Management of Grape Pests and Improved Fruit Quality with Altered Pruning Practices
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Executive Summary

The project was essentially completed during the 2004 season. Due to the delayed start at Tinhorn Creek Vineyard, Oliver, a limited amount of research is required to complete the study at that site. Based on the previous two years results, however, it is unlikely that we will obtain any meaningful data relating to differences in insect numbers or disease levels. We will, therefore, focus on plant growth parameters and effects of early season leaf removal on fruit quality. Results obtained during the 2005 season will be provided as an addendum to this final report. Due partly to increased time devoted to additional measures of plant growth parameters and effects of treatments on such things as numbers of lateral shoots and secondary fruits, additional monies were spent during 2004 compared with the previous two years. Travel expenses could also not be shared with other projects.

The study was carried out successfully and produced results consistent with those obtained during the previous two seasons. For the varieties Chardonnay and Pinot Noir at Summerhill Winery, Kelowna, early season removal of basal leaves resulted in significantly lower numbers of Virginia creeper leafhopper, *Erythroneura ziczac*. In the Pinot Noir plots, for example, captures of adult leafhoppers on vines with leaves removed early in the season were about one third that for vines that had not had any leaves removed. Powdery mildew was largely absent at this location, but we were able to show that removal of basal leaves early in the season helped control bunch rot. For both varieties combined, disease incidence at harvest averaged about 1% for the two treatments involving early season leaf removal, compared with about 6% for the non-stripped plots and 4% for vines that had leaves removed in August.

At Tinhorn Creek, there were insufficient numbers of leafhoppers or other insect pests to provide meaningful counts. Disease incidence was also very low, but early season removal of basal leaves was shown to reduce the incidence and severity of bunch rots in plots of Chardonnay.

As expected, exposure of fruit to the sun was lowest in non-stripped plots and the canopy was the most dense. At Summerhill, although berry weights were highest for non-stripped plots, the differences were not significant. Early removal of leaves did not have a negative impact on fruit quality, as there were no differences in sugar concentration, acidity or titratable acids between any treatments. For Cabernet Franc at Tinhorn Creek, early season leaf removal resulted in significantly smaller berries. It is generally believed that smaller berry size results in better wines, as the proportionately greater amount of skin contact leads to improved colour and flavour. Smaller berries and a more open cluster could also contribute to reduced bunch rots. Compared with vines that had not had any leaves removed, fruit from vines with basal leaves removed early had higher sugars, lower acidity and lower titratable acids at harvest. Not all of the differences were statistically significant, however.

Measurements of vine growth at both sites showed a modest reduction in vigour due to early removal of leaves. Few of the differences were significant, possibly because vines were hedged later in the season, which would tend to minimize differences in growth. There were also no significant differences in stored carbohydrate amounts or fruitfulness the following year.

Early leaf removal has other potential benefits, including suppression of secondary fruit clusters that have a negative effect on fruit quality. Exposure of fruit clusters also makes harvesting easier.

The successful completion of this three year study has demonstrated the effectiveness of early season removal of basal leaves for the control of leafhoppers and bunch rots. Removal of leaves in late June had little effect on fruit ripening and a small, positive effect on fruit quality. Vines that did not have any leaves removed tended to be the most vigorous, which can be considered a negative attribute in many vineyards. Hedging of vines erased any differences observed earlier in the season, and there were no significant differences in storage of carbohydrates. Various aspects of this research will be presented to growers at the upcoming BCWI Enology and Viticulture Conference to be held in Penticton in July, 2005. Findings will also be provided to the wine and grape industry via scientific papers and newsletter articles.

Background and Experimental Design

The purpose of this study was to evaluate the effectiveness of altered pruning practices (suckering, shoot thinning, leaf removal) on pest incidence, vine vigour and grape quality; and demonstrate in growers' fields the usefulness of this cultural method as a component of an integrated pest management program. Typically, growers do not remove any basal leaves, or leaves around the fruiting zone are removed in late summer to improve fruit quality by exposing the developing grapes to increased light. Leaf removal also increases air circulation and allows fungicide sprays to reach the fruit, thereby reducing bunch rots caused by *Botrytis cinerea*. The aim of the current study was to see if leaves could be removed earlier in the season to also help control leafhoppers.

