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RESPONSE OF GROWTH, YIELD AND BERRY COMPOSITION TO BASAL LEAF REMOVAL IN JAEN GRAPEVINE

EFFET DE L'EFFEUILLAGE SUR LE DEVELOPPEMENT VEGETATIF, LE RENDEMENT ET LA COMPOSITION DU RAISIN CHEZ LE CEPAGE JAEN

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Abstract:Results from a leaf removal experiment located at Dão Winegrowing region of Portugal are presented. Three intensity levels of defoliation (control non-defoliated, leaves removed up to the third basal node and up to the sixth basal node) are compared. Defoliation treatments had no significant effect on yield and on must soluble solids, showing that the remaining leaves were able to guarantee berry development and sugar accumulation in the fruit. The more intense defoliation treatment induced favorable effects on light microclimate in the cluster zone, with positive consequences for polyphenols synthesis and reduction of *Botrytis cinerea* Pers. incidence.

***Key words*:** Grapevine, defoliation, canopy microclimate, yield, berry composition, bunch rot.

Résumé: Les effets de trois intensités de l'effeuillage (témoin non effeuillé, trois et six feuilles supprimées des nœuds de la base ont été étudiées dans un vignoble du Centre d'Études Vitivinicoles de la Région Vitivinicole du Dão, au Portugal. Les traitements effeuillées n'ont eu aucun effet significatif sur le rendement et la teneur en sucre des baies, démontrant que les feuilles restants ont été capables d'assurer la croissance et la maturation de la baie. L'effeuillage plus intense a induit des effets favorables sur le microclimat lumineux au niveau des grappes, avec des conséquences positives sur la synthèse de polyphénols et sur la réduction d'incidence de la pourriture grise (*Botrytis cinerea* Pers.)

Mots clés: Vigne, effeuillage, microclimat des grappes, rendement, qualité des baies, pourriture.

1. INTRODUCTION

Leaf removal is a recognized canopy management practice, used in viticulture aiming at improving the quality of the grapes and controling pests and diseases. Leaves removed from the basal portion of the shoots may lead to a greater cluster exposure allowing better fruit composition and, consequently, an improvement in berry quality (Koblet *et al*., 1994). This improvement is determined by the increase in polyphenol and anthocyanin levels in the must of red wine grapes (Andrade, 2003). Futhermore, the removal of basal leaves around the cluster has been used to reduce the risks of diseases, particularly of bunch rot *Botrytis cinerea* Pers., leading to a less frequent application of fungicides (Pieri *et al*., 2001).

Basal leaf removal can increase the photosynthetic activity of the remaining leaves by a *source*/*sink* compensation effect (Candolfi-Vasconcelos, 1990). However, severe defoliation can induce an excessive cluster exposure and berry sunburn mainly in hot regions.

In this work partial results of a leaf removal field experiment on a red variety with small internode length are presented.

2. MATERIAL AND METHODS

This research was conducted in a vineyard at the Centro de Estudos Vitivinícolas do Dão, in Nelas (40° N, 7°51'W, altitude 440m) located at Dão Winegrowing region (Portugal). The variety of *Vitis vinifera* L. studied was Jaen, grafted on 1103 Paulsen rootstock in 1989. The vines were trained on a bilateral Royat Cordon system using a vertical shoot positioning with a pair of movable wires and spur pruned. The vineyard has a planting density of 5 555 vines per hectare with vines spaced 1.0 m within and 1.8 m between rows. The overall study occurred from 1999 to 2002, but in this work only the 2002 results are presented, the remaining results are presented in Andrade (2003).

The experimental design consisted of a three randomized block design and included three defoliation treatments: **T** - no main leaves removed (control); **D3 -** main leaves and lateral shoots removed at three basal nodes on all shoots of the vine; **D6** - main leaves and lateral shoots removed at six basal nodes on all shoots of the vine.

Defoliation was accomplished about one week after setting. Just before defoliation, all the treatments were topped to 18 nodes per shoot.

