



“Influence of climate, soil, and cultivar on terroir”

By: C. van Leeuwen, P. Friant, X. Choné, O. Tregoat, S. Koundouras, and D. Dubordieu

In: Am. J. Enol. Vitic. 55(3):207-217. 2004

- Terroir is sometimes defined as “an interactive ecosystem, in a given place, including climate, soil, and the vine”. Several authors have studied the effect of one or two terroir factors in grape quality, but the goal of this paper is to study the influence of all three parameters -soil, climate, and cultivar- on unirrigated vine development and grape composition all at once.

- The effect of **3 soils** were studied: 1) a *gravelly soil*: 50% stones, 1.2 m rooting depth, water-holding capacity of 40 mm; 2) a *clayey soil*: subsoil with clay greater than 60%, water holding capacity of 168 mm; and 3) a *sandy soil*: sandy-clay texture below 1 m, having a high water table in contact with the roots throughout the season. No water-holding capacity was calculated for this soil (as water uptake was unlimited). In each of these soils, the **3 varieties** studied were: Merlot, Cabernet Sauvignon, and Cabernet franc. The influence of climate was assessed through year-to-year variations from **1996-2000**.

- **Results: 1) Effect on phenology.** Date of veraison was highly influenced by vintage, with a difference between the earliest date (1997) and the latest (1996) of 17 days. In fact, all phenological events occurred earliest in 1997. As for variety, buds of Cabernet Sauvignon always broke later than those of Merlot or Cabernet franc. In addition, the ripening period for Cabernet Sauvignon was significantly longer, which translated into a later harvest date. Cabernet franc harvest was intermediate between that of Merlot and Cabernet Sauvignon. Soil did not have an important influence on the timing of phenological stages.

- **2) Effect on vine vigor.** Shoot length and growth cessation were highly influenced by vintage, followed by soil type, and much less by variety. Shoot growth stopped earlier in dry vintages (1998, 2000), with a difference between the driest (2000) and wettest vintage (1999) of 52 days. Shoot growth also stopped earlier in gravelly and clayey soils, where vines were subjected to water deficit.

- **3) Effect on yield.** Yield was affected by soil type but not by vintage or variety. Yield on sandy soil (which has unlimited water uptake) was 32% higher than that on clayey soil, and 62% higher than that on gravelly soil. These differences could be explained by higher berry weight and more berries per vine on sandy soils. Berry weight was lower for Cabernet Sauvignon and Cabernet franc, compared to Merlot.

- **4) Effect on vine nutrient status.** Petiole nitrogen (**N**) was affected by vintage and soil type, but not by variety. It was low in 1997 and 2000, and it was also low on sandy and clayey soils. Petiole phosphorus (**P**) was negatively correlated with N. As for petiole potassium (**K**), it was influenced by soil and by variety. Indeed, K was high on gravelly soils, and low on clayey soils; and it was also high in Merlot compared to the Cabernets. Finally, the authors measured petiole magnesium (**Mg**), which was affected mainly by soil, being high on clayey soils and low on gravelly soils. The authors could not find a relationship between petiole N, K, P, or Mg contents and berry composition (with the exception of petiole Mg correlating with berry sugar).

- **5) Effect on vine water status.** (Remember, all these vines were dry-farmed.) Vintage had the greatest effect on vine water status (44% of total variance), measured as predawn leaf water potential. In 1998,

vines were subject to medium stress, and stress occurred very early. In the hot, dry year of 2000, vines suffered a strong water deficit. In 1996 and 1997, almost no deficit was recorded. Soil also had a significant effect on water status (even though the authors do not elaborate on this). Finally, there was a small effect of variety, with water potentials for Cabernet Sauvignon less negative than for Merlot and Cabernet franc, which tended to stress readily. Water status also had an effect on berry composition. Berry sugar and anthocyanins both increased as vines became more stressed. Water deficit reduced total acidity.

• **6) Effect on berry composition and maturity.** As we just saw, there was an indirect effect on berry composition through the effect of vintage and soil on vine water status. In addition, variety, soil type, and vintage explained 41%, 32%, and 15%, respectively, of the total variance in **Brix**. Merlot grapes had the highest Brix, followed by Cabernet franc and Cabernet Sauvignon. The clayey soil was the soil that produced the highest Brix at harvest. Finally, 2000 was ahead by 2°Brix than 1997. As for **acidity and pH**, these were mainly determined by vintage (due mainly to malic acid being very high in 1996, and very low in 1998). Cabernet Sauvignon contained, on average, twice as much malic acid as Cabernet franc or Merlot. As for anthocyanin concentrations, both the high-quality vintages (1998 and 2000) and the average-quality vintages (1996 and 1999) produced grapes with high anthocyanin concentrations. The gravelly and the clayey soils produced wines with high anthocyanin concentration, unlike the sandy soil.

- In their discussion, the authors touch on the following important points:
 - _ yield did not seem to affect fruit quality in this study. The authors attribute this to yields being relatively low, and leaf area/fruit ratios relatively high, for this vineyard;
 - _ mineral uptake by the vine, or the ability of the soil to provide nutrients, did not seem to influence fruit quality in this study;
 - _ no general link could be established between daily sunshine hours and vintage quality;
 - _ the best quality seemed to be reached in vintages where low summer rainfall led to water-deficit stress. Good vintages were those where vine water uptake became limiting early in the season, as in 1998.

In conclusion, the effect of *climate* was greatest on most parameters, followed by *soil* and *cultivar*. Vintage influences vine water status through varying amounts of summer rain, whereas soil influences vine water status through varying water-holding capacities. **The best vintages** were those in which water balance from flowering to harvest was most negative (=1998). **The best soils** were those in which water deficits resulted in shoot-growth slackening early, reduced berry size, and high grape sugar and anthocyanin concentrations (=gravelly and clayey soils).

	1996	1997	1998	1999	2000
Temperature			Low maxima bb to-harvest	High minima bb to-harvest	High minima bb to-harvest
Sunshine	High sunshine hours	High sunshine hours	Low sunshine hours	Low sunshine hours	Low sunshine hours
Evapo- transpiration	Similar for all vintages				
Rainfall		Low rainfall April-Sept.		High rainfall April-Sept.	Low rainfall April-Sept.
	Year with low water deficit	Dry year with low water deficit	Year with moderate water deficit	Hot, humid year with moderate water deficit	Hot, dry year with very high water deficit
	Bad vintage for wine quality	Bad vintage for wine quality	Best vintage for wine quality		

Only highlights presented in this table; bb= budbreak

Author: Bibiana Guerra, Editor: Kay Bogart. This summary series funded by J. Lohr Vineyards & Wines.