Impact of Soil Properties on Nutrient Availability and Fruit and Wine Characteristics in a Paso Robles Vineyard

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Soil physical and chemical properties affect vine nutrition and fruit composition in a way that directly impacts wine properties. There is renewed interest in the effect of soil nutrients, as influenced by soil type and soil mineralogy, on fruit and wine characteristics (Tomasi 2006, Andres de Prado 2007, Mackenzie, 2005). This is a continuing study of own-rooted Cabernet Sauvignon vines grown on four distinct soil types in the same Paso Robles vineyard. The soils were classified as Palexeralfs, Haploxeralfs, Haploxerolls and Haploxererts. The soils covered contiguous vineyard patches planted with the same cultivar, on its own roots, and managed uniformly. Mesoclimatic conditions and slope aspect were similar. Berries from the four blocks exhibited different sensory attributes, as determined by a tasting panel. This confirmed earlier observations from an informal tasting made on small lot wines. To determine the influence of the four contrasting soil types on vine growth and wine chemistry, soils were analyzed for physical and chemical differences. The four soils exhibited important morphological differences in color, coarse fragment content, texture, water holding capacity, and hydraulic conductivity. The soils also showed important differences in chemical characteristics and nutrient availability. Differences in cation exchange capacity and cationic balance in the soil solution can affect nutrient availability to the vines, and likely contributed to the observed differences in the plant and fruit characteristics.

Materials and Methods

Eight soil pits were excavated for description and sampling in April 2007. The soils were described following the National Cooperative Soil Survey field description manual. Bulk samples were collected for chemical and physical analyses. A grid with 20 x 20 cm squares was constructed and positioned in the pit, encompassing the 1.80 meters between vines along the row. A similar grid was positioned across the row. Root distribution was recorded for each of the 72 grid squares for 4 of the profiles, to a depth of 1.2 meters. Samples of the soil were taken from each square for laboratory analyses. The pH, CaCl2 pH and electrical conductivity of a 1:1 saturated paste were recorded for each sample. Granulometric analyses were also performed for selected grid cells in the profile. TDR probes were positioned at 30, 60 and 90 cm within the profile, associated with a canopy thermometer. Suction lysimeters were installed in the soil and the soil solution collected at regular intervals during the growing season. Leaves were collected for tissue analysis at bloom, veraison and harvest. Grapes were harvested when ripe and small lot wines were made for analysis; berry samples were collected and frozen for later analyses. Pruning weights were measured in the fall season.

Results and Discussion

- Soil physical and chemical characteristics revealed pronounced differences between the four different soil types. Soil heterogeneity was primarily attributed to great variability in the soil parent material, alluvium from the Estrella River containing sand, silt, clay and coarse fragments. A second source of heterogeneity was attributed to differences in soil age.
- Mollisols were found on the upper parts of the topography, on block 52. These soils had calcic horizons, with remnants of laminar lime concretions below a more clayey surface horizon.
- Blocks 56 and 57 contained two related soil types. Flat surface remnants in Block 56 contained Palexeralfs, with an abrupt textural change and thicker argillic horizons dominated on the flat terrace remnants. Less developed Haploxeralfs, (Alfisol type II) with coarser surface textures and a higher proportion of coarse fragments, were found in shallow swales. These were shallower to an impeding layer than type I Alfisols.
- In block 53, swales were occupied by Vertisols, clayey throughout, and with high shrink-swell potential.
- The range of colors within profiles and between pedons was quite broad, reflecting variation in organic matter, carbonates and iron oxide content. Reaction with HCl indicated the presence of carbonates in two of the profiles. One soil was strongly calcareous.

- The four soil profiles showed distinct pH, buffering capacity and electrical conductivity. pH values ranged from 6.0 to 8.6, with average values between 7.6 and 8.0. In some of the profiles, pH values were higher than expected for soils with a given classification, likely reflecting the influence of cultivation practices. The soils were well buffered, as expected for soils in this pH range.
- Soil nutrient analysis revealed low amounts of available nitrogen. This was reflected in a low amount of yeast available nitrogen (YAN) in the grape juice at harvest. All profiles exhibited high potassium reserves in the topsoil, reflecting a good supply from fertilization, but were K deficient in the subsoil. Phosphorus values were low in the Mollisol, with its high calcium content, as was K availability in the same profile.
- Soil electrical conductivity values were moderate but could peak higher locally, indicating potential soil salinity problems; this was likely due to insufficient leaching of salts in some profiles. Factors contributing to high salt concentration included insufficient rainfall or water application, the presence of soil layers impeding drainage, and high initial amounts of salts in certain profiles. Cations in the soil solution indicated a high proportion of sodium with respect to calcium, magnesium and potassium (Figure 1).
- Root distribution generally showed high densities near the surface, as anticipated for a drip irrigated vineyard. However, each soil type had a specific root distribution (Figure 2). Roots were most evenly distributed in the Vertisol, which was clayey throughout. Compacted clay or weakly cemented layers in type II Alfisols tended to restrict root exploration of deeper soil layers. The density of fine roots generally increased in the upper part of argillic horizons in Alfisols with a coarser surface texture. The Mollisols had a greater root density in the subsoil due to heavier textured surface horizons.
- Vine vigor, which was moderate overall, tended to increase in swales, where runoff or soil internal drainage concentrated water, as well as in more clayey soils, such as profiles 2 and 6. This was reflected in pruning weight differences. However, cluster weights were similar.

This ongoing project is currently examining the relationships between plant tissue characteristics, berry juice and soil chemistry for the four vineyard sites.

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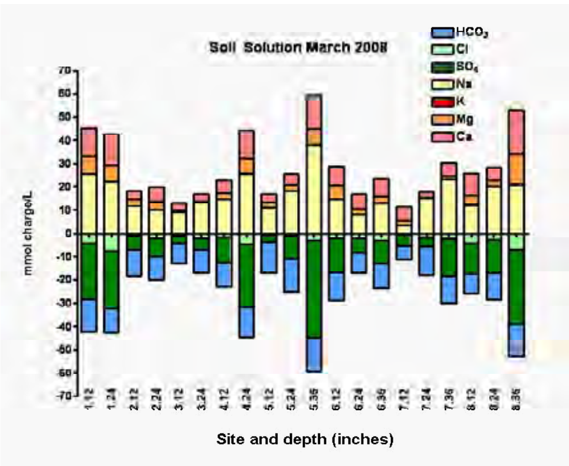

Figure 1. Cations and anions in the soil solution.

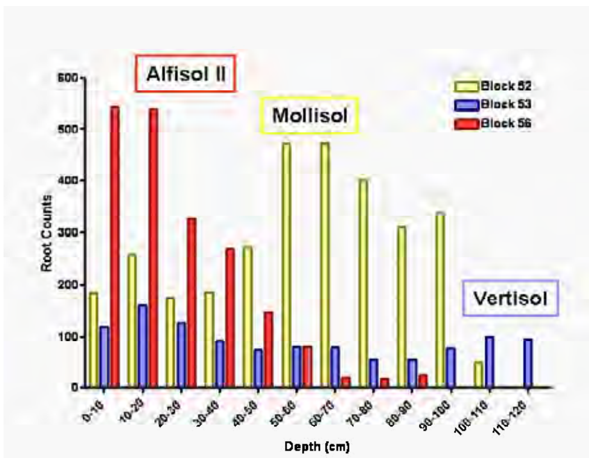

Figure 2. Root counts vary considerably by soil type.