INTERACTION «TRAINING SYSTEM X VIGOUR» ON MERLOT. COMPARISON BETWEEN VERTICAL TRELLIS AND MINIMAL PRUNING. FIRST RESULTS

INTERACTION « SYSTÈME DE CONDUITE/VIGUEUR » COMPARAISON ENTRE LES SYSTÈMES DE CONDUITE TAILLÉS ET LA TAILLE MINIMALE. PREMIERS RÉSULTATS

Alain DELOIRE[1], Alain CARBONNEAU[1], François LOPEZ[1], Sébastien SUAREZ[1,2], Carmen PEREZ[1,3], Pierre DOMERGUE[1], Alain SAMSON[4]

1 : Agro Montpellier, Unité Mixte de Recherche «Sciences pour l'Œnologie», 2 place Viala, 34060 Montpellier cedex 1, France
2 : Université Lujan de Cuyo, Mendoza Argentine
3 : Université Catholique de Santiago, Chili
4 : INRA, Unité expérimentale de Pech-Rouge, Gruissan, France

Résumé : L'objectif de ce travail a été de comparer des systèmes de conduite taillés (espalier, lyre ouverte, lys, rideaux double et simple) avec un système de conduite non taillé, appelé taille minimale, en interaction avec deux blocs de vigueur (forte et modérée) dépendant principalement de la teneur en eau du sol et de la plante. L'étude a porté en priorité sur la taille minimale.
La taille minimale du Merlot a augmenté la production dans les deux situations de vigueur en réduisant le volume des baies, mais principalement le nombre de grappes par pied. La composition des baies de la taille minimale est différente entre les deux situations de vigueur, pour les sucres, les anthocyanes et l'acidité. La composition des vins de la taille minimale est aussi différente en relation avec la vigueur. Les vins issus de la taille minimale en vigueur modérée sont parmi les plus concentrés comme ceux de Lyre, mais avec une composante acide ; la taille minimale en vigueur forte est en-dessous des autres systèmes de conduite sur l'ensemble des composantes qualitatives.
La vigueur modérée équivaut à une contrainte hydrique de l'ordre de –0,4 and –0,6 Mpa de véraison à maturité d'après l échelle de CARBONNEAU (1998) pour les potentiels hydriques foliaires de base. La taille minimale en vigueur forte présente les vins les moins concentrés. Le microclimat des grappes de la taille minimale en situation de vigueur modérée est plus favorable à une meilleure maturation des baies, que celui des grappes de la taille minimale en vigueur forte avec entassement du feuillage. Dans les deux cas les grappes sont plus lâches, en relation avec la taille réduite des baies, ce qui défavorise le *Botrytis*. La taille minimale en situation de vigueur modérée pourrait être une alternative économique intéressante pour certaines gammes de vins de pays ou vins de cépage, par réduction des coûts de la taille et des autres opérations culturales ; ceci à la condition de pouvoir contrôler régulièrement la vigueur à un niveau modéré.

Summary: The purpose of this investigation was to compare classical training systems manually pruned, (Vertical Trellis; Open Lyre, Lys, Geneva Double Curtain, Umbrella Kniffin) with a no pruned training system, the Minimal Pruning, in interaction with two vigour situations (high and moderate) mainly dependant on the soil and plant water content. The study focused particularly on Minimal Pruning.
Minimal Pruning on Merlot has increased the yield in both vigour situations while decreasing the berry size but mainly the total cluster number per vine. The berry composition of the (MP) in the two vigour situations is different, mainly for sugar, anthocyanins and acidity. The (MP) wine composition is also distinguished in relation to the vigour. The (MP) wine from moderate vigour is among the most concentrated such as the open Lyre one, but with a component of acidity; the (MP) wine from high vigour situation is far below all wines in terms of quality.
Moderate vigour means a water limitation between –0,4 and –0,6 Mpa since véraison to harvest maturation according to CARBONNEAU (1998) scale of the predawn leaf water potential. The high vigour (MP) wine is less concentrated than the wines from all the tested training systems.
(MP) in moderate vigour situation has a better cluster microclimate than (MP) in high vigour situation, what could also contribute to favorable berries ripening. In addition, for both, the clusters are less compact what is unfavorable to rots. Minimal Pruning in moderate vigour situations could be an attractive economical option for some range of wines as «vins de pays» or «vins de cépage» by reducing pruning expenses and total costs in general, that if vigour can be regularly controlled at a moderate level.

