progenies have produced varying degrees of segregation for compactness varying from 100 percent to none at all. Crosses including the dominant gene for scab resistance are also under evaluation.

However, K. R. Tobutt's work at East Malling has resulted in the release of four column varieties for amateur gardeners: an ornamental crab, 'Maypole,' and three dessert apples 'Telamon' ('Waltz'), 'Trajan' ('Polka') and 'Tuscan' ('Bolero'). These are being marketed under the 'Ballerina' trademark. East Malling reports (1993) over one million Ballerina trees have been sold.

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Fruit Maturation of 'Okanagan Riesling' Grapes: Effect of Site, Year, and Basal Leaf Removal

ANDREW G. REYNOLDS,[1] DOUGLAS A. WARDLE,[1]
JOHN W. HALL,[2] AND MARJORIE DEVER[1]

Abstract

'Okanagan Riesling' (*Vitis* spp.) berries were sampled for 2 years from two vineyards to document relationships between standard harvest indices (°Brix, titratable acidity, pH) and monoterpene and volatile ester flavor components. Experiment 1 (1987) compared a high heat unit site (Inkameep) and a low heat unit site (Summerland), and showed that pH and total volatile esters (TVE) were higher at Inkameep when sites were compared using data corrected for 10°C base accumulated heat units (growing degree days; GDD). Experiment 2 (1988) also tested the impact of basal leaf removal on fruit composition at the two sites. Influence of site was less in 1988, and only titratable acidity (TA) and pH were affected by site. Basal leaf removal increased concentrations of flavor compounds and reduced TA in the berries, and increased TVE in the juices. Tasters distinguished between sites on the basis of wine aroma and flavor, and between control and basal leaf removal wines from the Inkameep site on the basis of flavor. Site effects on fruit composition were partly contingent upon GDD but season, crop load, and canopy density may have also played a role.

Introduction

'Okanagan Riesling' (*Vitis* spp., parentage unknown) was the most widely planted grape cultivar in British Columbia until 1989. Although winter hardy and high yielding, 'Okanagan Riesling' provides several fruit composition problems. Fruit is usually harvested between 19° and 21 °Brix because labrusca flavor develops at higher levels, but at these "desirable" °Brix levels, titratable acidity (TA) can be high; pH can also be high simultaneously with high TA in vigorous canopies. There is also anecdotal evidence of a mild muscat flavor that disappears, or is masked by labrusca flavor at high °Brix. These phenomena appear to be year and site specific but have never been documented. Fruit composition may also be influenced by canopy manipulation practices such as training system (10) or shoot positioning, hedging, or basal leaf removal (12).

A more thorough understanding of the factors which influence fruit maturation of 'Okanagan Riesling' would benefit growers of this cultivar, as well as producers of other cultivars (eg. 'Bacchus,' 'Gewürztraminer') which display similar problems. The purposes

[1]Research Scientist and [2]Research Assistant, respectively, Agriculture and Agri-Food Canada, Research Centre, Summerland, British Columbia V0H 1Z0. Contribution No. 852.

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of this experiment were to: 1. Document relationships between monoterpene and volatile ester flavor components and standard harvest indices (°Brix, TA, and pH) during fruit maturation; 2. Document vineyard site effects on fruit composition and wine sensory attributes; 3. Determine the impact of basal leaf removal on fruit composition and wine sensory components, and whether site X basal leaf removal interactions existed. Since these investigations spanned 2 years, it was expected that inferences could also be made regarding effects of growing season.

Materials and Methods

Experiment 1. ***Experimental design and plant material:*** Two sites with similar soils, vine ages (18 years old), vine spacings, and training systems, but with large differences in 10°C base mean annual accumulated heat units (growing degree days; GDD) were chosen in 1987 to assess the impact of vineyard site on fruit maturation. Site 1 (Inkameep Vineyards, Oliver, B.C.) was a high GDD site (1568 GDD in 1987) (J. Vielvoye, pers. comm.), while site 2 (Agriculture Canada Research Station, Summerland, B.C.) was a relatively low GDD site (1325 GDD in 1987) (3). Both vineyards were located on Skaha gravelly sandy loam (7), managed with permanent sod alleys, trained to a Geneva Double Curtain system, and were shoot positioned. All vines were own rooted. Cordon height was 1.6 m, and 20 shoots per m of canopy were retained at both sites. Vines at both sites were all originally spaced 2.0 m apart; in east:west-oriented rows spaced 2.7 m apart at Inkameep, and in north:south-oriented rows spaced 3.0 m apart at Summerland. Some vines had died at Inkameep prior to establishment of the experiment, which necessitated cordon extension to achieve complete trellis-fill. Pest control practices were carried out according to published recommendations (2). Mean shoots per vine was 142 at Inkameep (to compensate for irregular vine spacing but still maintain 20 shoots per meter of canopy) and 76 at Summerland. There were four, two-vine plots (replicates) per site.

