EFFECT OF DROUGHT AND HEAT ON VINE PHYSIOLOGY AND GRAPE RIPENING

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Certain vintages reveal the effects of environmental constraints. This was the case in 2003, when drought and heat combined and forced vines to undergo exceptional adaptations, or exposed their inability to adapt to the situation.

Many think that such a situation was exceptional, even if some analogies can be found in the past, some of which, over a century ago. Without doubt, reality gives another account: For about 20 years, both climatologists and viticulturists have observed the effects of a *global climate change* leading to prematurity, as much as a temperature increases during the ripening period with higher maxima in numerous viticultural areas. Although in inconsistent pattern, these phenomena go along with greater variations of the water availability and with particularly severe summer droughts, which are often framed by violent precipitations, particularly in Autum in the Mediterranean.

Thus, the knowledge acquired in 2003 constitutes an investment for some vintages to come. Regarding the vine ecophysiology, the major effects of drought and heat are quite well understood. However, the adaptation of viticultural decisions should be even better handled, specifically *vineyard management and qualitative irrigation*. Moreover, as for the understanding of the effect of “terroirs”, the consequences of such events on grape physiology, biochemistry and genomics are rather incomplete. Similar observations affect the sensory analysis of wines.

In this context, it is useful to review the principles, which result from the energy balance of vineyards. Solar energy collected in the vineyard can be divided into several elements.

1. Vineyard microclimate:

- Light microclimate with effects on different plant organs, effects which depend on the wavelength, from far red over visible to near ultra-violet (phenomena summarized in Figure 1);
- Thermal microclimate, in response to thermal infrared effects and convective and conductive exchanges in the vineyard, with the special case of night temperatures (phenomena summarized in Figure 2)

Figure 1

SPECIFIC RADIATION EFFECTS

	+ Development (light red/dark red)
	floral initiation (overall radiation)
Solar Energy	+ Photosynthesis (visible: blue → red)
	± Structural changes (near ultra-violet)

Figure 2

SPECIFIC THERMAL EFFECTS

(Direct effects of infra-red, indirect effects of thermal exchanges)

	+ Global functioning, growth: active or optimum temperatures
Solar energy	- Modifications/damage: extreme temperatures: heat
	→ berry and leaf dehydration
	± Night temperatures during ripening:
	heat → colouring and aroma problems

Figure 3

OVERALL EFFECTS ON THE ENERGY AND WATER BALANCES

(Main compensation of the radiation enegery received occurs by evapotranspiration)

- Ψ = base leaf water potential

	1 No water stress
	$0 \geq -\Psi > -0.3$ Mpa
Solar energy	2 Moderate water stress:
	$-0.3 \geq -\Psi > -0.6$ Mpa
	3 High to extreme water stress:
	$-0.6 \geq -\Psi > -1.0 \ldots 1.6$ Mpa

Drought → weak photosynthesis, blocked growth with damaged leaves and affected production, limitation of carbon storage

Figure 5

MATURATION 2003

Trends

	Setting	End of Veraison	Maturity	"Quality"
rare	1	1	½	1 Low / 2 Medium
(frequent)	1	2	2/3	2 Optimum (Equillibrium 1 / 3 Optimum (Equilibrium 2))
if strong drought avoided before veraison				
(frequent)	2	3	2/3	2 Low (premature regulation of Grenache) / 3 Particular typicity (limited colour, astringency, particular aromas)
with different cases				
	3	3	3/3+	3 Production and maturation affected / 3+ General alteration causing problems for the following growth period (pruning)