Mots clés : systèmes de conduite, coût, taille minimale, vigueur, eau, biochimie de la baie, composition des vins

Key words : training systems, cost, minimal pruning, vigour, water, berry biochemistry, wine composition

*Corresponding author: Carbonne@ensam.inra.fr

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Table I - Basic forms and training systems.

Basic form	Training system
Erected Plan	Vertical Trellis – Cordon de Royat (VT)
Lyre	Open Lyre – Cordon de Royat (OL)
Lys	Lys – Cordon de Royat (LY)
Double Curtain	Geneva Double Curtain (GDC)
Tunnel	Umbrella Kniffin (UK)
Net	Minimal Pruning (MP)

INTRODUCTION

Significant percentage of labor costs in a vineyard is associated with the pruning and the harvest. Mechanization of the harvest is now a reality in a lot of vineyards over the world, but pruning full mechanization is still impossible with the classical pruning systems. The concept of minimal pruning has emerged as an alternative to both traditional manual pruning and mechanical hedging (CLINGELEFFER, 1984; MC CARTHY and CIRAMI, 1990; CLINGELEFFER, 1992; POSSINGHAM, 1996; PONI *et al.*, 2000; REYNOLDS and WARDLE, 2001). Minimal pruning is based on the premise that the pruning allows to control the plant vegetative expression, vigour and yield. Hence a minimally pruned vine may become self-regulating in term of balance between the vegetative growth and the yield.

The purpose of this investigation was to compare classical training systems manually pruned, (Vertical Trellis, Open Lyre, Lys, Geneva Double Curtain, Umbrella Kniffing) with a no pruned training system the Minimal Pruning, in interaction with two vigour situations mainly dependant on the soil and plant water content. The plant physiology and growth, the berry biochemistry composition and the wine composition and quality were studied.

MATERIAL AND METHODS

Plant material and field conditions: The variety is Merlot (*Vitis vinifera* L.) grafted onto SO4 and twenty year old. The training systems are described in table I, all of them are pruned in double Cordon de Royat. The Vertical Trellis (VT), the Open Lyre (OL) and the Lys (LY) have the first (pruning) wire at about 0.60/0.7 m from the soil, the Lys having the second wire at 1.0 m The foliage is hold by a pair of movable wires. The Minimal Pruning (MP), the Geneva Double Curtain (GDC) and the Umbrella Kniffin (UK) have the first (pruning) wire at about 1.5 m from the soil. The MP, GDC and UK are transformed VT of 7 years. The foliage is free. For all the training systems, the vines were set at 1,20 m in the row and 2,5 m between rows.

The experimental vineyard has two different vigour situations in relation to the soil depth: the vines in the strong vigour situation have no water restriction, and the vines in medium vigour situations have low hydric stress from véraison to harvest maturity, in relation to climatic conditions (figure 1). The training systems (excepted the Lys) are represented in both situations. The data are from one or two years, 2001 and 2002.

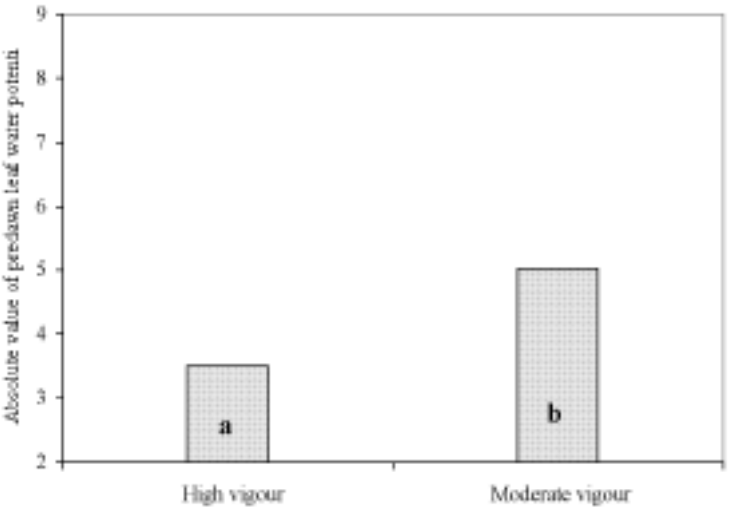


Figure 1 - Variance analysis of the training systems in interaction with the vigour for the predawn leaf water potential parameter (24/08/01). The statistical groups a,b are separated at a risk of $\alpha = 0{,}001$.

