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The soil component of terroir

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The authors discuss the results of their own trial when they arrive at a point in this review-style article when they ask themselves *"Can soil management influence terroir?"*

• **Is there a soil component to terroir?** The authors emphasize the small amount of published data addressing the effects of soil on wine character or wine "personality". They quote a 2001 author: "nobody has yet been able to demonstrate the processes by which elements of the soils are transferred to the flavors, colors, and other qualities of wines".

• **Role of soil chemical properties on terroir.** In a 1991 review of Australian viticultural soils, another author concluded there was no link between soil mineral composition and wine character, with the exception of nitrogen (N) and potassium (K). Indeed, when N is high, the vine can produce too much growth and be out of balance, something that delays ripening. As for K, it is involved in sugar transportation into the fruit. Also, too much berry K can increase the malic:tartaric acid ratio. Still, various authors concluded that there was no correlation between wine quality and the soil content of any given nutrient. As the current authors state, there is still much to be done to unravel any relationships between soil nutrients and wine quality, if any.

• **Role of soil phyical properties on terroir.** Several authors have concluded that the physical properties of a soil, like its structure –which influences **internal drainage-**, and its microrelief or topography – which influences **external drainage** - are the predominant forces determining wine quality and wine character. Sometimes, poor internal drainage is corrected with underground pipe (the authors mention examples in Saint-Emilion and Pomerol), or with "finger mixed ploughs" that rip through a dense subsoil (authors mention the example of South Africa). Good external drainage, which is due to slope or slight elevation, is also important for quality. The authors give the examples of the benches of Haut-Medoc (France), or Rutherford, Oakville, St. Helena, and Stag's Leap (Napa Valley, California). Both good *water drainage* and *cold air drainage* provide the potential for the production of top class wines. And the examples put forward are Rheingau (Germany), Barolo and Barbaresco (Piedmont, Italy), and Central Otago (New Zealand).

• **Can soil management influence terroir?** It would seem that there exists a view among some winemakers in the New World that any problems due to soil imbalances can be solved in the winery ("I don't care what kind of grapes you bring me, as long as they don't have too much nitrogen"). We do know that if N availability is too great, vines are out of balance and prone to excessive shading, something which hinders ripening. This problem can be corrected through canopy management, but in the authors' opinion, it is more appropriately corrected through soil and water management in the vineyard.

• The authors' trial took place in 3 cool-climate, fertile vineyards in Victoria (Australia), planted to Sauvignon blanc. The authors made the observation that, in all the vineyards, mineral N was greatest in the top 20 cm (8") of soil, and decreased with depth. This was confirmed by the fact that N mineralization rates for the top 10 cm of soil were some of the highest possible (24 kg of N per hectare per day). This high mineralization tended to produce wines vines with excessive growth. The authors hypothesized that "if the soil in this top zone could be kept as dry as possible during the most rapid N uptake (flowering to veraison), then uptake of N by the vine would be decreased". To test this hypothesis, they imposed 2 main treatments: full irrigation, and soil water deficit. And within each treatment, they imposed 4 sub-treatments: 1) cover crop consisting of the existing grass mix, 2) a ryegrass cover crop, 3) a clover cover crop, and 4) a dead-grass mulch. To be able to determine the proportion of soil nitrogen that was taken up from different soil depths, they labeled the soil nitrogen pool with ^{15}N (by injecting an amount of ^{15}N small enough to make a negligible contribution to the resident N, but large enough to allow monitoring of % of N absorbed). They carried their trial for four years.

• The main findings were: 1) N uptake by the irrigated vines was 4.5 times greater than for non-irrigated vines. Berry ^{15}N concentrations supported this result. 2) Withholding irrigation significantly decreased cluster weight. However, because the non-irrigated treatment had higher number of clusters per vine, yield was actually slightly higher in the non-irrigated treatment. 3) Brix of the non-irrigated vines was significantly higher than in the irrigated ones, whereas pH and TA were lower. 4) Yield/pruning weight ratios were significantly higher in the non-irrigated vines than in the irrigated ones. Finally, 5) Yield/pruning weight ratios were much lower in the dead-mulch treatment than in the native vegetation treatment. These results showed to the authors that, even in a deep soil, abundant in N, **vine N can be moderated through soil water management**. Additionally, they speculate that one of the reasons for the success of Regulated Deficit Irrigation (RDI) is the moderation of N uptake. This effect can occur *directly* -decreased N demand by the vine due to moderate water stress-, or *indirectly* – due to a decrease in the ability of the soil to mineralize N (mineralization rate) when the soil is kept dry.

• **Terroir, soil classification, and precision viticulture.** According to the authors, the real potential for identifying the soil component of terroir lies in the possibility of digitally mapping the soil in a given mesoclimate using instruments linked to a global positioning system (GPS). One example of such instruments is an EM38. The EM38 –for lack of a beter name- measures the *electrical conductivity* of the bulk soil using electromagnetic induction. The device is pulled over the soil being tested and the resultant data is transmitted to a datalogger. Electrical conductivity is then related to soil texture, water content, and concentration of soluble salts to an effective soil depth of 0.75-1.5 m (2.5-5 ft). A number of similar instruments are able to sense soil pH, penetrometer resistance, and visual changes such as color, mottling, cracking, and deposition of clay films. (Electromagnetic techniques can also be applied remotely, like from an aircraft, even if with lower resolution.) The **high resolution digital maps** that these techniques provide **can be used as the basis for precision viticulture**, in which vineyard layouts are planned, and cultural operations are effectively managed, using detailed knowledge of soil variation.

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