than would be expected from rainfall and soil water reserves. We have found in several recent studies that apparently uniform vineyard sites can be quite variable in available water, and it is difficult to predict this until a drought occurs. Of course, irrigation can directly increase available water. We are currently conducting trials on supplemental irrigation and its potential value in Fredonia. Even on the deep gravel soil, drought stresses have been significant in 1991.

Water Losses. Water losses from the soil reduce the water available to the vines, and such losses need to be limited in drought years. Although runoff and soil surface evaporation are obvious sources of water loss, the use of water by the cover crop in the vineyard is probably the greatest source of water loss. Thus, vineyard floor management is important to vineyard water balance. In dry years the detrimental cover crop competition for water can be reduced by herbicides (no-till), cultivation, or mulches. Cultivation is less effective than no-till and causes more problems with potential erosion and root cutting. Mulches are the most conservative of water because they greatly reduce both the cover crop competition and soil surface evaporation; however, the cost may limit the use of mulch to the driest sites and years.

DEMAND

Weather Factors. The weather factors that drive water use by a vineyard are the energy of sunlight warming the vineyard and the humidity of the air. The warmer, drier and sunnier the conditions, the higher the demand for water. For example, May 1991 had a 40 per cent higher evaporative demand than May 1990. Combined with less rainfall, the development of stress occurred very rapidly in 1991. The demand will also vary day-by-day as temperatures, cloudiness, and humidity change.

Vine Factors. The most important plant factor is the amount of leaf area that can intercept sunlight and can provide evaporating surfaces. The increasing leaf area of both the vines and the cover crop in the spring lead to an increase in water demand. In studies this year in Fredonia on water use and stress in minimal pruned versus conventionally pruned vines, minimal pruned vines that developed 200-300 shoots per vine produced a dense canopy very early in the season, used up the soil reserves quickly, and consequently experienced drought symptoms more rapidly than the more slowly developing conventional vines with fewer shoots. During the long period of full canopy in the summer, the form of the vine can influence demand for water by affecting the amount of sunlight intercepted. For example, a study by Dr. Cline in Ontario found that the more spreading form of the Geneva Double Curtain required more water and benefited more from irrigation than the narrower single curtain Umbrella form.

Cropping. A high crop on the vines can reduce total shoot length and pruning weights. However, unless severely overcropped, the crop does not affect the total water use by the vine markedly if a full canopy develops that will intercept a lot of sunlight. The greater concern with crop level is whether the vine can ripen a large crop in a drought year (see under Stress Responses section).

DROUGHT STRESS RESPONSES

Timing of Drought. Since many different growth and production processes in the vine occur at different times of the season, droughts will cause different responses depending on when they occur. Generally, however, growth processes such as shoot and leaf development, early berry growth, and fruit set are sensitive to early season drought stresses. Thus, early droughts lead to stunted shoots with small leaves, incomplete canopy fill, and poor potential crop via poor set and small berry size. Berry size lost early cannot be completely reversed later in the season by rains. Later droughts, after canopy fill and berry set, may have less noticeable effects until leaves begin to drop. Berry growth and sugar accumulation after veraison is much more resistant to drought than

the early growth. We have found that sugar accumulation by the grapes occurs strongly just after veraison with or without drought stress. Apparently the berries at this time have such a great ability to draw carbohydrates that they can even use reserves from the trunk and roots if not available from the leaves. In the last few weeks before harvest, however, drought effects on final berry growth and sugar accumulation become apparent.

Sensitivity of Different Processes. The relative sensitivity of different growth and production processes are listed in Figure 1 in approximate order of increasing resistance to water stress. As mentioned above, early growth is the most sensitive to drought. Leaf function (i.e. production of sugars by photosynthesis) is moderately resistant to stress, so that shoot growth is usually stopped before the leaf function is reduced. Once leaf function falls to near zero, then leaf drop will occur. Root growth tends to be more resistant than top growth so that the ratio of roots to leaves increases, a good adaptation to drought. Post-veraison berry growth and sugar uptake are quite resistant to drought. Thus, juice Brix tends to be one of the least affected processes.

Interactions with Cropping. In a study of the interactions of drought and cropping, we have found that the effects of drought stresses are aggravated by heavy crop levels. A late season drought had little effect on harvest brix on light cropping, thinned vines that had excessive leaf area per fruit, but caused a much more significant reduction in heavier cropping vines. The stress of cropping thus predisposes vines to other stresses such as drought. Again, irrigation gave a greater benefit to heavy cropping vines.