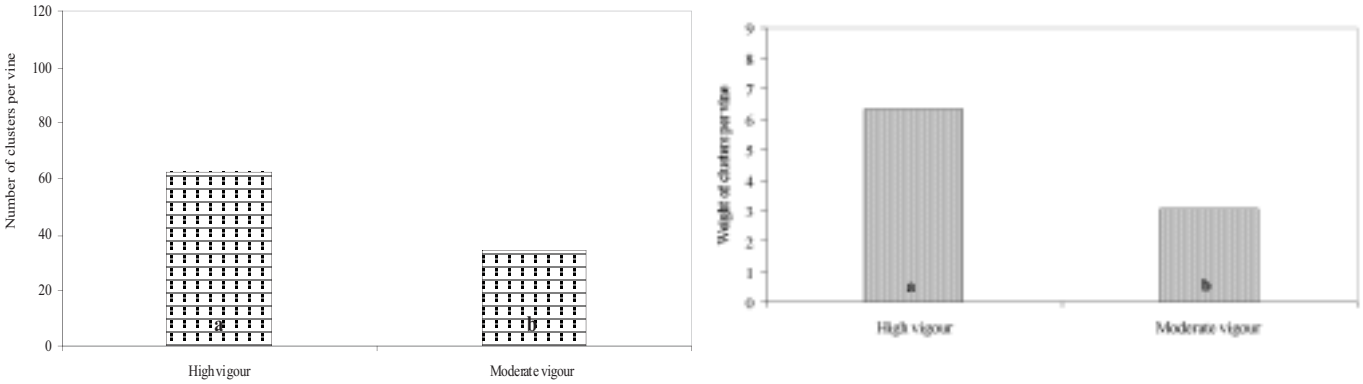
Plant Physiology: The following observations and measurements have been done: total buds per vines, phenological stages according to the scale of LORENZ *et al.* (1995), primary and secondary shoots number and growth from bud break to véraison or harvest maturity, number of leaves per shoot or per plant, exposed and total leaf areas (CARBONNEAU, 1995; MABROUK and CARBONNEAU, 1996), plant water status with the leaf water potential methods (SCHOLANDER, 1965; OJEDA *et al.*, 2001; CHONÉ *et al.*, 2001), bud fertility.

Berry growth and biochemistry: The following observations and measurements were done: number of clusters per shoot and vine, number of berries per bunch, berry size and weight with a method of berry classification (OJEDA *et al.*, 2001).

The following biochemistry compounds were analyzed: total sugar concentration by a temperature compensating refractometer, titrable acidity and pH and total anthocyanins according to OJEDA *et al.* (2002).

The date of harvest is determined according to sugar and titrable acidity level and with the berry sensorial tasting method (ROUSSEAU and DELTEIL, 2000).

Vinification and wine analysis: The wine is elaborated using a mini-vinification method (SAMSON, personal communication, INRA Pech-Rouge, Gruissan,



Figures 2 and 3 - Variance analysis of the training systems (VT, OL, LY, GDC, UK, MP) in interaction with the vigour, showing the mean vigour effect for the following parameters at harvest: number of clusters per vine (figure 2) and weight of clusters per vine (figure 3). The statistical groups a,b are separated at a risk of $\alpha = 0{,}001$

France) with 80 to 100 kg of grapes. After alcoholic and malolactic controlled fermentation, the wine is filtered, aerated, bottled, and tasted by a specific wine tasting panel. Classical analysis are performed on the wine: pH, titrable acidity, alcohol, dry matter, anthocyanins, total phenols, colour intensity, potassium.

RESULTS

Vigour characterization of the two situations: To characterize the two vigour situations, for all training systems, we have used the plant water content measured by the predawn leaf water potential and the yield parameters (figures 1, 2 and 3).

Wine composition of the training systems in interaction with the vigour: The wines from the training systems are distinguished by the following parameters: dry matter, anthocyanins, total phenols, tartaric acid, alcohol and potassium for the horizontal axis or first principal component, and the titratable acidity for the vertical axis or second principal component (figure 4).

The vigour situations are clearly gathered.

The MP wines are separated from the other training systems wines, and are separated between them in interaction with the vigour.

Notice the position of the other training systems which will be more analysed in next publications, particularly the Open Lyre – Moderate Vigour which shows the best equilibrium of maturity.

Specific comparison between Vertical Trellis and Minimal Pruning in interaction with the vigour

Vegetative growth: The shoot growth of VT, in high and moderate vigour situations, reflects the vigour status and is active until véraison and later for vigorous situation. The shoot growth of MP occurs only until anthesis – berry set (figure 5).

The number of shoots per vine is 5 to 6 time higher in MP than for VT, but the length of a shoot is 2 to 2,5 time inferior. The vigour has no effect on the number of shoots per vine, but has an influence on the length of a single shoot for MP. The number of leaves is in general in relation to the shoot length. There is no secondary shoot with MP (table II).

