Vitis 49 (2), 51–53 (2010)

Early leaf removal increases flower abscission in *Vitis vinifera* 'Semillon'

N. Lohitnavy, S. Bastian and C. Collins

School of Agriculture, Food and Wine, University of Adelaide, Adelaide, Australia

Summary

Leaf removal was applied to Semillon vines in two different vineyards at different growth stages. Percentage fruit set and yield were reduced by leaf removal treatments. The magnitude of the reduction in yield was due to a decrease in bunch weight which was largely due to an increase in flower abscission and possibly the proportion of seedless berries and LGOs. The greatest reduction in yield was achieved when leaf removal was applied before and at the start of flowering.

Key words: abscission, fruit set, flowering, yield.

Introduction

The practice of leaf removal is used in vineyards to manipulate yield (Coombe and Dry 1988). Previous studies have demonstrated that leaf removal can be used to manipulate yield and that timing and severity is critical (Bledsoe *et al.* 1988, Candolfi-Vasconcelos and Koblet 1990, Poni *et al*. 2006). When management practices such as shoot topping and the application of plant growth regulators are applied during the flowering period yield can also be manipulated. These yield responses have been correlated to fruit set and the level of flower abscission and/or a disruption in the fertilisation process (Collins and Dry 2009). The aim of this study was to investigate which reproductive parameters were affected when leaf removal was applied before, during and after the flowering period in 'Semillon' vines.

Material and Methods

Two vineyards in South Australia, Australia were chosen for this study; one in the Barossa Valley (BV) (34°4' S, 139°0' E) and the other the Waite Coombe vineyard, University of Adelaide (WC) (34°9' S, 138°6' E). Both vineyards were own-rooted 'Semillon' (*Vitis vinifera*) vines trained to a bilateral cordon. At the WC vineyard, 'Semillon' (clone SA 32) was planted in 1991 with 3 m row spacing (rs), 1.8 m vine spacing (vs), hand pruned to 35 nodes per vine and trained by vertical shoot positioning. At the BV vineyard, 'Semillon' (clone unknown) was planted in 1989 with 3.4 m rs, 1.4 m vs, mechanically pruned to 34 nodes per vine and a sprawling canopy trellis system. Apart from applied treatments, the same cultural practices were employed at both vineyards to maintain healthy vines.

In 2007, three treatments were applied at different grapevine growth stages determined using the modified E-L system (Coombe 1995). Leaf removal before flowering - stage 18 was applied 23 October at WC and 27 October at BV. Leaf removal at start of flowering - stage 23 was applied 2 November at WC and 11 November at BV. Leaf removal after flowering - stage 29 was applied 19 November at WC and 25 November at BV. Sixty percent of leaves on all shoots with fourteen expanded leaves or less were removed. For shoots with more than fourteen leaves, eight leaves were removed (from the base of the shoot).

Vegetative measurements recorded included; number of shoots per vine, shoot length and diameter, number and length of lateral shoots and pruning weight per vine. Three randomly selected inflorescences per vine were covered with mesh bags before flowering to collect flower caps and estimate flower number. The same three bunches per vine were then harvested and frozen (-20 °C) for reproductive measurements. Bunch number and yield were also recorded at harvest for all vines.

Bunch weight, berry weight and diameter, seeded berry number, seedless berry number and live green ovaries (LGOs) (as defined in May 2004) were recorded from all frozen bunches. Flower cap number was then used with berry numbers (seeded and seedless) to determine percentage fruit set. Two novel indicators of fruit set were also determined; Coulure Index (CI)[1] and Millerandage Index (MI)[2] (Collins and Dry 2009).

CI is an indicator of the proportion of flowers which do not develop into either a berry or an LGO. MI is an indicator of the proportion of all post-flowering organs that develop into seedless berries or LGOs. For both indices, which can range from 0 to 10, the higher the numerical value, the greater the degree of expression of the condition.

Five representative shoots were collected from each vine at pruning. Nodes one to ten from the base of each shoot were dissected under a light microscope and the number of inflorescence primordia (IP) in the primary bud (n + 1) recorded. The incidence of primary bud necrosis (PBN) (expressed as a percentage) was also evaluated. The IP in the secondary bud (n + 2) were counted and included in the measurement of total inflorescence primordia per

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[1] Coulure Index = 10 – [{(no. of seeded berries per bunch + no. of seedless berries per bunch + no. of LGOs per bunch) x 10} / no. of flowers per inflorescence].