The Virginia creeper leafhopper, *Erythroneura ziczac*, and the western grape leafhopper, *E. elegantula*, overwinter as adults and deposit the majority of their eggs on the first fully expanded leaves in spring. Removal of these leaves can reduce leafhopper populations significantly; thereby preventing damaging levels and the need for insecticide sprays. Small scale trials conducted in growers' vineyards have shown that removing four to six basal leaves from each shoot in late June or early July when shoot thinning normally occurs can effectively reduce numbers of leafhoppers and erineum mites with no apparent damage to vines or subsequent yields. There is a need, however, to assess the effect of early leaf removal on grape quality, vine vigour, compensatory activity of remaining leaves, and bud set the following spring.

Research plots were established at Summerhill Winery, Kelowna, in a block of Chardonnay and a block of Pinot Noir. At Tinhorn Creek Vineyard, Oliver, similar large plots were established in the varieties Chardonnay and Cabernet Franc. Individual treatment plots were large, around 20 m square, and each treatment was replicated twice for each site and variety. Treatments consisted of: (1) suckering in May, shoot-thinning in June, and no additional leaves removed; (2) suckering in May, shoot-thinning in June, and leaves removed in August; (3) suckering in May, shoot-thinning and leaf removal in June; and (4) suckering, shoot-thinning and leaf-removal on the same date in June. The first two treatments are 'typical' vegetation management practices carried out by the majority of grape growers in the Okanagan and Similkameen Valleys of B.C.

Progress and results for 2005.

An insignificant number of leafhoppers were captured at Tinhorn Creek Vineyard, Oliver, to allow for comparisons of treatment effects. Unlike the previous year, there were also few mealybugs or other pests on either variety at this site. Leafhopper pressure at Summerhill Winery, where they utilize organic production practices, was higher than during the previous two years. As shown in Table 1, removal of leaves early in the season resulted in significantly fewer adult leafhoppers compared with vines that had no leaves removed, or had leaves removed in August. For Chardonnay, numbers of leafhoppers per trap per day for the two treatments involving early-season leaf removal averaged 4.9 compared with an average of 9.0 for the two treatments where vines did not have leaves removed early, which is a 46% reduction in leafhopper numbers over the season.

For Pinot Noir, early season leaf removal reduced leafhoppers by 55% over the entire season (Table 1). Comparing the two early season leaf removal treatments, leafhopper numbers were higher when suckering was performed in May and leaves were removed in June. Presumably, a greater proportion of leafhopper eggs were removed when suckers were allowed to remain on the vines longer. Removal of suckers prior to leafhopper oviposition would result in more eggs being deposited on leaves that were not removed in June.

Early season leaf removal might have been more effective for the control of leafhoppers than the results indicate. Although treatments were applied to large plots, substantial pest pressure likely caused adult leafhoppers to move from heavily infested plots to those with less damage. More detailed analysis of leafhopper counts that considers the position of the traps and the adjacent treatments will be conducted at a later date.

Removal of basal leaves early in the season helped control bunch rot. Inoculation of agar plates with extracts from grape bunches resulted in the data shown in table 2. *Botrytis* inoculum levels were much lower, less than one fifth, for vines that had leaves removed early compared with those that did not. At Summerhill Winery, an assessment in mid-September provided an average incidence of bunch rots for both varieties combined of about 1% for the two early-season leaf removal treatments, compared with 6% for the non-stripped plots, and 4% for vines that had leaves removed in August (data not shown). At the same location, a more detailed assessment conducted on the 22nd September showed a much higher incidence of bunch rot on both varieties (Table 3). However, disease incidence and severity were still significantly lower for vines that had basal leaves removed early compared with vines that did not have leaves removed, or those that had leaves removed in August.

The effect of early season leaf removal on fruit quality was evaluated in two ways. Samples of 50 grapes were collected from 25 randomly-selected grape clusters from each plot weekly until harvest. As well, all the grapes from two vines per plot were collected at harvest. Samples were weighed to provide a measure of berry size, and then the fruit was crushed and the juice evaluated for sugar content, pH, and titratable acidity. For the whole-vine samples, in addition to measurements of fruit quality, data relating to shoot-lengths, diameters, leaf area, number of leaves, etc., was also collected.

Table 4 shows the fruit assessment data for the variety Chardonnay at Tinhorn Creek. Although not statistically significant, removal of leaves in June resulted in smaller berries, which

is consistent with the results from previous years. For the final sample date, fruit from vines that had been suckered and had leaves removed in June had a significantly higher sugar content (23.3 ^{0}Brix) and higher pH (3.5) compared with fruit from vines that had leaves removed in August (21.1 ^{0}Brix; pH 3.4). There were no significant treatment differences for titratable acidity.

