SOIL ACIDITY IN VINEYARDS OF THE FINGER LAKES OF NEW YORK

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INTRODUCTION

Growing grapes for wine is a complicated endeavor. High quality wine is produced only when geology, climate, topography, and weather work together with the wine makers. The tangible and intangible factors that determine the quality of wine are described collectively as *Terroir*, the French word for earth and soil.

A very important aspect of grape growing is the soil in which they are grown. The soil is where grapes initially begin their life as seedlings and from where they draw nutrients and collect water. The roots of grape vines grow deep, and can reach 10 meters in length in their quest for water and nutrients. Because of this, wine growers are concerned with the entire soil profile from the surface to the bedrock. Significant changes at any depth can affect grape vines. Furthermore, soil makeup directly influences many aspects important in quality grape growth. One of these aspects is the acidity of soil. Soil acidity has a direct influence on nutrient uptake and is therefore of great importance to grape growers. Where soil is too basic or acidic, many essential nutrients are inaccessible to the grapes (White, 2003). The goal here is to examine the role geology has played on the wine produced in the New York Finger Lakes AVA, and specifically how that geology has affected the acidity of soil and the agricultural practices of the grape growers.

Geologic History

During the Late Silurian through the Upper Devonian, a vast sea covered the Finger Lakes Region of New York. Through this long period of time the sea underwent periods of transgression and regression depositing deep-water shale, dolostone, calcareous limestone, and evaporates across central New York. These sediments were subsequently buried, lithified, and slightly tilted, uniformly dipping south. Around 360 million years later, the then rolling topography of Upstate New York was scoured by a series of continental glaciers during the Pleistocene. As these glaciers came and went, they had the effect of stripping existing soil from the top of the bedrock and depositing a thin layer of glacial till over much of the Finger Lakes Region. Finally, as the glaciers retreated, some of the river valleys they occupied were dammed by the terminal moraines of the glacial fronts. These valleys then filled with water and became what are known today as the Finger Lakes (Isachsen, 1991).

Vineyards of the Finger Lakes of New York

The Finger Lakes are the reason quality wine is possible in Upstate New York. The large inland bodies of water act to regulate extreme temperature preventing early season frost and damaging summer heat. With few exceptions, vineyards of the Finger Lakes AVA are all located near the lakeshore of one of the Finger Lakes. The climate of the Finger Lakes is temperate with cold winters and warm summers. The region receives ample amounts of sunshine and rain during most years and is known for consistently producing quality wine. During some years, too much rain can be a problem as the poorly drained, clay-rich soils can cause excessive vine vigor. To viticulturalists, excessive vigor means a decrease in the quality of grape yield as well as an increase in pruning (Wilson, 1998). Bedrock below the vineyards in the Finger Lakes region varies from calcareous shale to non-calcareous shale (Isachsen, 1991). This distinction plays a key role in soil acidity as discussed below.

Dr. Konstantin Frank's Vinifera Wine Cellars was examined in the most detail for this study as soil acidity plays a key role in the vineyard management. It is located on the western slope of the western shore of Keuka Lake in the southwestern portion of the Finger Lakes AVA. Though the vineyard is at a high elevation and Keuka Lake is smaller in size than Seneca and Cayuga lakes, it has a well-established tradition of producing some of the most respected wines of New York. Award-winning varieties include Pinot Gris and Riesling as well as several sparkling wines.

The soil in the vineyard consists of glacial till and ranges in depth from several centimeters to 1.5 m. Clast size varies dramatically from clay to boulders. Two distinct clay layers can be recognized throughout most of the vineyard. The upper layer consists of a rusty red clay, and the lower layer consists predominantly of a bluish grey clay. According to the classification criteria of White (2003), the upper red layer is an iron-oxidized clay that is drier than the bottom clay. The lower layer is an iron-reduced layer that begins at the top of the local water table (White, 2003). The boundary between these two layers varies from around 0.5m to 1.0m in depth. The bluish grey clay is not present where the soil is shallow.

Soil pH

Acid rain is a problem across the Northeastern United States and the Finger Lakes region is no exception. Rain in the area has an average pH of 4.5 (National Atmospheric Deposition Program) and has a mixed effect on the local vineyards. Lajewske and others have proposed that the low pH of the rainwater has the effect of dissolving calcium carbonate from limestone and depositing it in the soil and lakes (Lajewske, 2003). This addition of calcium carbonate in acidic soils buffers the pH of the soil creating an ideal environment for grape growth as shown in Figure 1. By contrast, vineyards located over non-calcareous bedrock have fewer natural buffers in the soil and owners typically add ground limestone to the soil to buffer the soil of pH.

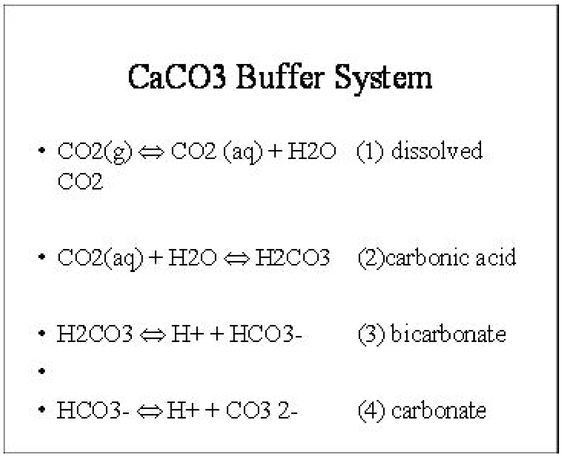

Figure 1

One of the most important factors influencing nutrient availability to plants is soil pH. Grape vines grow best and receive the most nutrients at optimum pH levels (White, 2003). This is because nutrient availability is a direct function of soil pH(). Many macronutrients (C,H O,N, P,S, Ca, Mg, K, and Cl) essential to plant growth are best absorbed at approximately neutral pH. Micronutrients (Fe, Mn, Zn, Cu, B, Mo) occurring in concentrations less than 1000mg/kg in soil are also essential to plant growth and are best absorbed at slightly lower than neutral pH (White, 2003).