Fruit composition: Berry sampling commenced on 5-6 August 1987 (preveraison) and continued weekly until 8 September at Inkameep and 23 September at Summerland (over-ripeness). One 150-berry sample and one 300-berry sample per plot were collected weekly at each site, and stored at -40°C until analysis. Extraction of berries for measurement of TA was done according to Mattick (9). Measurements of °Brix, TA, pH, free volatile terpenes (FVT), and potentially-volatile terpenes (PVT) were as previously described (13), while total volatile esters (TVE) were analyzed according to the Hill method (6) described by Reynolds et al. (11).

Yield records were not kept in 1987, but cane pruning weight (vine size) data for the 1987 season were collected during pruning in March 1988.

Experiment 2. ***Experimental design and plant material:*** Using the same sites and vines as in Experiment 1, the presence or absence of basal leaf removal (≈ three leaves per shoot) was included as a second factor in the 1988 season, to see if manipulation of canopy microclimate affected site-based fruit composition differences. GDD in 1988 were 1224 and 1115 for Inkameep and Summerland, respectively (J. Vielvoye, pers. comm.; 4). Bloom dates were recorded at each site (20 June at Inkameep; 26 June at Summerland) and vines were hedged to approximately 14 leaves per shoot 9-12 days following bloom (29 June at Inkameep and 8 July at Summerland). Basal leaf removal was imposed randomly to either the right or left portion of each bilateral cordon of each vine canopy 23-28 days after hedging (22 July at Inkameep and 5 August at Summerland). The appropriateness of the timing of this treatment was based on previous research (13). The other portion of the vine was maintained as a control. Other cultural practices were the same as in 1987. Hereafter, "treatment replicate" refers to either the control or leaf removal portions of a two-vine plot at an individual site. As in 1987, there were four, two-vine plots at each site.

Yield components: Fruit was harvested at each site following the final berry sampling. Cluster number and yield data were collected on a per vine basis. Cluster weight was calculated from these data, with berries per cluster estimated from cluster weight and berry weight data.

Canopy characteristics: Canopy density was assessed at each site in 1988 by point quadrat analysis (20). Twenty insertions per treatment replicate were made into the fruit zone with a thin 1 m-long metal probe on 16 August 1988. The number of canopy contacts per insertion and the nature of each contact were recorded. Information was generated from these data on exposed cluster "faces," partially-exposed cluster "faces," and shaded leaves.

Berry, juice, and wine composition: Sampling from each site X basal leaf removal combination was every 10 days from 17-18 August (pre-veraison) to 27 September at Inkameep and 7 October at Summerland (commercial maturity), and finally on 12 October (harvest sample) at Summerland. One 150-berry and one 300-berry sample were collected from each treatment replicate at each site, and were treated as in 1987. Potassium (K^+) was also measured in the berry extracts in 1988 in the manner described by Reynolds et al. (12).

Fruit from the control and leaf removal portions of each plot was kept separate for subsequent winemaking. Winemaking was carried out according to a previously described protocol (13). All treatment replicates were kept separate, giving 16 total fermentations, or eight per site.

Juice samples (250 mL) were collected from each treatment replicate at pressing, and were stored at -40°C until analyzed as the berries for °Brix, TA, pH, K^+, TVE, FVT, and PVT. Amerine and Ough's method (1) was used to determine juice TA. Monoterpenes and TVE were measured on 100 mL and 50 mL of juice, respectively. Titratable acidity, pH, and TVE were determined on the finished wines according to aforementioned methods, while ethanol concentration was measured in the wines using a Hewlett-Packard 5700 gas chromatograph [Hewlett-Packard (Canada) Ltd., Mississauga, Ont.].

Sensory evaluation: Wines were tasted in November 1990, after 20 months of bottle storage. Preliminary bench testing indicated that fermentation replicates within treatment combinations were nearly identical in aroma and flavor, therefore only one fermentation replicate was tasted. Three triangle tests were used to evaluate differences between sites for the control treatments, and those between the control and basal leaf removal treatments within sites. Fifteen experienced tasters were requested to choose the odd sample on the basis of aroma and flavor separately, and were also asked to indicate whether both muscat/lychee and floral/fruity characters were more intense in the odd or duplicate samples, or absent completely. Wines were presented as 40 mL samples in black, tulip-shaped glasses. Tasting order was randomized for each taster, both treatments in each triangle test were equally designated as odd samples, and tasting codes and sample order were changed after aroma was assessed.