For Cabernet Franc at Tinhorn Creek, suckering and leaf removal in June resulted in significantly smaller berries at harvest compared with vines that did not have any leaves removed (Table 5). Fruit from non-stripped vines also had the lowest sugar content, lowest pH, and highest titratable acidity at harvest, but not all of the differences were significant. At the completion of this study we will be able to conduct more detailed analyses of fruit quality parameters for the three years combined, but the results to date suggest a slight positive effect of early leaf removal on fruit quality. Improved fruit quality most likely results from increased exposure of fruit bunches to light, and also to reduced berry size.

Removal of leaves early in the season had little effect on numbers of shoots or fruitfulness the following season (data not shown). There was a significant difference, however, in shoot lengths. At both sites and for all varieties, early removal of leaves resulted in reduced shoot lengths. These differences were largely eliminated by the end of the season, however, when vines were hedged. Removal of basal leaves early in the season resulted in lower numbers of secondary fruit clusters.

Summary:

During the course of this three year study conducted on two varieties of grapes at each of two sites, we have shown that removal of basal leaves in late June or early July provides several beneficial effects. These include:

- a significant reduction in numbers of leafhoppers.
- lower incidence and severity of bunch rot.
- a marginal improvement in fruit quality.
- potential for improved wine quality due to smaller berry size, thicker skins, and increased berry colour.
- moderate reduction in vine vigour and fewer unwanted secondary fruits.
- removal of leaves and secondary shoots from around fruit clusters makes harvesting easier.

We could not detect an increased incidence of sun scald or negative effects on fruit ripening, carbohydrate storage, or fruitfulness the following year.

The success of this project has suggested a number of follow-up studies. It is uncertain at this time if the results we obtained apply to vines with low vigour, or if other varieties respond in a similar manner. The potential for improved wine quality should also be evaluated with the assistance of a commercial winery. Finally, removal of leaves early in the season might provide effective control of sour rot, and it would be worthwhile to conduct a smaller scale trial in several vineyards with a history of this disease.

Table 1. Effect of early season removal of basal grape leaves on numbers of adult Virginia creeper leafhopper, *Erythroneura ziczac*, per yellow sticky trap per day for plots of Chardonnay and Pinot Noir at Summerhill Winery, Kelowna, 2004.

	Sample Date						
	17 May	14 July	21 July	17 August	25 August	31 August	**Average***
Chardonnay							
No leaf removal	16.7	1.6	7.4	9.9	12.3	-	**7.8**
August leaf removal	19.3	2.4	8.1	13.4	17.0	-	**10.2**
June leaf removal/ May suckering	13.2	1.2	6.5	6.1	9.9	-	**5.9**
June leaf removal/June suckering	10.3	0.9	4.6	5.3	4.6	-	**3.9**
Pinot Noir							
No leaf removal	29.2	13.0	31.8	16.3	22.5	20.5	**20.8**
August leaf removal	42.3	7.6	20.3	10.0	11.6	8.9	**11.7**
June leaf removal/ May suckering	36.4	7.5	9.8	6.5	8.7	7.3	**8.0**
June leaf removal/June suckering	19.0	5.1	7.0	5.4	7.4	8.0	**6.6**

*Average daily trap counts for the period following leaf removal in late June.

Table 2. Number of grape clusters with *Botrytis* bunch rot inoculum based on detection of colonies on agar medium inoculated with extracts from 20 clusters per treatment collected on August 24, 2004.

	Summerhill Winery		Tinhorn Creek Winery		
Treatment	Chardonnay	Pinot Noir	Chardonnay	Cabernet Franc	**Totals**
No leaf removal	10	2	3	2	**17**
August leaf removal	8	5	2	1	**16**
June leaf removal/ May suckering	2	0	0	0	**2**
June leaf removal/ June suckering	2	1	1	0	**4**

Table 3. Incidence (%) and severity of Botrytis bunch rot infections assessed 22 September, 2004, for Chardonnay and Pinot Noir vines with and without basal leaves removed.

	Chardonnay		Pinot Noir	
Treatment	Incidence	Severity	Incidence	Severity
No leaf removal	18.6 %	4.2	9.5%	0.6
August leaf removal	14.5%	1.7	8.5%	0.6
June leaf removal/ May suckering	8.1%	1.1	3.0%	0.2
June leaf removal/ June suckering	6.9%	2.9	7.0%	0.4

Table 4. Effect of early season leaf removal on berry weight (gm) and grape quality for Chardonnay at Tinhorn Creek, 2004.