The total leaf area of a MP vine is 2 or 3 time superior compared to VT, but the area of a MP single leaf could be 1,5 to 3 time inferior than for VT.

The shoot fertility, in relation to the total shoot length and number per vine, is inferior for MP than for VT with an effect of the year for MP in moderate vigour situation (table II).

There is no water stress in high vigour situation for both training systems, according to the predawn leaf water potential scale of CARBONNEAU (1998). The predawn leaf water potential is lower for MP (on average –0,6 Mpa) compared to VT (on average –0,3 Mpa) in moderate vigour situation from véraison to harvest maturity. The observation of the leaf water potentials during the day has shown that the water constraint is more important for MP in moderate vigour situation than in high vigour, and than VT in both vigour situations.

Berry growth: the cluster number per vine is always superior for the MP in comparison with VT. The number of berries per cluster, the berry size and weight are always inferior for MP compared to VT (table III).

Berry biochemistry: the less favorable results were obtained with MP in high vigour situation, both for sugar and total anthocyanins. The highest sugar and total anthocyanins contents were observed with VT and MP in mode-

Table II - Vegetative growth parameters for Minimal Pruning and Vertical Trellis in interaction with the vigour on Merlot. Data from 2001 and 2002.

Training systems	total shoot lenght / vine (m)		total secondary shoot lenght / vine (m)		total shoot number / vine		lenght of a single shoot (cm)		number of leaves / shoot		total leaf area / vine (m^2)		exposed leaf area (m^2)		shoot fertility	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Vertical Trellis high vigour	25,232	18,4	6,48		16	12	151,7	152	26	29	5,7	5,4	/	0,80	2,1	
Vertical Trellis moderate vigour	32,4	20,7	5,65		20	16	162	128,8	31	28	7	6,44	/	0,68	1,27	1,6
Minimal Pruning high vigour	87	89,9	0	0	127	138	68,5	65	16	18	17,34	22,88	/	1,16	0,85	
Minimal Pruning moderate vigour	65	74,63	0	0	127	151	51,2	49,5	15	15	12,77	20,15	/	0,94	0,39	0,9

Table III - Yield and ripening parameters for Minimal Pruning and Vertical Trellis of Merlot. Data from 2001

Training systems	Number of clusters / vine	Number of berries / cluster	Weight of a cluster (g)	Weight of a berry (g)	Yield/vine (kg)	Estimated yield / hectare (t)	Probable alcohol (%)	pH	Titrable acidity (g/l)	Total anthocyanins (mg/kg)
Vertical Trellis high vigour	34	80	141	1.76	4.8	15	12.6	3.58	3.52	407
Vertical Trellis moderate vigour	25	73	117.7	1.62	3	9,8	13.0	3.46	3.50	530
Minimal Pruning high vigour	108	60	82	1.37	8,8	28	11.8	3.38	4.10	434
Minimal Pruning moderate vigour	50	44	59.2	1.33	3	9,8	14.3	3.52	2.91	550

rate vigour situation. The less titrable acidity is observed with MP in moderate vigour, (table III). The berry weight of MP in both vigour situations is similar, suggesting that the difference of berry composition between the two MP in both vigour situations is few in relation to the berry concentration. A good explanation of berry maturity in general is provided by the ratio «Exposed Leaf Area (m^2/m^2 soil)/ yield (kg/m^2 soil)», expressed as m^2/kg; in 2002 the values are :

0.96 for (MP, MV), 0.41 for (MP, HV), 0.69 for (VT, MV) and 0.53 for (VT, HV).

DISCUSSION AND CONCLUSION

Minimal Pruning on Merlot has increased the yield in high vigour situation without increasing the berry size but mainly through the total clusters number per vine; in moderate vigour situation the yield is similar to the control (on the second year of minimal pruning, 2001). The berry composition of the MP in the two vigour situations is different, mainly for sugar, anthocyanins and acidity. The MP wine composition is also distinguished in relation to the vigour. The MP wine from moderate vigour is more concentrated. Moderate vigour means a water stress between –0,4 and –0,6 Mpa since véraison to harvest maturation according to CARBONNEAU (1998) scale of the predawn leaf water potentials. The high vigour MP wine is less concentrated than the wines from all the tested training systems.

The moderate vigour MP wine fits many quality criteria, but a more precise comparison with other wines (Open Lyre and Vertical Trellis) is needed. In any case, those interesting results are explained for a great part by an high value of the ratio «potential Exposed Leaf Area/yield».