Statistical analysis: All data were analyzed using the SAS statistical package (SAS Institute, Cary, NC). The General Linear Models procedure was utilized. Data from Experiment 1 were analyzed within the context of a completely randomized design using plot X site as an estimate of error. Data from Experiment 2 were analyzed as a split plot, with error due to site given by plot X site, and error due to basal leaf removal given by basal leaf removal X (plot X site).

Due to phenological differences between sites, all berry weight and composition data in both experiments were also analyzed by using GDD, °Brix, TA, and pH as independent variables. In this fashion, the sites could be compared in terms of FVT, PVT, and TVE at equivalent GDD, °Brix, TA, or pH. The assumption was made that the relationship between each response variable and each designated independent variable was linear, and that the slopes of the lines for each site were the same. Heterogeneity of slopes was determined by including GDD X site as a factor in the analysis of berry composition data.

Results and Discussion

Effects of vineyard site; Experiment 1. ***Vine vigor:*** Vine size (2.1 kg/vine at Inkameep; 3.3 kg/vine at Summerland), was not significantly different between sites. Berry weight increased from 1.61 g on 5 August to 1.96 g on 31 August at Inkameep, and from 1.20 g on 5 August to 1.71 g on 23 September at Summerland.

Berry composition: The 1987 season was considerably warmer than average. Large differences in all fruit composition variables were observed between sites at all sampling dates in 1987 due to differences in budbreak-to-veraison GDD (1139 at Inkameep; 958 at Summerland). Site differences also occurred for mean daily GDD (10.2 at Inkameep; 8.2 at Summerland) for veraison-to-harvest periods of 34 and 53 days, respectively. Hence, fruit maturation at Inkameep (in terms of °Brix) was at least 2 weeks ahead of Summerland. FVT concentrations changed very little at either site over the sampling period (Fig. 1D), but PVT (Fig. 1E) and TVE (Fig. 1F) increased. FVT and PVT concentrations at Summerland eventually attained or surpassed those at Inkameep, but TVE concentrations did not. When compared at equal GDD, differences between sites were not observed for °Brix, TA, FVT, and PVT, but were found for pH ($p \leq 0.0015$) and TVE ($p \leq 0.001$; Fig. 1). Responses to site by berry weight (data not shown), TA, FVT, and PVT were characterized by homogeneous slopes, which suggested that these variables reacted equally to GDD. Slopes of pH ($p \leq 0.0015$) and TVE ($p \leq 0.0001$) were significantly different, and suggested that these variables increased more rapidly at Inkameep in response to GDD than at Summerland. These results indicate as well that changes in pH and TVE were not exclusively GDD dependent, but were also influenced by some aspects of the sites, despite similar soils, cultural practices, and vine sizes at each location.

By the final sampling dates in 1987, 1357 GDD (Inkameep) and 1272 GDD (Summerland) had accumulated, grapes had reached an overripe stage (28.6 and 27.0 °Brix, respectively), and their respective mean TVE concentrations of 27.6 and 11.8 mg/L suggested that labrusca flavor was present (> 10 mg/L; 5). Maximum corresponding soluble solids content to avoid this flavor (i.e. < 10 mg/L) thus appears to be 24 to 25 °Brix (Fig. 1A), with TA of approximately 13 g/L (Fig. 1B) and a pH of 3.10 to 3.20 (Fig. 1C). These fruit composition values were achieved following accumulation of ≈ 1250 GDD.

Effects of vineyard site; Experiment 2. ***Vine vigor and yield components:*** There were no significant differences in vine size in 1988 between the two sites, although vine size was reduced between 1987 and 1988 at Summerland and Inkameep, respectively, to 1.8 and 1.2 kg per vine. The very hot, dry 1987