		Date					
Treatment		23 Aug	30 Aug	7 Sept	13 Sept	20 Sept	**Average**
No leaf removal	Weight	1.15	1.24	1.25	1.27	1.31	**1.24**
	Brix	16.1	18.3	20.5	22.3	22.4	**19.9**
	pH	3.1	3.2	3.3	3.4	3.5	**3.3**
	TA*	11.9	9.5	8.3	8.1	7.2	**9.0**
August leaf removal	Weight	1.08	1.15	1.19	1.26	1.31	**1.20**
	Brix	14.3	16.9	18.7	21.6	21.7	**18.6**
	pH	3.0	3.2	3.3	3.5	3.4	**3.3**
	TA	12.3	9.8	8.4	8.3	7.7	**9.3**
June leaf removal/ May suckering	Wt.	1.13	1.17	1.18	1.20	1.24	**1.18**
	Brix	14.6	17.5	19.0	20.7	22.0	**18.8**
	pH	3.1	3.2	3.3	3.4	3.4	**3.3**
	TA	12.6	9.7	8.8	8.7	7.6	**9.5**
June leaf removal/ June suckering	Wt.	1.00	1.06	1.06	1.07	1.09	**1.06**
	Brix	16.9	19.4	21.4	23.1	23.3	**20.8**
	pH	3.1	3.3	3.3	3.5	3.5	**3.3**
	TA	11.5	8.9	8.0	8.1	7.1	**8.7**

*Titratable acidity.

Table 5. Effect of early season leaf removal on berry weight (gm) and grape quality for Cabernet Franc, Tinhorn Creek, 2004.

		Date							
Treatment		23 Aug	30 Aug	7 Sept	13 Sept	20 Sept	27 Sept	4 Oct	**Average**
No leaf removal	Weight	1.12	1.37	1.37	1.31	1.31	1.34	1.31	**1.30**
	Brix	13.7	17.1	19.3	21.3	22.2	23.5	24.9	**20.3**
	pH	3.0	3.1	3.3	3.4	3.4	3.4	3.5	**3.3**
	TA*	17.5	12.5	10.7	9.9	9.1	8.9	8.8	**11.1**
August leaf removal	Weight	1.03	1.17	1.25	1.20	1.20	1.25	1.18	**1.18**
	Brix	12.7	14.8	18.5	20.9	21.8	22.6	24.6	**19.4**
	pH	3.0	3.1	3.2	3.4	3.4	3.4	3.5	**3.3**
	TA	20.0	15.0	11.7	9.7	8.8	9.2	8.6	**11.9**
June leaf removal/ May suckering	Weight	1.07	1.23	1.23	1.16	1.20	1.24	1.12	**1.18**
	Brix	13.7	16.9	19.5	21.7	22.4	23.6	25.2	**20.4**
	pH	3.0	3.2	3.3	3.4	3.5	3.4	3.6	**3.3**
	TA	17.5	12.2	10.0	8.9	8.3	8.7	8.3	**10.6**
June leaf removal/ June suckering	Weight	1.00	1.03	1.02	1.01	1.02	1.03	1.00	**1.02**
	Brix	14.1	16.7	19.8	22.2	22.5	24.1	25.4	**20.7**
	pH	3.0	3.2	3.3	3.4	3.4	3.4	3.5	**3.3**
	TA	17.2	13.6	10.9	10.0	9.0	8.8	8.6	**11.2**

*Titratable acidity.

Budget Summary (1 April, 2004 - 31 March, 2005)

100% allocated to research on the outlined project.

Materials and supplies		nil
Contract services		
Technical assistance		$19,995.00
Lowery Ent. Res. Ltd		$10,000.00
Travel, mileage		$2,850.64
	Total	**$32,845.64**

Total Project Expenditures (1 April, 2002 - 31 march, 2005).

Materials and supplies		$463.29
Contract services		
Technical assistance		$34,345.30
Lowery Ent. Res. Ltd.		$15,500.00
Travel (lease and fuel, or mileage)		$5,765.54
	Total	**$58,074.13***

Total amount provided by BCWI **$10,162.97**

Total amount provided by AEPI **$47,911.16**

Previous expenditure (1 April 2002 - 31 March, 2004)	$25,551.22
Total expenditures to date	$58,074.13
Budgeted expenses to date	$60,000.00
Monies lapsed	$1,925.87

Calculation of final claim

Cash contributions from AEPI and other sources to date a	$25,551.22
Total expenditures to date b	$58,074.13
Surplus (Deficit) c=a-b	$32,522.91
Expenditures expected for next quarter	nil
Claim from AEPI	$26,831.40