[2] Millerandage Index = 10 – [{no. of seeded berries per bunch x 10} / (no. of seeded berries per bunch + no. of seedless berries per bunch + no. of LGOs per bunch)].

Correspondence to: Dr. C. Collins, University of Adelaide, Waite Campus, PMB 1, Glen Osmond, SA, 5064, Australia. Fax: +61-8-8313-0431. E-mail: cassandra.collins@adelaide.edu.au

node position only when the primary bud was necrotic. At both sites a randomised complete block design with six replicates was used. The data analysis package Genstat® (10th Edition, 10.1.0.72, Lawes Agricultural Trust, 2007) was used to analyse the data using a one-way analysis of variance (ANOVA). The significantly different means of each treatment were determined by using a least significant difference (LSD) test calculated at the 5 % level.

Results and Discussion

The only significant difference found between treatments for vegetative parameters at both vineyards was a slight increase in the number of laterals when LB and LS were applied (Tabs 1 and 2). PONI *et al.* (2005) also observed an increased lateral shoot number with severe early leaf removal. PETRIE *et al.* (2003) found that some photosynthetic compensation occurred in 'Sauvignon Blanc' vines whose leaves were removed from the lower quarter of the canopy and this may explain why vegetative parameters were mostly unchanged by treatments.

At both vineyards bud fertility was unaffected by leaf removal which is supported by previous studies (PONI *et al.* 2006). However, the focus of this study was the significant differences in other reproductive parameters found at both vineyards (Tabs 1 and 2). At both sites a significant reduction in the number of seeded berries was found with treatments. PONI *et al.* (2006) defoliated vines from nodes 1 to 8 on shoots and found that the number of berries significantly decreased when treatment was applied at the start of flowering and at fruit set. A decrease in berry numbers also coincided with a decrease in fruit set which in turn reduced bunch weights and final yield which is supported by recent research (PONI *et al.* 2006, INTIERI *et al.* 2008). CANDOLFI-VASCONCELOS and KOBLET (1990) reported that early and severe defoliation caused mobilisation of stored carbohydrate reserves from various parts of the vine resulting in a yield decrease.

Seedless berry numbers have been affected by leaf removal treatments at the start of flowering in other studies (PETRIE *et al*. 2003, PONI *et al*., 2006). The number of seedless berries was significantly higher in vines treated with LS and LA at BV. This was the opposite of what was seen at WC but does suggest that reproductive development and in particular ovule development was disrupted by treatments at both sites. This is further supported by the increase in CI and therefore, an increase in flower abscission and while not significant, changes in MI (seedless berry and LGO numbers) with leaf removal.

As a result of the reduction in fruit set the number of berries per bunch and therefore bunch weight were consequently decreased. As berry weight and berry size were found to be unaffected by treatments, berry number was the

Table 1

Means of all vegetative and reproductive parameters measured in response to leaf removal treatments at Waite Coombe vineyard, South Australia, Australia

Components	Treatments[z]				Significance[y]
	C	LB	LS	LA	
Vegetative measurements					
No. of shoots per vine	73.3	74.8	78.5	80	ns
No. of laterals per shoot	2.9[a]	3.9[b]	3.38[b]	2.57[a]	*
Shoot length (cm)	79.3	83.6	85	79.5	ns
Lateral length (cm)	3.04	3.56	3.86	3.22	ns
Shoot diameter (mm)	8.85	8.77	8.76	8.92	ns
Pruning weight (kg)	1.525	1.642	1.712	1.525	ns
Reproductive measurements					
Bunch no. per vine	67.7	69	74	73.7	ns
Flower no. per bunch	272	271	265	289	ns
No. of seeded berries per bunch	154[a]	72[b]	82[b]	160[a]	***
No. of seedless berries per bunch	29.6[ad]	10.5[b]	16.9[bc]	30.9[a]	***
No. of live green ovaries per bunch	10.8	6	11.3	8.9	ns
Fruit set (%)	69.5[ad]	34.5[b]	47.7[c]	72.4[d]	***
Bunch weight (g)	111.8[a]	55.2[b]	70.3[b]	113.9[a]	***
Berry diameter (cm)	1.09	1.098	1.087	1.064	ns
Berry weight (g)	0.571	0.615	0.631	0.551	ns
Coulure Index	2.84[a]	6.62[b]	5.81[b]	2.98[a]	***
Millerandage Index	2.12	1.92	2.58	1.98	ns
Yield per vine (kg)	7.57[a]	3.78[b]	4.84[b]	8.31[a]	***
No. of IP[x] (nodes 1-10)	1.799	1.713	1.828	1.832	ns
PBN[v] (%) (nodes 1-10)	0.7	0.3	1.3	1	ns

