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How to measure and manage the soil effect in terroir expression

Sourced from the research article "Soil-related terroir factors: a review" (OENO One, 2018)[1].

>>> Terroir relates the taste of wine to the place where it was produced. It involves the influence of climate, soil, cultivar and viticultural practices on wine. A lot of progress has been made over the years in understanding how soil can shape the quality and style of a wine. To observe and explain the soil effect, it needs to be broken into measurable factors. Once these are quantified by appropriate approaches, a terroir can be mapped and managed. By fine-tuning the choice of plant material (rootstock and variety) and viticultural techniques according to local soil conditions, it is possible to optimise terroir expression. <<<

■ Soil effect in terroir expression

It is surprising how different vineyard soils can be. Great wines can be produced on acidic soils with a high gravel content, or on calcareous or heavy clay soils. It is not possible to define a potential high-quality soil by its composition. It would be tempting to conclude from this diversity that soil does not matter. However, a study conducted on 500 vineyard blocks located in famous winegrowing estates in the Bordeaux area has shown that soil type does, in fact, impact wine quality; the soil type significantly influenced the probability that the grapes would be selected for the first quality wine on these estates[2]. Although this study proves that soil type has an impact on wine quality, it does not explain the mechanisms involved. Rocks are studied by geologists and soils by soil scientists; these scholars give names to rocks and soil types and produce maps. These maps provide useful information on how rocks and soils are distributed over a given area, but they cannot explain the process by which they might impact wine quality. To do so, the effect of the soil needs to be decoupled from climate and broken down into measurable units. If soil influences wine quality, this effect is necessarily mediated through the vine. Soil modifies vine phenology and development, as well as ripening traits and grape composition[3]. As a result, wines produced on different soils vary in sensory attributes, because the composition of the grapes changes according to the soil type on which they were produced[4]. To obtain an insight into how soils influence wine quality, we need to understand how the soil influences vine phenology, growth and grape composition at ripeness.

■ Back to basic agronomy

Like any plant, vines respond to their environment. Agronomists know that light, temperature, minerals and water resources are needed to make plants grow and for fruit to ripen. In any given place, these environmental resources are available in different proportions: more or less light, higher or lower temperatures, more or less water, and differing availability of specific minerals.

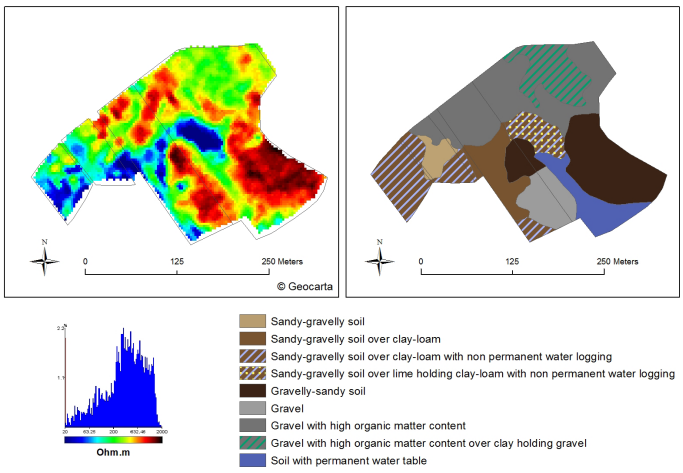

Figure 1. Soil resistivity map and soil map of a winegrowing estate in Bordeaux. Red and black on the resistivity map indicate coarse textured warm soils, blue correspond to cooler soils with higher clay content.

Among minerals, nitrogen matters more than any other. Vine development, phenology, vigour, yield and grape composition at ripeness vary according to the set of available resources. As a result, different soils can either directly (e.g., though modifying berry ripening dynamics) or indirectly (e.g., by impacting the choice of the harvest date) produce grapes with different compositions in primary (sugar, organic acids) and secondary (polyphenols, aroma compounds) metabolites and are likely to produce wines with a different taste.

In terms of soil-related factors, soil temperature, water availability and nitrogen availability can have a major impact on vine physiology and grape composition. Soil temperature influences vine phenology and grapes will ripen earlier on warm soils. Water influences shoot and berry growth and ripening traits. It has been shown that water deficit (but not severe stress) is required for optimal quality and terroir expression, in particular in red wine production[5]. When vines experience water deficit, shoot growth stops early in the season, and berries remain small and contain more polyphenols[5]. Water deficit needs to remain mild to attain optimum white wine quality. Low nitrogen increases berry skin phenolics[6], which is usually positive for red wine making, but can be detrimental for some white wine aromas[7]. Hence, optimum vine nitrogen status is lower in red wine production compared to white wine production.