Besides, it can be indicated that MP in moderate vigour situation has a better cluster microclimate than MP in high vigour situation, what could also contribute to favourable berry ripening. In addition, for both, the clusters are less compact what is unfavorable to rots.

Minimal Pruning has to be studied over more vintages, particularly in respect with the stability of the vine development and wine sensorial analysis. At the moment, it can just be indicated that Minimal Pruning and moderate vigour vines can produce wine with an interesting level of concentration (sugars, phenols); the aromatic characteristics require more data and replicates, and first indi-

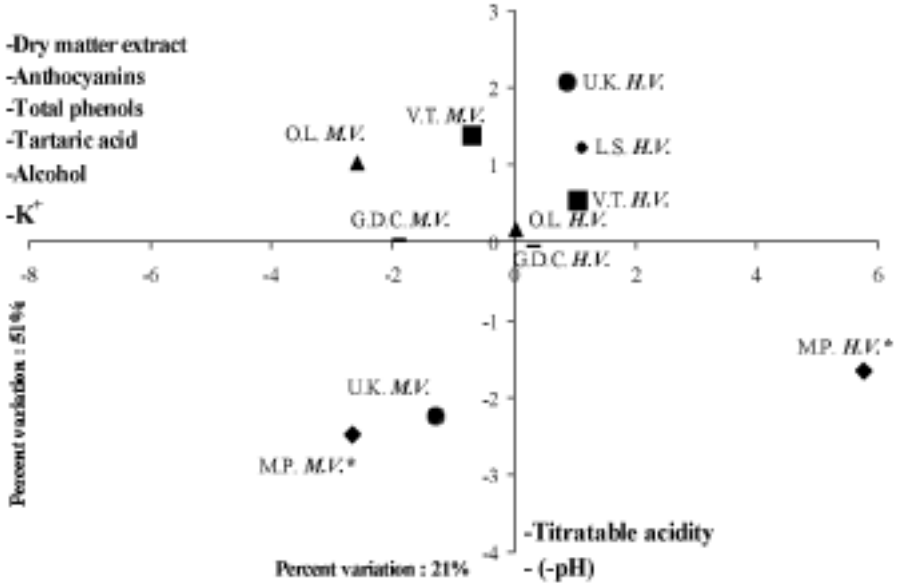


Figure 4 - Principal component analysis of the wines from the training systems in interaction with the vigour. Minimal Pruning wines (*) are well separated in relation to the vigour situations.

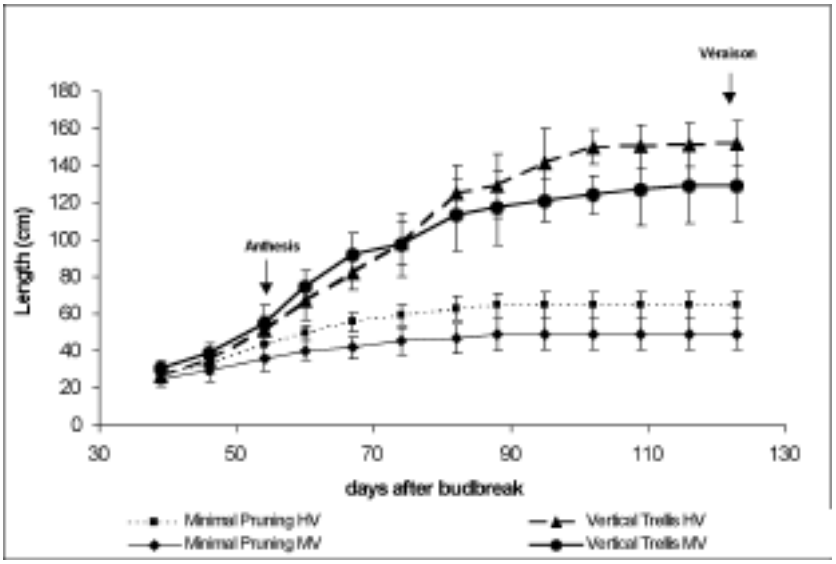


Figure 5 - Shoot growth from budbreak to véraison. Interaction between vigour and the training systems Minimal Pruning or Vertical Trellis. Data from 2002. HV: High Vigour; MV: Moderate Vigour.

cations show that its aromatic profile seems to be less complex and typical than those of the references. If the global results of such studies are positive, even if the top quality is not reached as for the Lyre for instance, Minimal Pruning in moderate vigour situations could be an attractive economical option for medium range wines such as some «vins de pays» or «vins de cépage» by reducing pruning and general expenses.

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