[z]Treatments: C - control; LB - leaf removal before flowering, LS - leaf removal at the start of flowering; LA - leaf removal after flowering.

[y]Means (n=6) with different letter superscripts separated within rows by ANOVA are significantly different (*, ***, ns: significant at $p \leq 0.05$, 0.001, or not).

[x]IP - inflorescence primordia.

[v]PBN - primary bud necrosis.

Table 2

Means of all vegetative and reproductive parameters measured in response to leaf removal treatments at Barossa Valley vineyard, South Australia, Australia

Components	Treatments[z] C	LB	LS	LA	Significance[y]
Vegetative measurements					
No. of shoots per vine	56.3	57.3	47.8	60.9	ns
No. of laterals per shoot	1.44[a]	1.90[b]	2.05[b]	1.62[a]	*
Average shoot length (cm)	72.6	71.8	76.6	75.7	ns
Lateral length (cm)	2.48	2.97	3.58	2.99	ns
Shoot diameter (mm)	8.81	8.76	9.24	8.65	ns
Pruning weight (kg)	0.673	0.767	0.733	0.881	ns
Reproductive measurements					
Bunch no. per vine	68.3	74.0	66.8	88.3	ns
Flower no. per bunch	360	381	437	366	ns
No. of seeded berries per bunch	228[a]	201[b]	210[ab]	168[b]	*
No. of seedless berries per bunch	15.2[a]	23.3[ab]	30.2[b]	26.3[b]	*
No. of live green ovaries per bunch	33.9	28.7	37.5	33.9	ns
Fruit set (%)	67.9[a]	59.4[b]	55.3[b]	53.5[b]	*
Bunch weight (g)	238[a]	203[b]	219[ab]	190[b]	*
Berry diameter (cm)	1.161	1.247	1.249	1.143	ns
Berry weight (g)	1.00	0.92	0.92	0.99	ns
Coulure Index	2.20[a]	3.60[b]	3.56[b]	3.55[b]	*
Millerandage Index	1.79	1.69	2.35	2.6	ns
Yield per vine (kg)	16.4[a]	14.7[b]	14.2[b]	16.7[a]	*
No. of IP[x] (nodes 1-10)	1.713	1.618	1.735	1.688	ns
PBN[v] (%) (nodes 1-10)	12.3	11.1	13	15.9	ns

[z]Treatments: C - control; LB - leaf removal before flowering, LS - leaf removal at the start of flowering; LA - leaf removal after flowering.

[y]Means (n=6) with different letter superscripts separated within rows by ANOVA are significantly different (*, ***, ns: significant at $p \leq 0.05$, 0.001, or not).

[x]IP - inflorescence primordia.

[v]PBN - primary bud necrosis.

main contributor to lower yield. Intrieri *et al.* (2008) suggested that berry size and weight were unaffected because the remaining leaves were able to compensate, therefore, carbohydrate availability was not limited by leaf removal treatments during berry development.

In conclusion, parameters linked to fruit set and yield were strongly influenced by leaf removal treatments in 'Semillon'. The magnitude of the reduction in yield was due to a decrease in bunch weight which was largely due to an increase in flower abscission and possibly the proportion of seedless berries and LGOs. The greatest reduction in yield was achieved when leaf removal was applied before and at the start of flowering.

Acknowledgement

The authors would like to thank W. Blass winery for vineyard use during this study.

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Received July 24, 2009