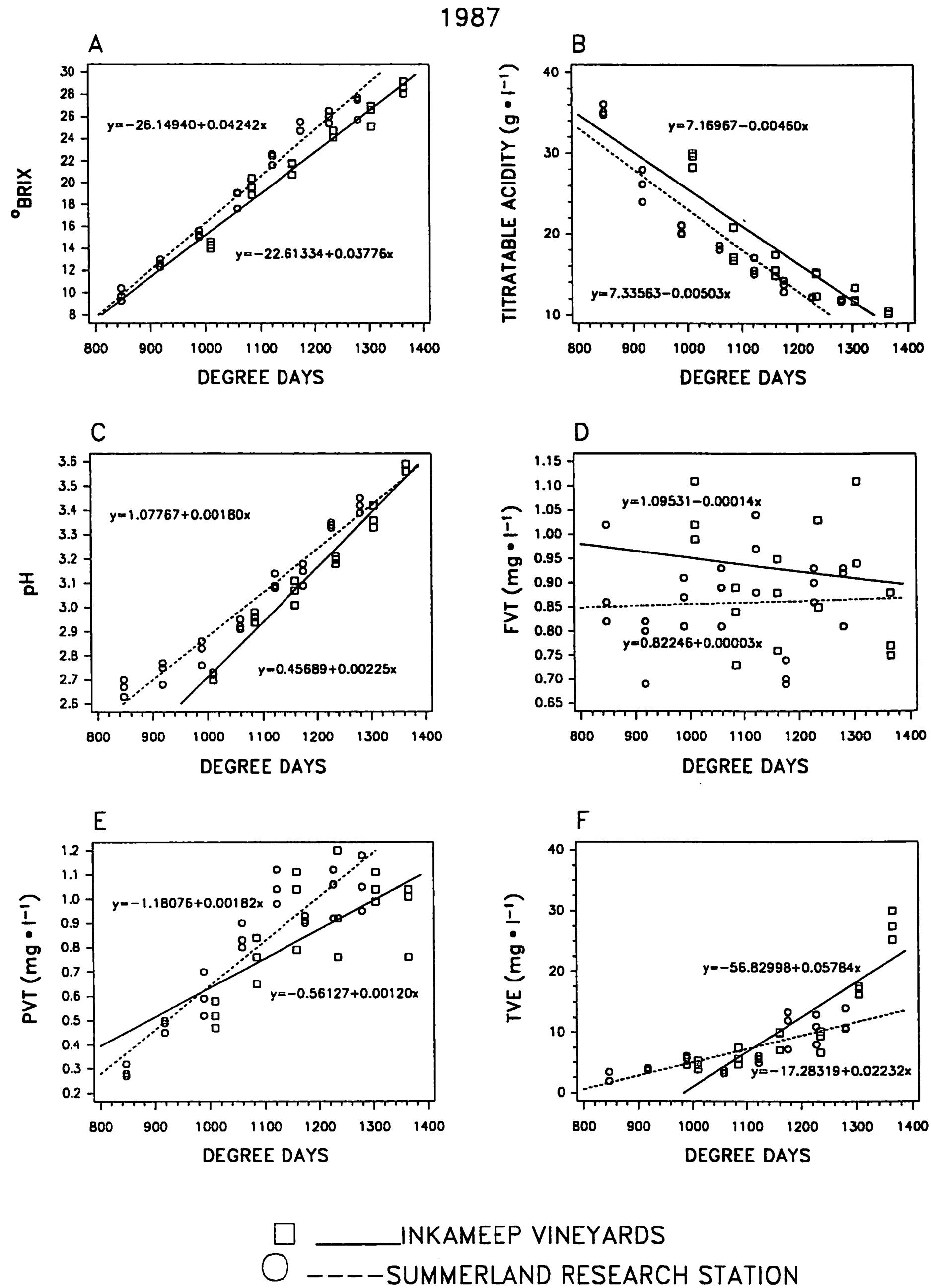

Figure 1. Changes in 'Okanagan Riesling' berry composition during maturation, at sites in Oliver (Inkameep Vineyards) and Summerland, B.C., 1987. Data are corrected for GDD. (A) Soluble solids (°Brix); (B) Titratable acidity; (C) pH; (D) Free volatile terpenes (FVT); (E) Potentially-volatile terpenes (PVT); (F) Total volatile esters (TVE).

