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VITICULTURE & ENOLOGY
UNIVERSITY OF CALIFORNIA DAVIS

Ecophysiological and agronomic response of Tempranillo grapevines to four training systems

By: P. Baeza, C. Ruiz, E. Cuevas, V. Sotés, J. Lissarrague

In: American Journal of Enology and Viticulture. 56(2):129-138. 2005

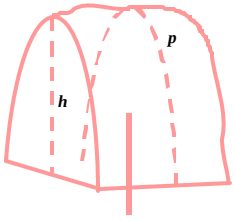
• Training system impacts canopy parameters such as amount of exposed canopy surface, spatial distribution of leaves, and ratio of adult and young leaves, and in turn, determines a vine's physiological performance (vegetative growth, yield, fruit composition) in any given climate.

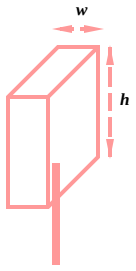
• In this study conducted in Madrid, Spain, from 1990 to 1992, the authors compared a 10-year-old Tempranillo/110R trained to the following training systems:
1) single curtain with free-hanging shoots (=**umbrella**)
2) double-Guyot with vertical upward shoot-positioning (=**VSP**)
3) **high bush** (0.6 m) with 7-8 arms (=vertical cordon)
4) **short bush** (0.2 m) with 8-9 spurs arising from a head (=head pruning).

• For each treatment, the authors measured the following: photosynthetic active radiation (PAR), transpiration and stomatal conductance, yield and yield/pruning ratio (Ravaz index), canopy surface area, and juice composition (Brix, TA, pH). The authors positioned and trimmed the shoots as needed throughout the season to preserve the shape that seemed natural for each trellis system canopy. There were 4 replicates of each treatment, with 7 vines per replicate, in rows running north-south.

• To calculate surface area, the authors likened each treatment to a given geometric figure (i.e. the VSP was a parallelepiped; the high-bush was a hemisphere; the short-bush was a continuous semicylindre). Then they measured the perimeter, radius, and height of each figure to calculate its area. (Canopy gaps were fitted to geometrical figures, such as triangles and squares, and were subtracted.)

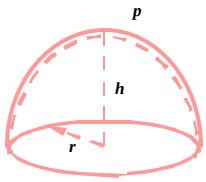
umbrella

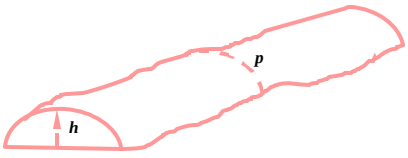




VSP

high bush





short bush
(3 vines)

Diagrams by authors

• **Results.**

		VSP	UMPRELLA	HIGH-BUSH	SHORT-BUSH
GROWTH	**Surface area (SA)** (m^2/m^2 soil)	highest			lowest
	Photosynthesis ($\mu mol\ CO_2/m^2\ s$)	second highest		highest	
	Transpiration ($mmol\ HO_2/m^2\ s$)	lowest			highest
	Stomatal conductance ($mmol\ HO_2/m^2\ s$)	lowest			highest
	Water use efficiency (WUE) ($\mu mol\ CO_2/mmol\ H_2O$)	highest			
	Vegetative growth (kg prunings/m^2)		lowest (tied w/ high-bush)	lowest (tied w/ umbrella)	highest
YIELD	**Yield**	highest		lowest	second lowest
	Ravaz index (Yield/pruning weight)	highest (tied w.umbrella)	highest (tied w. VSP)		lowest
JUICE	**Brix**	highest (2 out of 3 years, tied w/ short-bush)			highest (2 out of 3 years, tied w/ VSP)
	TA				highest
	pH	no difference			

* All stated differences are statistically significant

• **Recommendations:**

VSP had a clear advantage over the other systems in this study, as its large surface area and its high photosynthetic rate were a consistent guarantee of high grape yield. On the opposite extreme, the short-bush had the poorest production potential. This was because, even though its vigor would theoretically allow for an increase in bud load, lack of space on the vine head make this increase impractical. All the systems showed a loss of photosynthetic ability in the afternoon. To mitigate this drawback the authors recommend that:

_ vine rows (umbrella, VSP) be oriented NE-SW to avoid constant, high light intensity on the western side;

_ untrained vines (high bush, short bush) have their vegetation controlled –shortened- so that *"shoots can sway in the breeze and clusters can be aerated yet sheltered from excess light"*.

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