Are All Drought Stresses Bad? In many cases, having unlimited water can lead to excessively large dense canopies due to large leaves and long shoots, and to large dilute berries. Heavy canopy shade generally leads to poor spray penetration, more disease pressure, and poor fruit quality. For grapes, the optimum appears to be when adequate water is available in the early season to support good canopy and berry development, followed by a mild-to-moderate stress that stops shoot growth once the canopy is filled, while leaving healthy leaves and a relatively open canopy for light and spray penetration. Wine grape quality appears to be optimal with some stress that reduces final berry size somewhat and a canopy that allows good cluster exposure. Consequently, we ideally would like to be able to "manage" the stress if possible.

OVERALL WATER BALANCE

It is clear that the overall water balance of a vineyard depends on many factors and will be different in every vineyard block, every day. With the same supply the stress that develops will vary with the daily weather. Vines on cloudy cool days will be under less stress than on clear, hot, and dry days, even with the same supply of water. Since this is so complex, we need to simplify by understanding how the factors discussed help us categorize each vineyard into different drought stress risk categories, similar to the risk assessment used for Grape Berry Moth. Considering that in dry weather the vineyards in New York may use up to three to four inches of water per month, then:

Low Risk occurs in vineyards with deep soils with a high total water (five to six inches or more) in the rooting zone (3+ feet of good Honeoye loam, 5+ feet of sandy loam with good root penetration), restricted single curtain canopies, a relatively low crop, good percolation of rainfall, and mulch or no-till floor management.

High Risk occurs in vineyards with less than two to three inches of water available in the rooting zone due to shallow or restrictive soils, especially with light soils, heavy cropping, broad minimal pruned or divided canopies, and a heavy competitive sod on the vineyard floor.

Current experiments indicate that drought stress has become quite severe even on the deep gravelly loams of the Chatauqua Belt. If the droughts of 1988 and 1991 foreshadow increased droughts associated with global warming, the feasibility of irrigation should be further explored, especially for high risk vineyards. Short of irrigation, the most effective practice to combat drought is to reduce competition of cover crops as much as possible with no-till or mulch, especially in dry sites. ■

This research was partially supported by the New York Wine and Grape Foundation, the New York Grape Production Research Fund and the Kaplan Vineyard Research Program.

Research Program Strengthens Industry

James Trezise
President
New York Wine and Grape Foundation
350 Elm Street
Penn Yan, New York 14527

The New York Wine & Grape Foundation was formed in 1985 — a pivotal year for the New York grape and wine industry. After years of steady economic decline, the industry experienced a dramatic and fundamental economic turnaround catalyzed by a combination of private sector initiatives and enlightened public policy. Governor Mario Cuomo and the New York State Legislature forged a market-oriented public policy framework — including the formation of the Foundation — that has stimulated industry growth, and has become a model for other states.

An underlying purpose of the Foundation's creation, and of its programs, has been to stabilize and improve the economic viability of the State's grape industry, which represents about 1,500 farms covering 35,000 acres, and employing about 10,000 people in four regions. One aspect of this program involves decreasing costs and increasing revenues through research.

The Foundation's research program reflects the diversity of the industry, and is also based on a process involving broad industry input. Reducing costs and increasing revenues are the goals underlying the many projects designed to enhance vineyard productivity. These include the mechanization of many vineyard operations, efficient control of common grape diseases, identification of the most promising grape varieties, grape breeding, and other areas. One project worthy of special note involved control of the grape berry moth through the use of pheromone traps rather than chemical sprays. Several years of Foundation-sponsored research by Dr. Tim Dennehy and his colleagues resulted in an unprecedented definition of the problem, a practical and environmentally safe solution, and ultimately the approval by the Environmental Protection Agency and other regulatory bodies.

Foundation-sponsored research focusing on the control of powdery mildew with fewer sprays can now save growers across the state nearly $700,000 for each spray that is made unnecessary. And, nearly $2,500,000 per year can be saved by growers who apply the research into shoot positioning and mechanical pruning.

Complementing the viticultural research are several grape processing projects designed to improve the overall quality of New York wines and grape juices, and to increase the efficiency, safety, and reliability of various processing techniques. A particularly valuable service to the grape and wine industry is the Foundation-sponsored "Wine Lab" run by top-flight scientists with state-of-the-art equipment at the New York State Agricultural Experiment Station, Geneva. In addition to providing immediate feedback on juice and wine samples, the Wine Lab is establishing a long-term data bank of information on grape varieties, vintages, regional variations, winemaking techniques, and many other subjects which will enhance the industry's development in future years.

