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Development of Viticultural Practices to Improve Winegrape Performance

Experiment I: Effect of Trellis Type and Canopy Location on Yield Components, Fruit Composition, Fruit Set, and Shoot Morphology in Pinot noir Grapevines

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ABSTRACT

Five different trellis and training systems were compared in their effect on yield components, fruit composition, fruit set, and shoot morphology in Pinot noir grapevines in 1996 and 1997. This trial was performed on established vines planted on a low-vigor valley floor site, in the Willamette Valley of Oregon. The treatments were: upright vertical, cane pruned (Guyot); upright vertical, spur pruned (Bilateral Cordon); Scott Henry, cane pruned; Lyre, cane pruned; and Geneva Double Curtain (GDC), cane pruned. The GDC and the Scott Henry had the highest yield, but were not significantly different from the Lyre or Bi-lateral Cordon in 1996. There were no significant differences in yield in 1997. The GDC, Scott Henry, and Lyre had the most clusters per shoot, the GDC had the highest cluster weight and the GDC and Scott Henry had the most berries per cluster in 1996. These differences were not seen in 1997. In 1996, the Scott Henry had significantly higher anthocyanins than did the other systems. There were no significant differences in juice soluble solids, pH, or titratable acidity between the different trellis systems in either year. The three double canopy trellis systems were also evaluated by canopy to determine differences within the vine. In 1996, there were no significant differences in yield components between double canopies within the vine. In 1997, the top canopy of the Scott Henry had a significantly higher titratable acidity and more berries per cluster than did the bottom canopy.

INTRODUCTION

A great deal of research has been done on the effects of manipulating grapevine microclimate. Microclimate components include light, temperature, humidity, and evaporation. Increased grapevine canopy exposure to solar radiation has been shown to positively influence both fruit composition and yield. The appropriate trellising system is the foundation for effective canopy management. With the correct trellis and training system a winegrape canopy can be balanced with crop load to produce quality grapes, and at the same time maintain the health of the vine. The choice of trellis system depends upon many factors, and is the basis for all other canopy management techniques. These factors include site characteristics, vine vigor, variety and clone, and rootstock. Training systems can either be cane pruned or spur pruned, single canopy or divided canopy. Divided canopy systems such as the Geneva Double Curtain, Open Lyre, or Scott Henry system can increase leaf surface area and decrease shoot density. The method by which a grapevine is trained may effect parameters such as light exposure, and therefore photosynthetic capability. Exterior leaves are responsible for 80-90% of estimated vine photosynthesis (4). A training system may also effect wind speed, and berry temperature. In many cases,

micrometeorological data have been related to fruit composition (2). Training system may influence yield by increasing vine size and thus leaving more nodes via balance pruning. Light microclimate may be increased resulting in better bud fruitfulness. Fruit set or berry weight may be influenced. Lastly, training system may influence losses due to cold temperatures either in winter or in spring (1). Reynolds *et al.* (3) found in a fiveyear study of five training systems, divided canopies increased yields over single curtain canopies by an average of 42%. It was also found that training system had a major impact on anthocyanin concentration in the fruit, brix (% soluble solids), and pH. Titratable acidity appeared to be unaffected by training system. It is the hope that this experiment will determine differences between several trellising systems used in Oregon, providing Oregon growers with more knowledge in which to determine the appropriate trellis to integrate into their production system.

MATERIALS AND METHODS

The Lewis-Brown Farm trellis trial was planted in the Spring of 1984 in a randomized complete block design. Four cultivars are present: Pinot noir, Chardormay, White Riesling, and Gewurztraminer. For this experiment, only the Pinot noir vines were evaluated. The vines are trained to five trellis and training systems: upright vertical, cane pruned (Guyot); upright vertical, spur pruned (Bi-lateral Cordon); Scott Henry, cane pruned; Lyre, cane pruned; and Geneva Double Curtain, cane pruned. The two single canopy systems are spaced 1.5m x 2.0m, and the divided canopy systems are spaced 1.5m x 3.0m. Each treatment consisted of 8 vines. There were guard rows between each replication, and between single and divided canopy systems within replication. The treatments were replicated 5 times. The Pinot noir vines were balance pruned (28 buds/Kg wood) in February of 1996 and 1997.

Yield and fruit composition

The trellis trial was harvested October 16, 1996 and September 30, 1997. All fruit from the six center vines was harvested and weighed. The fruit from the double canopy systems was harvested by canopy, and weighed separately. A 24 cluster subsample was used to determine cluster weight, and was then crushed to determine soluble solids, pH, and titratable acidity. A six-cluster subsample was used to find berry weight, berries per cluster, skin weight, and percent skin to berry ratio.

Fruit set

Just prior to bloom, in 1996 and 1997 one inflorescence per vine was enclosed in a pollination bag to catch all shed flowers. After bloom was completed, the bags were removed, and all shed flowers were counted. At harvest, the same clusters were picked separately, frozen, and then all berries and remaining flowers were counted. Total flower number and percent fruit set could then be calculated from the total number of flowers and berries.

Shoot morphology

Shoots were hedged one foot above the top wire, and one foot above ground level for the downward hanging canopies. In 1996, immediately post harvest, and in 1997 just prior to harvest, one shoot per vine on the single canopy treatments, and one shoot per canopy on the double canopy treatments were removed. Diameter, shoot length, main leaf area, and lateral leaf area were measured. Leaf Area Index (LAI) was determined using total leaf area and square meter surface area. After leaf fall, total shoot number was determined.