■ Assessment of soil temperature, nitrogen and water availability

Soil temperature can be measured with specific probes, but it is not easy to integrate results spatially (over the field) and temporally (over the season). The measurement of soil resistivity can be considered as a proxy for soil temperature: soils with high resistivity are generally coarse

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textured and warm, and soils with low resistivity contain more clay and are cooler (Figure 1). Vine water status can be measured by $\delta^{13}C$ on grape sugars (see van Leeuwen *et al.*, 2009 for methodology[5]). By measuring $\delta^{13}C$ on samples taken from a regular grid of 8 - 10 points/ha, vine water status can be mapped (Figure 2). Vine nitrogen status can be assessed by measuring yeast available nitrogen (YAN) in grapes. These measurements can be carried out on the same samples as those collected for $\delta^{13}C$ analyses, and results can subsequently be mapped (Figure 3). By combining soil resistivity, water status and nitrogen status maps, a very precise assessment can be made of the major factors which drive terroir expression.

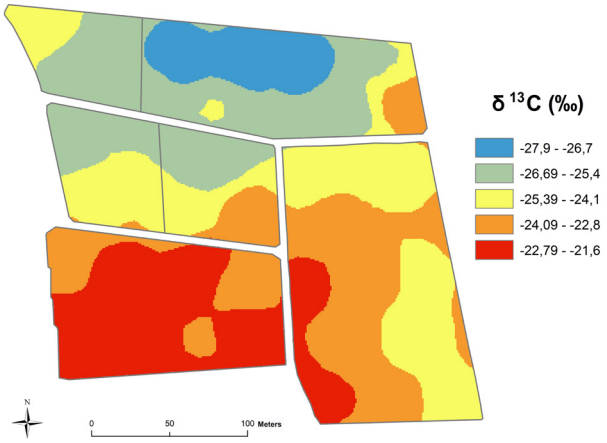

Figure 2. Vine water status map created with $\delta^{13}C$ measured on grape sugars (8 samples/ha). The south-western part of the vineyard experiences significant water deficit, while there is no water deficit in the northern-most block. It was shown that $\delta^{13}C$ correlates well with water potential[5].

■ Management of terroir

Growers can optimise terroir expression by choosing plant material and viticultural techniques according to the set of locally available resources. Rootstocks need to be adapted to soil type. High vigor rootstocks perform better in poor and shallow soils, and low vigour rootstocks in rich and fertile soils. On cool soils, berries risk not attaining full ripeness; hence early ripening grape varieties will perform better. On warm soils, grapes may be too high in sugar, too low in organic acids and show undesirable cooked fruit aromas; these pitfalls can be avoided with late ripening varieties. White varieties perform better on soils with medium to high water and nitrogen availability, while red varieties will produce more concentrated wines on soils where vines undergo water deficit and low nitrogen. The training system should be chosen as a function of available water. High density plantations will adapt to soils with high water holding capacity, while the detrimental effect of excessive water stress can be mitigated with low density plantations, or goblet trained bushvines[8]. Vineyard floor management and fertilisation practices can fine-tune the amount of soil available nitrogen. Cover cropping can create a competition with the vines for nitrogen and lower vine nitrogen status, while nitrogen deficit can easily be compensated for via organic or mineral fertilisation.

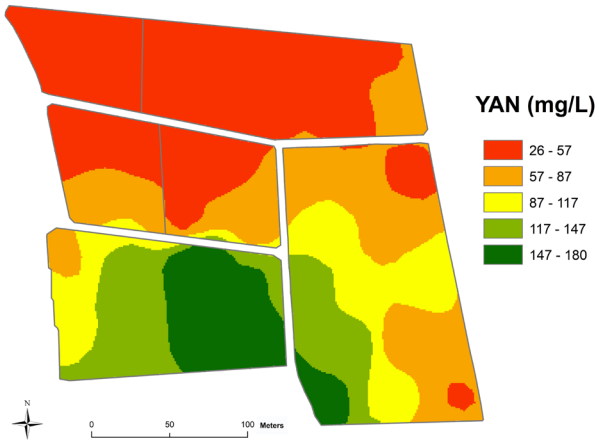

Figure 3. Vine nitrogen status map created with YAN measured on grapes (8 samples/ha). Vine nitrogen status is moderately high in the south-western block, while it is very low in the northern-most block.

■ No myth

Terroir expression is considered by some authors as a myth[9]. We disagree. The terroir effect can be observed and explained when the multiple factors driving terroir expression are hierarchised[3] and broken down into measurable units. Because terroir is highly variable in space, the tools used for measuring these units should ideally be able to produce maps. Once key factors are quantified and mapped they can be used by growers to fine-tune the choice of plant material and viticultural techniques in order to optimise terroir expression. ■

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