Communicating the results of research is as important as the research itself if it is to be of use to the industry which sponsors it. To facilitate practical application of research results, the Foundation has sponsored, in conjunction with the New York State Agricultural Experiment Station at Geneva, this *Grape Research News* — a quarterly newsletter which highlights grape research findings. Foundation-sponsored meetings, seminars, and conferences also aid in passing on the practical results of the research program. In addition, the Foundation has published books on Concord table grape production, *Vitis vinifera*

grape production, a New York State Winery Handbook, and a New York Wine Course and Reference.

The Foundation's research program is based on financial support and professional guidance from many industry sources, and particularly the New York State Grape Production Research Fund, Mr. John Dyson, and the National Grape Cooperative. The Foundation's fiscal year 1990–1991 research program included 21 separate projects covering vineyard productivity and grape processing.

As a private, non-profit organization, the Foundation depends on membership, which has grown substantially during the past several years. Through individual and association memberships, the vast majority of New York grape growers support the Foundation; and about 90 per cent of processed production (grape juice and wine) is represented by the Foundation. While grape growers and processors form the core of the Foundation's membership base, other members include wholesalers, retailers, restaurateurs, associated businesses, community supporters, and consumers.

For additional information on the New York Wine & Grape Foundation, and membership benefits, contact: New York Wine & Grape Foundation, 350 Elm Street, Penn Yan, NY 14527 or call (315)-536-7442. ■

FROM THE EDITOR

Martin Goffinet

The long dry spell that grape growers faced this season in New York is reflected by the current growth status of vines and the crop quality and yield at harvest. To put this year in perspective, one need only compare the seasonal accumulation of heat units (growing degree days above 50F baseline) and total inches precipitation at Geneva, NY from April 1 through August 15 (the time of this writing) for years 1988 through 1991. The accompanying table shows that 1991 is significantly warmer than the drought year of 1988, with only slightly more precipitation. Years 1989-1990 were a little more normal in both heat units and precipitation.

YEAR	DEG. DAYS	PRECIP.
1988	1,880	8.9
1989	1,680	17.3
1990	1,680	18.5
1991	2,040	11.8

Such dry, warm years as this impose physiological restrictions on vine growth and fruiting. Dr. Alan Lakso, Grapevine physiologist at the Geneva Experiment Station, discusses this in the lead article.

In our other major article, Mr. James Trezise, President of the New York Wine and Grape Foundation, explains how the Foundation serves the State's industry via its funding of research in conjunction with other industry research dollars. In this manner, important but limited dollars for grape research are stretched across more research projects of interest to the industry.

As of this writing the harvest is on! I hope yours is a successful one. ■

Annual Meeting of the New York State Fruit Testing Association

On September 19–21, The New York State Fruit Testing Association will host its annual meeting at Jordan Hall, New York State Agricultural Experiment Station, Geneva. There will be many displays of grape varieties and numbered selections from the grape breeding program at Geneva during the Fruit Fair Exposition, as well as an opportunity to see the vines that produced them during the field tour to the Station's grape research plots. The mission and activities of the U.S.D.A.'s Clonal Repository for Grapes will be explained by its curator, Mr. Philip Forsline. For information about the program and tours, contact Robert Andersen, Department of Horticultural Sciences, 315-787-2235. For information on registration and fees, contact Elizabeth Munzer, Manager of the New York State Fruit Testing Association, 315-787-2205.

Moet Hennessy Louis Vuitton to Host Sixth International Symposium, *"Grapevine and Environment: Integrated Protection of Grapevine"*

September 30, October 1 and 2: The French Group, LVMH Moet Hennessy Louis Vuitton, will host its *Sixth International Symposium, "Grapevine and Environment: Integrated Protection of Grapevine,"* in Budapest, Hungary. The program will be arranged with collaboration of the Institut National de la Recherche Agronomique (I.N.R.A., France). Topics include: detection of disease and simulation of its development, the development of integrated controls, grower education, and regulatory, toxicological, environmental and economic issues. Contact: Moet-Hennessy U.S. Corp., **Attn**: Mr. Oliver Goniak, 135 East 57th Street, New York, NY 10022. Telephone: (212)-758-7200. Fax: (212)-758-2801.