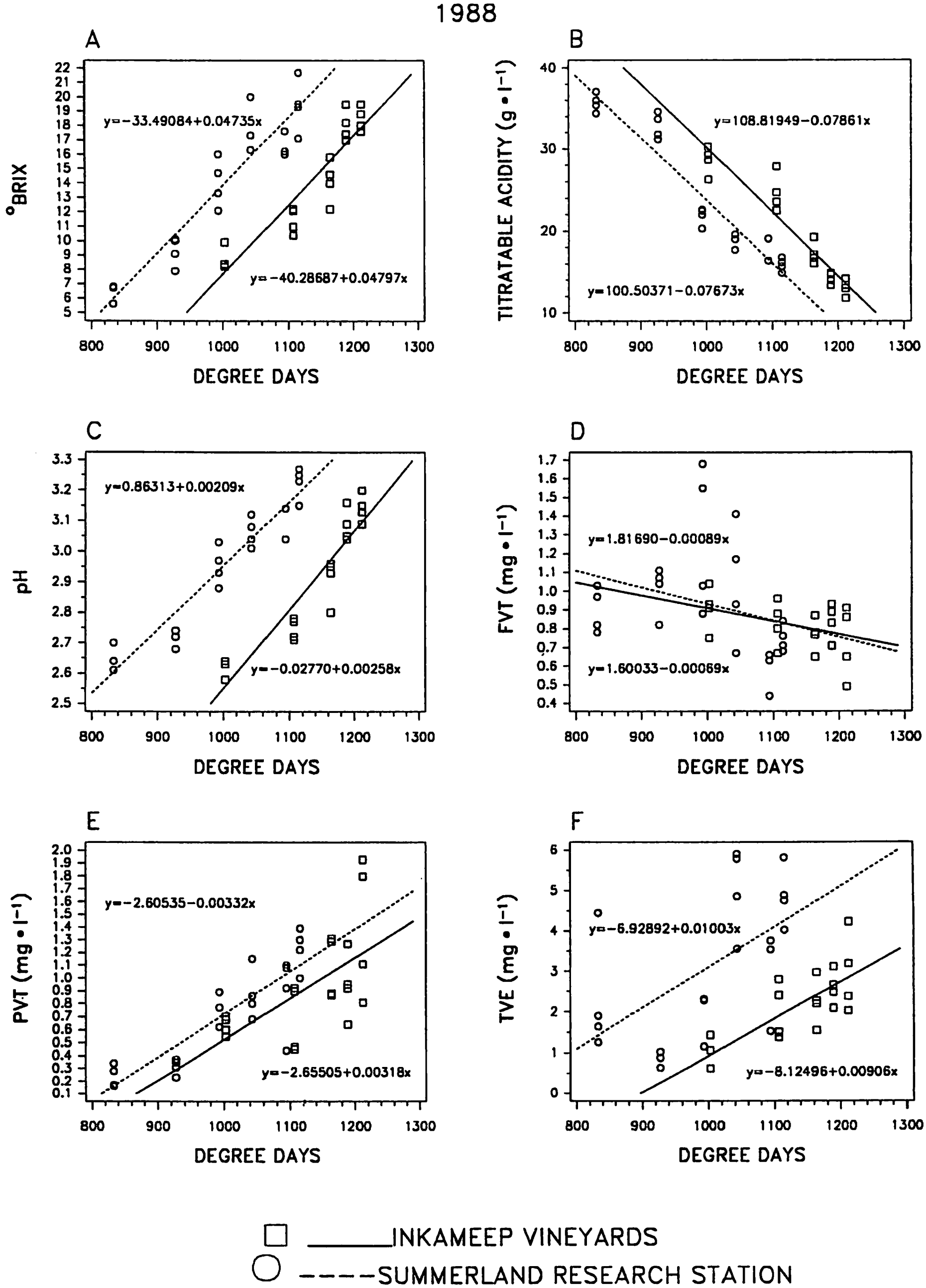

Figure 2. Changes in 'Okanagan Riesling' berry composition during maturation, at sites in Oliver (Inkameep Vineyards) and Summerland, B.C., 1988. Data are corrected for GDD. (A) Soluble solids (°Brix); (B) Titratable acidity; (C) pH; (D) Free volatile terpenes (FVT); (E) Potentially-volatile terpenes (PVT); (F) Total volatile esters (TVE).

season with accompanying water stress very likely contributed to these vine size decreases. The irregular vine spacing at Inkameep produced trends towards higher yield per vine, clusters per vine, and crop loads, but it must be stressed that cluster weights, berries per cluster, clusters per shoot, and yields per meter of canopy did not differ significantly from Summerland. Yields at Inkameep averaged 27.2 kg per vine compared to 15.7 kg per vine at Summerland, due to a greater number of clusters per vine (389 at Inkameep and 191 at Summerland), but neither variable differed significantly. Crop load (kg yield/kg vine size) differed substantially between sites ($p \leq 0.005$); crop load at Inkameep was 24.2 compared to 8.2 at Summerland. Although these crop load differences appear large, it has nonetheless been shown recently (16, 17) that large crop load differences in French-American hybrid grapes lead to little or no differences in fruit composition. Furthermore, Shaulis (18) has emphasized that yield per linear measure of row is the most accurate measure of vine productivity. In our study, yield per m of row did not differ between the sites. Unlike 1987, Summerland berries were larger than at Inkameep (1.91 and 1.55 g at their respective final samplings; $p \leq 0.007$), perhaps due to lower cluster number.

Canopy characteristics: Differences in canopy density were observed between sites (Table 1). Summerland vines had more canopy contacts and shaded leaves, and fewer partially-exposed clusters. The interactions for canopy contacts, partially-exposed clusters, and shaded leaves indicated that the site-based differences for these measurements existed only in the control portions of the canopies.