Gas exchange measurements of the exposed leaves from the upper third of the shoot were carried out under saturated light conditions, using a portable IRGA– ADC-LCA4 system. The photosynthetically active radiation (PAR) intercepted at cluster zone was measured on sunny days at midday using a Sunflek Ceptometer (model SF-40, Delta T Devices LTD) and the ratio red/far red (660/730 nm) with a R/FR sensor (Skye Instruments LTD, UK). Must composition was analyzed according to O.I.V. methods OIV, (1990). Leaf area per shoot was assessed in a non-destructive way, using the methods described by Lopes *et al*. (2004).

3. RESULTS

Main leaves reached full expansion at 55 days after full bloom. Treatment D6 (intense defoliation) shows mean leaf area values per main leaf significantly higher than treatment T (control), while treatment D3 (moderate defoliation) showed an intermediate value (Fig.1a).

At harvest, the mean leaf area per main leaf of treatment D6 was about 6 % higher than the control and 3 % higher than D3.

Figure 1b refers to the evolution of the total leaf area per vine throughout the vegetative cycle. 17 days after full bloom, the total leaf area per vine was identical in all treatments. Defoliation, carried out one week after setting, induced a reduction of 17 % and 33 % in the initial leaf area of the treatments D3 and D6, respectively, when compared to the control plants. Total leaf area increased in all treatments, reaching a maximum at veraison and then decrease until harvest. After basal leaf removal and up to 97 days after full bloom, treatment D6 showed a total leaf area significantly lower than the remaining treatments. However at harvest no significant differences were observed.

When compared to the control, D6 treatment induced a significant increase on the percentage of PAR intercepted at the cluster zone, while treatment D3 presented intermediate values that didn´t differ significantly from the remaining treatments (Fig.2a).

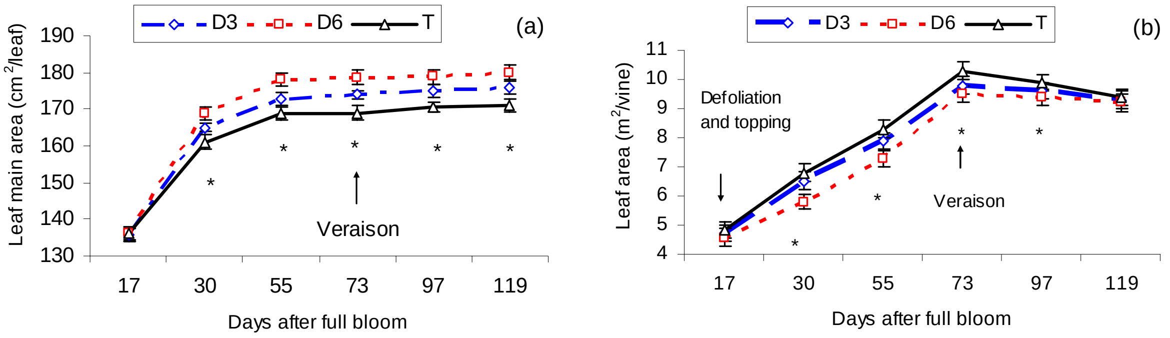

Figure 1
*Effect of leaf removal on main leaf area growth (a) and on the evolution of total leaf area (b) of the plant in the 2002 experiment. T - no main leaves removed (control); D3 and D6 - main and lateral leaves removed at the first 3 and 6 basal nodes respectively. Values shown represent the mean of 36 shoots with standard error; * - show statistically significant differences at P<0.05*

Figure 1
*Influence de l'effeuillage sur l'évolution de la surface foliaire par feuille principal (a) et sur l'évolution de la surface foliaire total par cep (b) pendant l'année 2002. T - témoin non effeuillé; D3 et D6 - effeuillage des feuilles principales et des entrecoeurs sur les 3 et 6 premières nœuds de la base respectivement. Les valeurs sont la moyenne de 36 sarments avec l' écart type. * - significatif au niveau de P<0.05.*

Regarding the quality of the intercepted light, estimated as the ratio of red to far red, it was observed that the clusters of treatment D6 had significantly higher values than those of the control and D3 plants (Fig.2b).

