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Terroir influence on water status and nitrogen status of non-irrigated Cabernet Sauvignon (*Vitis vinifera*). Vegetative development, must and wine composition (Example of a Medoc top estate vineyard, Saint Julien area, Bordeaux, 1997)

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• Within a single estate in Bordeaux, there is generally no climatic variation, but there are usually several different types of soil. In a *dry season*, high berry quality -and therefore wine quality- are strongly linked to a mild water potential. But in a *rainy season*, mild water stress is less likely to occur, and other components of the soil, such as nitrogen, play more of a role. If the vineyard is not fertilized, vine nitrogen status would depend on soil organic matter, its mineralization rate, and the C/N ratio. In this study, the authors explore the effect of soil variation on vine vigor, berry composition, and wine quality.

• To explore soil variation, the authors selected 4 vineyard blocks in Bordeaux, all 25+-year-old Cabernet Sauvignon grafted to *Vitis riparia*, with very different soils (A, B, C, D), as shown below:

	Soil A	***Soil B***	***Soil C***	***Soil D***
Type	Neoluvisol (on gravely soil)	Planosol (heavy clay subsoil	Redoxisol (heavy clay subsoil)	Podzosol
Gravel content	75%	15%	50%	15%
Water table	no	no	yes	no
Texture	Sandy clay	Heavy clay	Sandy clay	Sandy
Organic matter (top 60 cm)	1.5%	1.2%	0.5%	2%
Rootzone depth (meters)	1	1.5	0.7	2

The main differences between these soils are reflected in the texture (sandy, sandy clay, or clay), the amount of gravel (highest in A), the amount of organic matter (very low in C), the depth (highest in D), and the presence of a water table (present only in C). The authors estimated the *water status* of each of these soils by measuring pre-dawn leaf water potentials. And they estimated their *nitrogen status* by measuring juice total nitrogen.

• **Water status of the soils**. Throughout the season, vines in Soil A had a leaf water potential significantly more negative –more stressed- than that of the other locations (-0.12 to -0.30 MPa from July to September). This reflects the low water-holding capacity of this soil, due to the high proportion of gravel and the shallow rootzone. On the other extreme, Soil D, twice as deep and with 5-fold less gravel, showed a higher water potential (-0.10 to -0.17 MPa). Overall, **Soil A was the only soil where vines were subject to a mild water deficit** in 1997.

• **Nitrogen status of the soils**. Soil C had the lowest total nitrogen, which reflected the low organic matter of this soil. In contrast, Soil D, high in organic matter, had nitrogen levels threefold higher. Overall, berry total nitrogen followed soil organic matter content rather closely.

Let's see how these varying water and nitrogen contents affected vine vigor and fruit and wine composition:

• 1) **Effect of soil on vine vigor**. Total leaf area per vine was not significantly different for Soils A, B, and C. However, total leaf area, pruning weights, and yield per vine were all higher in Soil D. The significant differences in vine vigor between soils seem to be due to their nitrogen status rather than to their water status, which tended to be the same. This applies to Soils C and D (with C significantly weaker than D, and with less N but similar water potential) and to Soils B and D (with B significantly weaker than D, again, with less N but similar water potential).

• 2) **Effect of soil on fruit composition**. The low nitrogen status of Soil C reduced yields to a greater extent than did the mild water deficit of Soil A. Berry weight was highest in Soil D, and lowest in Soil C. This is agreement with the greatest and least vigor of the vines on these soils, respectively. The authors attribute the low berry weight of Soil A to the mild water deficit, and the low berry weight of Soil B to the lower nitrogen status. Musts from Soil C –with low organic matter- and Soil A –with mild water deficit- exhibited the highest sugars and the lowest TAs. For all sites, a strong correlation was observed between vine water potential and berry malic acid content at harvest.

• 3) **Effect of soil on anthocyanins, tannins, and wine appreciation**. Anthocyanin content in the resultant wines was highest for Soils C and A. This was also true for tannin concentrations and for the total polyphenol index (IPT). A professional panel of tasters distinguished wines from Soils C and A as the best quality of the four.

In summary, in this French study, two combinations of vine water status and soil nitrogen led to the two highest quality Cabernet Sauvignon wines in a non-irrigated vineyard: 1) a low nitrogen status throughout the season, without water deficit (as in Soil C); and 2) a medium nitrogen status coupled to a mild water status (as is Soil A). The authors also found that low nitrogen status reduced vigor more than mild water deficit. Low nitrogen status also decreased berry weight, increased anthocyanins and tannins in the skins, and reduced yield. But how low is "low nitrogen", and how much yield do we have to sacrifice to increase quality? As the authors said, "it remains to be defined how low nitrogen can be more accurately managed in order to maintain an equilibrium between the highest possible wine quality and a decreased but economically acceptable yield".

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