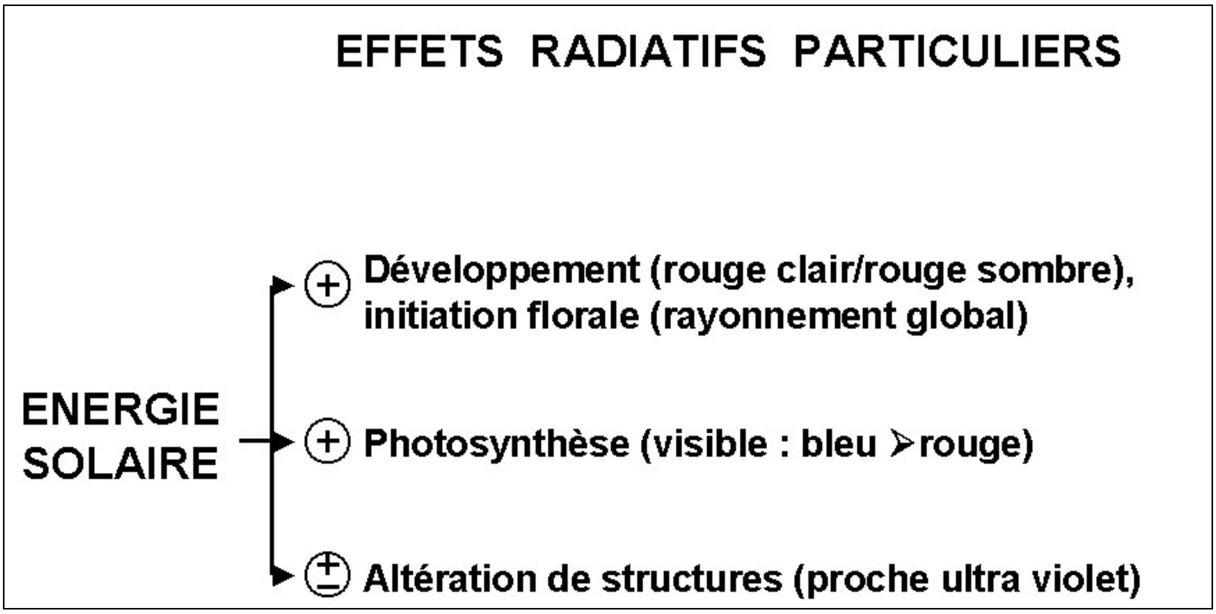

Figure 1

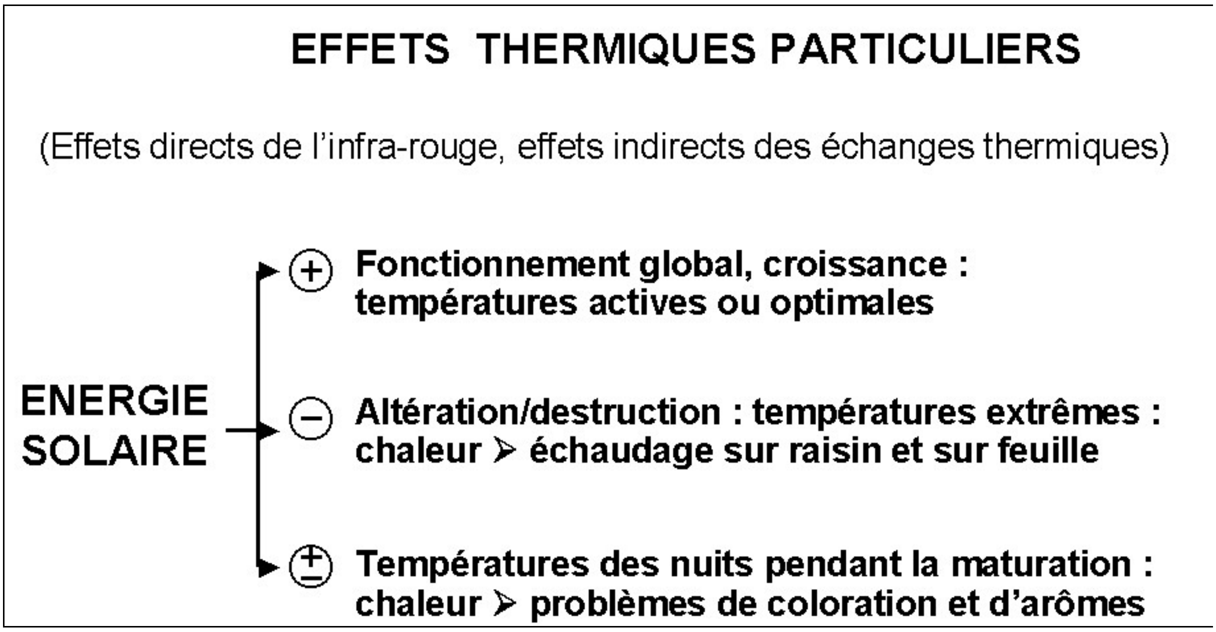

Figure 2

2. Physiological regulation:

- The water balance expresses the equilibrium between the climatological requirements and the soil reserves, and is basis of the regulation of transpiration. Certain physiological limits appear as the water stress increases.

- Define the different stages of the regulation with thoroughly validated thresholds for the base leaf water potential. Without doubt, the technology can be improved, specifically for its practical application (Figure 3).

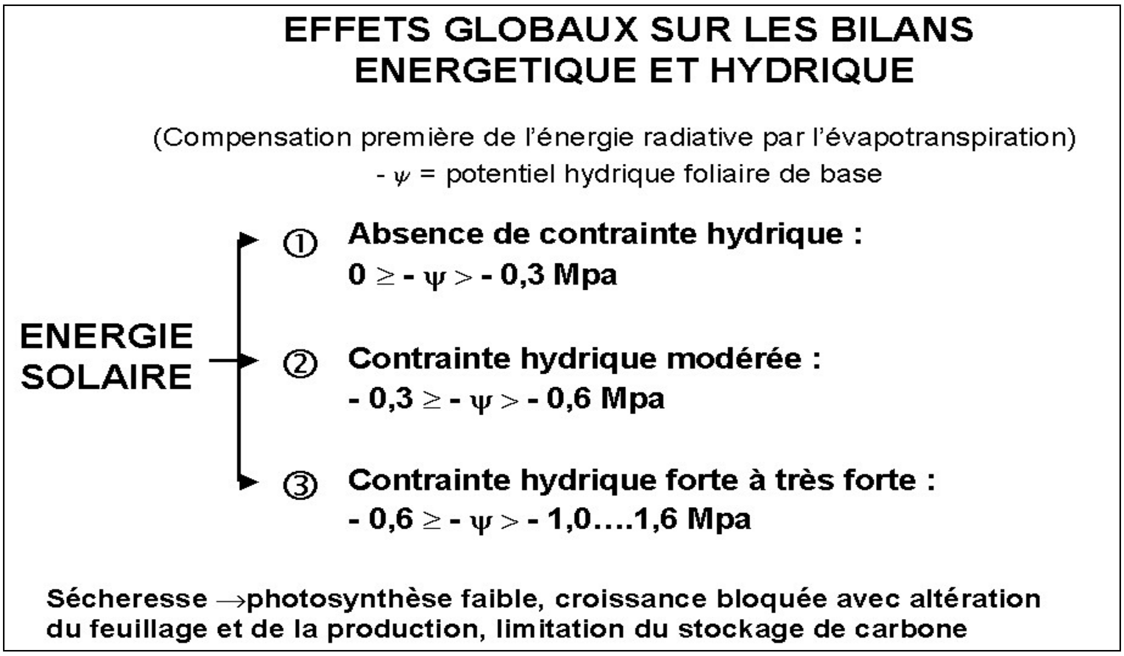

Figure 3

The assessment of the degree of water stress allows to estimate the status of the carbon balance. The latter results from the intensity of the photosynthetic source, which is relatively unaffected by moderate water stresses, and vine vigour. However, vine vigour is reduced with the first manifestations of water stress. Therefore, carbon becomes available for other uses than growth, sush as for grape and shoot maturation. Finally, depending on the crop load, part of the available carbon will feed the grapes and will be more or less concentrated therein. Moderate water stress optimises ripening. A water stress too weak, will underline the limiting factor of the vegetative carbon sink. On the other hand, drought will reveal the limiting factor of the carbon source (Figure 4).