METHODS

Soil samples from four vineyards Sheldrake Point, Silver Thread, Dr. Konstantin Frank Vinifera Wine Cellars, and Standing Stone vineyards in the Finger Lakes AVA were tested for soil pH. All samples were analyzed in the lab for pH values using a Horiba Twin Digital pH Meter.

Dr. Konstantin Frank's vineyard was studied in the greatest detail to determine how soil pH varied within a vineyard developed on non-calcareous bedrock. Eleven trenches were dug, all to the bottom of the soil profile. The trenches were dug both down the slope of the vineyard and across it. All trenches were located on a topographical map using a GPS unit. Three soil samples were taken from each trench–one at the surface, a second midway to the bottom and a third at the bottom of the trench. Soil samples were tested for pH levels both in the field and in the lab. Field testing of pH levels was conducted using a Cornell pH Test Kit for Lime Levels. The Cornell pH kit uses chlorophenol red and bromothymol blue and a matching color chart for reading soil pH. Samples taken from trenches were also analyzed for soil pH using a Horiba Twin Digital pH Meter. The lab measurements appeared to be more accurate and were used in subsequent analysis.

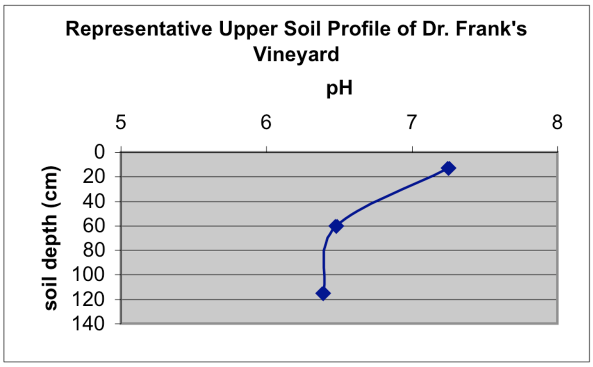

Figure 2

RESULTS

Soil samples from all vineyards displayed pH values within acceptable ranges for growing grapes. Dr. Konstantin Frank's vineyard exhibited soil pH variations from the highest to lowest elevations within the vineyard.

Representative soil depth vs. soil pH graphs from Dr. Konstantin Frank's Vineyard are shown in Figures 2 and 3. At higher elevations, soil pH tended to decrease with depth. In contrast, in the lower elevations of the vineyard, soil pH tended to increase with depth.

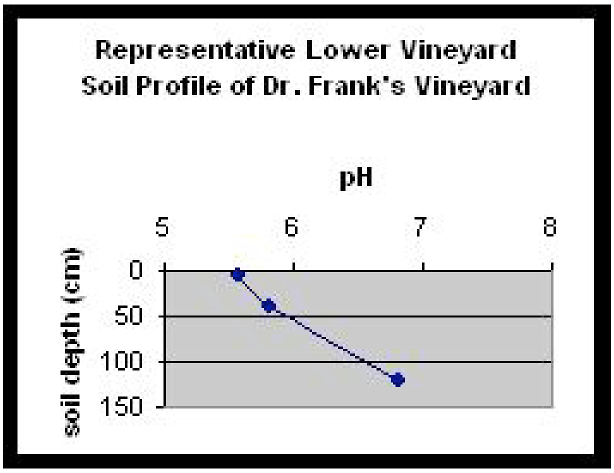

Figure 3

CONCLUSIONS

Vineyards with calcareous limestone bedrock require little or no lime addition for pH correction despite the low pH of regional acid rain. In contrast, very heavy lime addition is required in vineyards located over non-calcareous bedrock. The high lime requirements in these vineyards are the result of both low rain water acidity and high clay content. Calcium carbonate transport through clay rich soils is inefficient and slow therefore requiring higher amounts of lime addition to the soil. As shown in Table 1, significant lime addition is sufficient for the low pH of soils studied at Dr. Konstantin Frank's vineyard. It is postulated that the added calcium carbonate travels down slope through the water-rich blue clay layer in the lower portion of the soil column. If this is the case, higher concentrations of calcium carbonate would be expected further down slope in the lower portions of the soil column. This would increase the relative amount of calcium carbonate in the wetter blue clay at the lower elevations and would have the effect of increasing the soil pH in the blue clay layer in the lower elevations of the vineyard as suggested by Figures 2 and 3.

Table 1

Vineyard	Number of Samples Tested	Average Soil pH	Calcareous bedrock?	Lime Addition?
Dr. Frank's	34	6.65	No	Yes
Shell Drake	31	6.81	Yes	No
Silver Thread	11	6.83	Yes	No
Standing Stone	16	7.07	Yes	No

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