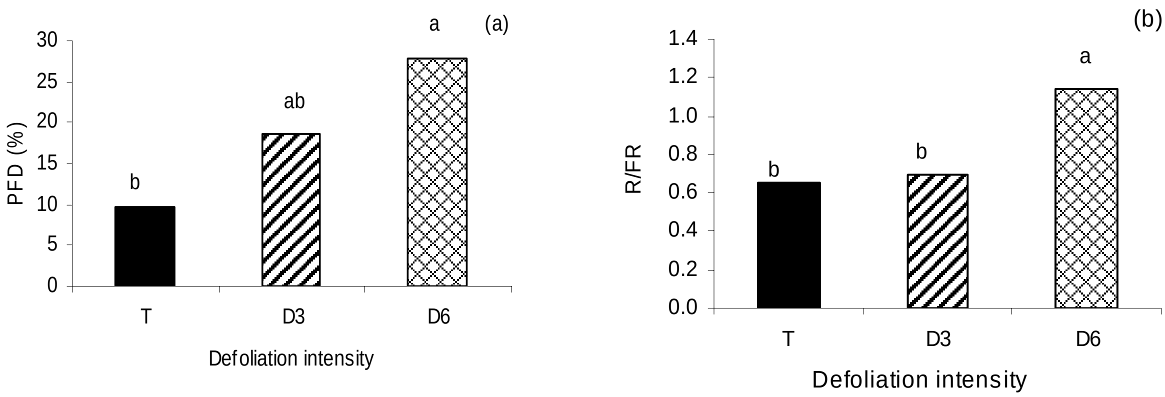

Figure 2
Effect of defoliation intensity in the % of the photosynthetic photon flux density (%PFD) (a) and in the ratio of red to far red (R/FR) light received by the clusters (b) in the 2002 experiment. T - no main leaves removed (control); D3 and D6 - main and lateral leaves removed at the first 3 and 6 basal nodes respectively. Mean of 24 measurements per treatment. Different letter suffixes show statistically significant differences at P<0.05.

Figure 2
Influence de l'effeuillage sur la pourcentage de densité de flux de photons (%PFD) (a) et sur le rapport R/FR (b) reçue au niveau des grappes pendant l'année 2002. T - témoin non effeuillé; D3 et D6 - effeuillage des feuilles principales et des entrecoeurs sur les 3 et 6 premières nœuds de la base respectivement. Les valeurs représentent la moyenne de 24 measures.

The more defoliated plants (D6) showed a significantly higher photosynthetic rate (A) when compared to the remaining treatments and a stomatal conductance (g_s) significantly higher than the control (Table 1). In treatment D3 intermediate g_s values were registered which did not differ significantly from the remaining treatments.

The control vines presented a significantly higher severity of cluster bunch rot than the defoliated treatments (Fig.3).

Table 1

Effect of leaf removal on photosynthetic rate (A) and stomatal conductance (g_s) in the 2002 experiment. T - no main leaves removed (control); D3 and D6 - main and lateral leaves removed at the first 3 and 6 basal nodes respectively.

Tableau 1

Influence de l'effeuillage sur la photosynthèse (A) et la conductance stomatique (g_s) pendant l'année 2002. T - témoin non effeuillé; D3 et D6 - effeuillage des feuilles principales et des entrecoeurs sur les 3 et 6 premières nœuds de la base respectivement.

	A (*µmol m*$^{-2}$ s^{-1})	g_s (mmol m^{-2} s^{-1})
Intensity of defoliation		
T	6.6 b	134.0 b
D3	7.4 b	150.0 ab
D6	9.2 a	191.5 a
Sig.	*	*

Note: Sig. – level of significance; * significant to the 0.05 level, for the test of Fisher. In each column, the followed values of the same letter do not differ significantly to the level of 0.05 for the test of the MDS.

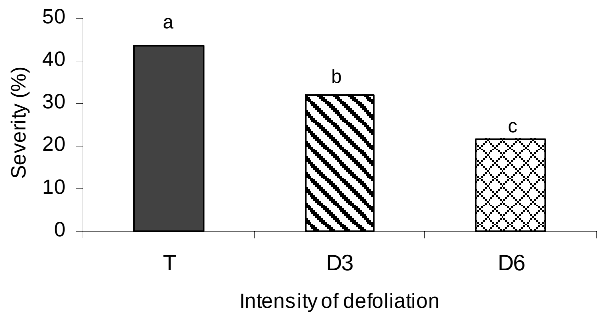

Figure 3

Effect of leaf removal on Botrytis cinerea Pers. severity in the clusters at the 2002 experiment. T - no main leaves removed (control); D3 and D6 - main and lateral leaves removed at the first 3 and 6 basal nodes respectively. Values shown represent the mean of 180 clusters for treatment. Different letter suffixes show statistically significant differences at P<0.05.