Berry, juice, and wine composition: The 1988 season was considerably cooler than 1987. Budbreak-to-veraison GDD were 1004 (Inkameep) and 823 (Summerland), with mean daily GDD of 5.1 and 5.2 during their respective sampling periods of 41 days (Inkameep) and 56 days (Summerland). Soluble solids, pH, and TVE concentrations were consequently much lower in 1988 when physical signs of full fruit maturity were reached (e.g., deep gold berry color). Concentrations of monoterpenes were higher in 1988 than 1987, despite lower °Brix. Differences between sites in °Brix, K^+ (data not shown), FVT, PVT, and TVE were not significant when data were corrected for GDD (Fig. 2). Sites differed in terms of TA ($p \leq 0.0378$; Fig. 2B) and pH ($p \leq 0.0336$; Fig. 2C). Since only GDD X pH and GDD X TA regression lines were heterogeneous, this suggests that most site-based differences in berry composition could be largely explained by GDD. Slopes of these lines suggested that pH increased and TA decreased more rapidly at Inkameep than at Summerland in response to GDD; this also infers that other factors such as crop load or canopy density may have played a part. Berry TVE was much lower in

Table 1. Impact of vineyard site and canopy manipulation on canopy density of 'Okanagan Riesling,' 1988. Data shown in this table are means of 20 insertions per treatment replicate, expressed on a per insertion basis.

Factor	Contacts	Cluster faces: Exposed	Cluster faces: Partially exposed	Shaded leaves
Site[z]				
Inkameep	3.7	0.34	0.49	1.13
Summerland	5.5	0.09	0.16	2.64
Significance[y]	*	NS	**	*
Canopy Manipulation[z]				
Control	4.4	0.21	0.33	1.88
Leaf removal	2.7	0.68	0.62	0.42
Significance[y]	***	***	***	***
Interactions[y]	*	NS	*	***

[z]Site data are for control treatments only; canopy manipulation data are pooled across both sites.
[y]*, **, ***, NS: Significant at $p \leq 0.05$, 0.01, 0.001, or not significant, respectively.

1988 than in 1987, and tended to be higher at Summerland (Fig. 2F).

The harvest schedule (27 September at Inkameep; 11 October at Summerland) permitted juices for winemaking at almost equal °Brix (Table 2). Summerland juices were lower than Inkameep in TA, and higher in pH, K^+, FVT, and TVE. Juice TVE concentrations were presumably higher than in the berries because of esterification reactions (microbiological or enzymatic) during skin contact (T. Fuleki, pers. comm.). Concentrations of juice FVT and TVE at the Summerland site were enhanced by its longer ripening period, denser canopies, lower crop loads (but equal yields per m of canopy), and larger berries. These may have also given rise to lower TA and higher pH in the juices (berries and wines also). Summerland wines were also higher than Inkameep wines in ethanol and pH (Table 2). TVE were higher in Inkameep wines.

Sensory Analysis: Tasters distinguished between sites on the basis of aroma and flavor, and specifically found Inkameep wines stronger in floral/fruity aroma and muscat/lychee flavor (Table 3). Stronger floral aroma and muscat flavor in Inkameep wines may have been reflective of higher wine TVE concentrations (i.e. fermentation esters), or possibly the high TVE in Summerland juices masked the terpene-derived floral and muscat characters in their resultant wines.

Experiment 2; effects of basal leaf removal. As expected, basal leaf removal reduced canopy contacts and shaded leaves, and increased exposed and partially-exposed clusters (Table 1). Basal leaf removal had no significant main effects on berry weight, °Brix, pH, or K^+ at either site (data not shown). However, a significant site X basal leaf removal interaction ($p \leq 0.022$) on 27 August showed that basal leaf removal reduced K^+ at Summerland by 160 mg/L (data not shown). Some authors (8,20) have reported slight increases in °Brix and reductions in pH and K^+ due to leaf removal in the fruit zone, whereas others (13, 21) have shown no effect. In this study, berry TA was reduced by basal leaf removal on two of six sampling dates. These reductions in TA are consistent with many previous studies (8, 12, 13, 20, 21) and are a consequence of enhanced malic acid degradation (17). Berry FVT and PVT were both increased by basal leaf removal on three and four of six sampling dates, respectively, and TVE was increased on one of six sampling dates (Fig. 3). On 27 August, leaf removal increased TVE at Inkameep but not at Summerland (significant site X basal leaf removal interaction, $p \leq 0.045$, data not shown). These increases in berry monoterpenes by basal leaf removal are consistent with Reynolds and Wardle (13), who found that basal leaf removal increased FVT and PVT concentrations in 'Gewürztraminer' berries, as well as Smith et al. (20), who reported that basal leaf removal increased several free and bound aroma compounds in 'Sauvignon blanc.'

Table 2. 'Okanagan Riesling' juice and wine composition at two vineyard sites, 1988. Data are pooled across canopy manipulation treatments.