Figure 4

The specific trends of the 2003 vintage, particularly in the French Mediterranean, are summarized in Figure 5 according to the water status of diverse terroirs. Please note the diversity of these water conditions which reached extremes, particularly with the Grenache, which may have blocked certain mechanisms somewhat too early or too fast. It is suggested that there is an association of the typicity with the quality of wines according to the pool of information gathered from regional and experimental vineyards.

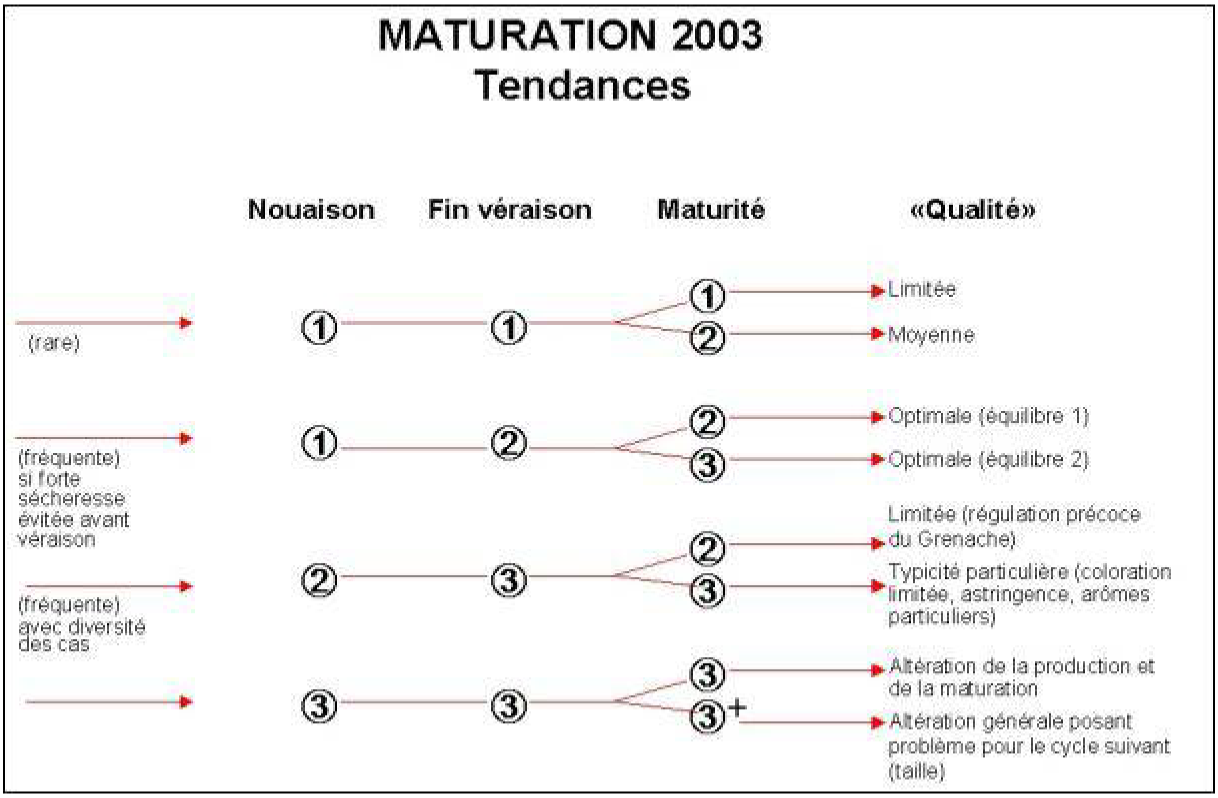

Figure 5