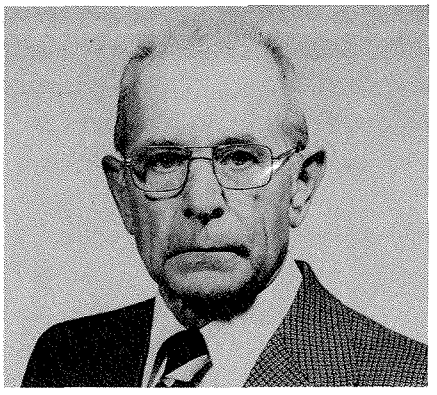
Wine Microbiologist Receives Outstanding Achievement Award

On July 12, Don Splittstoesser, Professor in the Department of Food Science and Technology at the New York State Agricultural Experiment Station, Geneva, NY, received the Outstanding Achievement Award for 1991, at the Annual Meeting of the Eastern Section of the American Society for Enology and Viticulture, at Erie, Pennsylvania. The Outstanding Achievement Award was given to Don "in recognition for his many years of contribution to the Eastern wine industry, for his research as a wine microbiologist, as an advisor to graduate students, and as a leader in The American Society of Enology and Viticulture/Eastern Section."

Thomas Henick-Kling named 1991-1992 Chairman-elect of the Eastern Section of American Society for Ecology and Viticulture

Thomas Henick-Kling, Associate Professor of Enology and Microbiology, Department of Food Science and Technology, New York State Agricultural Experiment Station, Geneva, NY, was selected as 1991-1992 Chairman-elect of the Eastern Section of the American Society for Enology and Viticulture, at its annual meeting in Erie, Pennsylvania on July 10-12. As Chairman-elect, Thomas will serve as Program Chairman for the 1992 annual meeting of the Eastern Section, and as Chairman of the Eastern Section for the1992-1993 annual term. If you have ideas for the 1992 program, please telephone Thomas, at 315-787-2277. ■

Fredonia Vineyard Laboratory Named to Honor E. Frederick Taschenberg



On May 30 of this year, the main building at Cornell's Vineyard Research Laboratory in Fredonia, New York was named The Taschenberg Laboratory, after the entomologist who made his career there. Dr. E. Frederick Taschenberg served the grape and wine industry of New York with distinction from 1939 until his retirement in 1982.

He received an A.B. degree in biology from Gettysburg College in 1938, and a Ph.D. degree from Cornell University in 1945. He started working at the New York State Agricultural Experiment Station's Vineyard Research Laboratory in Fredonia in 1939 as a Temporary Assistant. From 1940 through 1945, he held the position of Investigator. He became Assistant Professor of Entomology from 1945 to 1948, Associate Professor from 1948 to 1959, and Professor from 1959 until he retired in 1982, at which time he was named Professor Emeritus.

His research efforts at Fredonia were focused on the biology, ecology, and control of major and minor insect pests of grape. He carefully studied and tested the many new insecticides that became available after after World War II, and designed effective treatment programs. These were followed religiously and with great confidence by New York State grape growers. He cooperated with pesticide residue chemists to ensure that his recommendations avoided excessive residue on the grapes or in the juice. He was also committed to alternative methods of insect control.

Dr. Taschenberg also developed the hooded boom sprayer which improved spray efficiency. A modification of this sprayer, designed to further reduce environmental contamination, is currently being tested by Cornell. He worked tirelessly and often for long hours rearing insect pests and parasitoids in the laboratory to supplement his field work. He supplied Dr. Wendell Roelofs, department of entomology at Geneva, with the grape berry moths needed to identify its sex pheromone complex. Dr. Taschenberg then conducted the initial field monitoring and control research that provided the basis for additional work by his successor, Dr. Timothy Dennehy, an entomologist based at the New York State Agricultural Experiment Station at Geneva. The pheromone, which is incorporated in a plastic "twist tie," was recently registered for use to control the grape berry moth. The twist ties are placed on the top trellis wire throughout the vineyard and control the insect by disrupting mating. He is the author of numerous publications on grape insects and allied disciplines. ■

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Question:

Gratitude is expressed to those organizations whose support makes possible ongoing and valuable research activities for the benefit of the State's grape industry. Major funding is provided by the **New York State Wine & Grape Foundation; the Grape Production Research Fund, Inc.; and, the J.M. Kaplan Vineyard Research Program.**

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Got A Question? We are trying to address the many questions from grape growers and processors that come to Cornell's grape research community. We invite you to write to us at *Grape Research News* to bring to our attention any questions you have about grapes. We will see to it that those questions are answered by someone knowledgeable in the area of your concern.

Save yourself a long distance phone call. Put it in writing on the back of form below, cut it out, and send it to us.

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