	Juice for winemaking							Wine			
Factor	°Brix	Titratable acidity (g/L)	pH	K^+ (mg/L)	FVT[z] (mg/L)	PVT[y] (mg/L)	TVE[x] (mg/L)	Titratable acidity (g/L)	pH	Ethanol (%)	TVE[x] (mg/L)
Site											
Inkameep	17.8	9.7	3.02	470.4	0.81	0.79	6.30	9.9	3.06	10.4	75.15
Summerland	18.2	8.5	3.24	600.2	0.84	0.71	16.54	10.2	3.32	11.6	69.18
Significance[w]	NS	**	***	**	*	NS	***	NS	**	**	*

[z]FVT = Free volatile terpenes
[y]PVT = Potentially-volatile terpenes.
[x]TVE = Total volatile esters.
[w]*, **, ***, NS: Significant at $p \leq 0.05, 0.01, 0.001$, ;or not significant, respectively.

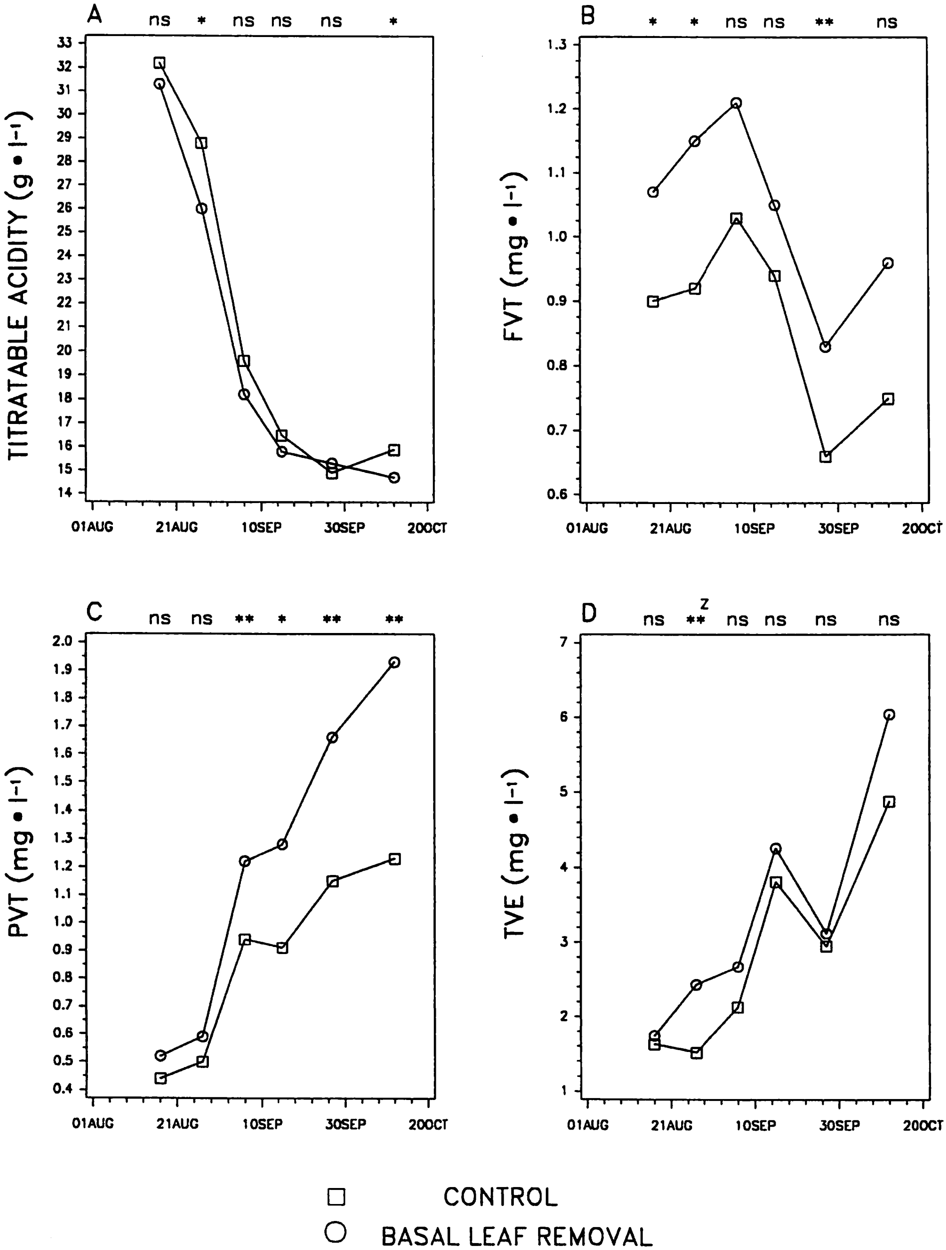

Figure 3. Changes in titratable acidity and flavor compounds of 'Okanagan Riesling' berries during maturation in response to presence or absence of basal leaf removal. Data for the first five sampling dates are pooled for the Inkameep and Summerland sites; sampling date six is reflective of the Summerland site only. (A) Titratable acidity; (B) Free volatile terpenes (FVT); (C) Potentially-volatile terpenes (PVT); (D) total volatile esters (TVE). Legend: *, **, NS: Significant at $p \leq 0.05$, 0.01, or not significant, respectively; Site x canopy manipulation interaction, $p \leq 0.05$.