Figure 3

Effet de la intensité de l'effeuillage sur la Botrytis cinerea Pers. au niveau des grappes) pendant l'année 2002. T - témoin non effeuillé; D3 et D6 - effeuillage des feuilles principales et des entrecoeurs sur les 3 et 6 premières nœuds de la base respectivement. Les lettres différents indiquent des différences significatives au niveau de 0.05.

At harvest leaf removal had no significant effect on yield components and on sugar content, titratable acidity and pH of the juice (Table 2). However, the D6 treatment showed berry skin anthocyanins and phenols content values significantly higher than the control, while D3 presented intermediate values not significantly different from T nor D6.

Table 2

Effect of leaf removal on yield components and quality of the must in the 2002 experiment. T - no main leaves removed (control); D3 and D6 - main and lateral leaves removed on the first 3 and 6 basal nodes respectively.

Table 2

Influence de l'intensité de l'effeuillage sur le rendement et la qualité du moût pour le cépage Jaen pendant l'année 2002. D3 et D6 - effeuillage des feuilles principales et des entrecoeurs sur les 3 et 6 premières nœuds de la base respectivement.

Treatment	T	D3	D6	Significance
Yield (kg/vine)	2.0	2.1	1.8	n.s.
clusters/vine	15.5	15.2	13.9	n.s.
Cluster Weight (g)	122.6	126.5	128.8	n.s.
Must prob. alcohol (% v/v)	11.2	11.3	11.3	n.s.
Titratable acidity (g tart. ac./L)	5.80	5.70	5.60	n.s.
pH	3.51	3.50	3.51	n.s.
Anthocyanins (mg/L)	815 b	922 ab	966 a	*
Total phenols (IFC)	33.0 b	39.3 ab	44.5 a	*

Note: IFC – Index of Folin Ciocalteu; Sig. – level of significance; ns – not significant; * significant to the 0.05 level, for the test of Fisher. In each column, the followed values of the same letter do not differ significantly to the level of 0.05 for the test of the LSD.

4. DISCUSSION

Despite the significant decrease on leaf area per vine observed after leaf removal, at harvest the defoliated plants showed approximately the same leaf area of the control as a consequence of higher leaf senescence rate of the control vines during the ripening period.

The higher photosynthetic rates presented by D6 treatment show that the reduction of the souce size by leaf removal induced an increase on the photosynthetic efficiency of remaining leaves, as already observed on other varieties by Candolfi-Vasconcelos (1990) and Queirex (2001).

The absence of significant differences on must sugar and acidity content indicates that defoliation did not induce any delay in berry ripening, similar results to those obtained by Koblet (1990) and and Koblet *et al*. (1994). However, when compared to the control plants, D6 induced a significant increase (15 % more) in anthocyanin and total phenols concentrations. These higher concentrations of anthocyanin and total phenols were also observed by other authors in defoliation experiments with other varieties (Leppert, 1994; Hunter *et al*., 1995; Serrano *et al*., 2001) and can be explained by the positive effect of leaf removal on cluster light microclimate (Haselgrove *et al*., 2000; Bergqvist *et al*., 2001).

The D3 treatment presented a berry composition intermediate or similar to the control indicating that this defoliation intensity (first 3 basal nodes) was not enough to promote significant alterations in must quality.

Basal leaf removal induced a better light microclimate at fruit zone and reduced the severity of *Botrytis cinerea* Pers. attacks. These results can be explained by the positive effects of the leaf removal on canopy density reduction which promotes air circulation on cluster zone, enabling a faster drying of the dew or the rain on the berries (Koblet *et al*., 1994).

In conclusion our results show that, in Dão region and with this variety with small internode length, the removal of the main and lateral leaves from the 6 basal nodes can be a favourable practice to increase berry colour and to reduce *Botrytis cinerea* Pers. incidence.

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