Except for FVT, basal leaf removal did not affect juice composition; a site X basal leaf removal interaction showed that basal leaf removal reduced FVT at Summerland, and that site-based differences in juice FVT were confined to the control treatments only (data not shown). Basal leaf removal also had no main effects on wine TA, pH, or ethanol, but an interaction showed that basal leaf removal reduced ethanol content in Summerland wines (12.2% in control; 11.0% in leaf removal; $p \leq 0.05$). Wine TVE were increased by basal leaf removal (pooled data across sites: 63.1 mg/L for control; 81.2 mg/L for basal leaf removal; $p \leq 0.0001$). Interactions showed that this main effect increase of TVE by basal leaf removal was similar at the Summerland site but reversed at Inkameep. Summerland leaf removal wines also had highest wine TVE of all four treatment combinations (84.2 mg/L). This is the first evidence that shows TVE response to either site (berries, juice, and wines) or canopy manipulation (berries and wines only).

Tasters found Inkameep control wines more floral in flavor compared to the leaf removal wines (Table 3). The stronger floral flavor in those wines may have been attributable to higher TVE in the leaf removal wines, which could have masked the floral character derived from the terpenes.

Significance of monoterpenes and volatile esters. Slight decreases in FVT and increases in TVE in 'Okanagan Riesling' berries provide compositional evidence for the anecdotal flavor changes during fruit maturation, from a slightly grassy flavor to mild muscat to labrusca. Fuleki (5) suggested that labrusca flavor is likely to occur at TVE concentrations > 10 mg/L. The 4-year range of TVE concentration of 'Okanagan Riesling' in Ontario was 4-7 mg/L (°Brix of 18.7 to 21.6) (T. Fuleki, pers. comm.). Although unlikely for labrusca flavor to be present at the maturity levels observed in a preliminary 1986 trial (3 mg/L TVE), it should have been organoleptically detectable in these experiments because of high TVE concentrations. The high TVE concentrations measured in British Columbia suggest, in accordance with the hypothesis of Reynolds et al. (11), that 'Okanagan Riesling' is a hybrid with *V. labrusca* in its genetic background; its origin may be the Teleki collection in Hungary (22). Only cultivars with *V. labrusca* ancestry contain TVE concentrations > 6 mg/L (5).

Monoterpene concentrations in 'Okanagan Riesling' were found in insignificant amounts compared to TVE concentrations (Fig. 1, 2). Ranges of FVT and PVT in the aromatic cultivar 'Gewürztraminer' were 1.50-1.89 mg/L and 1.95-2.55 mg/L, respectively (13,

Table 3. Results of triangle tests (N - 15) comparing 'Okanagan Riesling' wines from two sites and two canopy manipulation treatments, 1988.

Cultivar and comparison	Correct responses[z]	Allocation of treatments by correct respondents			
		Strongest muscat[y]		Strongest floral[y]	
		1	2	1	2
AROMA					
Site (Inkameep vs. Summerland)	10 **	2/10	4/10	7/10	2/10
Leaf removal vs. control (Inkameep)	6 NS				
Leaf removal vs. control (Summerland)	5 NS				
FLAVOR					
Site (Inkameep vs. Summerland)	10 **	5/10	1/10	3/10	3/10
Leaf removal vs. control (Inkameep)	9 *	2/9	2/9	1/9	5/9
Leaf removal vs. control (Summerland)	NS				

[z]*, **, NS: Significant at $p \leq 0.05$, 0.01, or not significant, respectively.
[y]1 and 2: Refers to first and second listed treatment, respectively.

14). These values are considerably greater than those measured in 'Okanagan Riesling' at comparable °Brix.

Conclusions

Fruit composition of 'Okanagan Riesling' is responsive to vineyard site and basal leaf removal. In warm years, fruit maturation can proceed to a point where labrusca flavor is likely to develop, at soluble solids of 24-25 °Brix. In seasons when GDD are high, TA, pH, and terpene and ester flavor components reach higher concentrations at high GDD sites. In cooler years, low GDD sites appear to promote higher berry terpene and ester concentrations especially if accompanied by lower crop loads. Basal leaf removal can increase both terpenes and esters in the berries, reduced TA, and increased TVE in the juices and wines. Site and basal leaf removal-based differences in berry and juice composition can be confirmed by taster response. High TVE concentrations in 'Okanagan Riesling' berries and juices suggest *Vitis labrusca* ancestry.

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