RESULTS AND DISCUSSION

Yield and yield components

Table 1 summarizes the yield and yield components of Pinot noir grapevines trained to the five different trellis systems in 1996 and 1997. The Geneva Double Curtain and the Scott Henry trellis systems had

the highest yields in 1996, but were not significantly different from the Lyre and Bi-lateral Cordon. The Guyot has the lowest yield at .43 Kg per square meter (1.9 tons per acre). In 1997 there were no significant differences in yield between the five trellis systems on a Kg per square meter basis. There were no significant differences in clusters per square meter for either year. The Scott Henry, Geneva Double Curtain, and Lyre had the most clusters per shoot in 1996, but in 1997 there were no significant differences between the trellis systems.

Table 1: Yield and yield components of Pinot noir grapevines trained to five different trellis systems.

Year	Trellis	Yield (Kg/m ²)	Tons/ Acre	Clusters/ m ²	Clusters/ shoot	Cluster wt. (g)
1996	Cordon	0.76 ab	3.4 ab	7 a	1.0 bc	100.67 c
	GDC	1.17 a	5.2 a	9 a	1.6 a	130.67 a
	Guyot	0.43 b	1.9 b	6 a	0.8 c	71.00 d
	Lyre	0.77 ab	3.4 ab	7 a	1.5 ab	111.67 bc
	Scott Henry	1.02 a	4.5 a	9 a	1.6 a	115.67 b
	Significant F	* ¹	*	ns	**	***
1997	Cordon	0.66 a	2.9 a	6 a	1.0 a	99.45 a
	GDC	0.68 a	3.0 a	6 a	1.3 a	104.63 a
	Guyot	0.54 a	2.4 a	6 a	1.3 a	97.40 a
	Lyre	0.55 a	2.5 a	6 a	1.1 a	94.32 a
	Scott Henry	0.56 a	2.5 a	5 a	1.0 a	102.43 a
	Significant F	ns	ns	ns	ns	ns

¹ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01 and 0.001 levels. Values followed by the same letters do not differ significantly.

Fruit composition

Fruit composition data from the Pinot noir grapevines trained to the five different trellis systems in 1996 and 1997 are summarized in Table 2. There were no significant differences in must soluble solids, pH, or titratable acidity between the 5 training systems in either year. The GDC had the highest cluster weight most berries per cluster in 1996. There were no significant differences in cluster weight and berries per cluster in 1997. The Lyre and the GDC had the highest skin weight in 1996 (Table 3), although there were no significant differences in percent skin to berry weight. In 1996, the Scott Henry system had the highest skin anthocyanins both per berry weight and per ing skin weight (Table 3).

Table 2: Fruit composition of Pinot noir grapevines trained to five trellis systems.

Year	Trellis	Brix	pH	TA (g/L)	Berry wt. (g)	Berries/ cluster
1996	Cordon	19.0 a	3.06 a	8.38 a	0.94 a	112 b
	GDC	19.0 a	3.04 a	8.48 a	0.91 a	152 a
	Guyot	19.4 a	3.04 a	8.96 a	0.84 a	88 c
	Lyre	19.2 a	3.10 a	8.60 a	0.93 a	123 b
	Scott Henry	19.0 a	3.05 a	8.54 a	0.91 a	131 ab
	Significant F	ns ¹	ns	ns	ns	***
1997	Cordon	22.0 a	3.19 a	7.53 a	1.13 a	90 a
	GDC	21.2 a	3.15 a	7.28 a	1.05 a	100 a
	Guyot	21.9 a	3.18 a	7.70 a	1.03 a	95 a
	Lyre	21.4 a	3.18 a	7.28 a	1.03 a	93 a
	Scott Henry	21.4 a	3.16 a	7.14 a	1.05 a	99 a
	Significant F	ns	ns	ns	ns	ns

¹ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01 and 0.001 levels. Values followed by the same letters do not differ significantly.

Table 3: Skin characteristics from Pinot noir grapevines in 1996 trained to five trellis systems.

Year	Trellis	Skin wt. (g)	%Skin/ Berry wt.	Skin anthocyanins (mg/berry)	Skin anthocyanins (mg/g skin)
1996	Cordon	0.102 b	11 a	0.583 b	5.801 c
	GDC	0.106 ab	12 a	0.736 a	7.156 ab
	Guyot	0.100 b	12 a	0.611 b	6.300 bc
	Lyre	0.116 a	12 a	0.680 ab	6.285 bc
	Scott Henry	0.098 b	11 a	0.763 a	7.792 a
	Significant F	*** ¹	ns	**	**

¹ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01 and 0.001 levels. Values followed by the same letters do not differ significantly.

Shoot morphology

Table 4 summarizes the shoot characteristics of Pinot noir grapevines trained to the five different trellis systems in 1996 and 1997. There were no significant differences in Leaf Area Index (square meter leaf area per square meter ground surface area), in the Bi-lateral Cordon, GDC, Lyre, and Scott Henry, however the LAI for the Guyot was significantly less than for all the other systems in 1996. In 1997, LAI was significantly higher in the Scott Henry system, and significantly less in the Lyre. There were no significant differences found in percent main leaf area, percent lateral leaf area, shoot length, shoot diameter, and percent fruit set between the five trellis systems in either year.

Table 4: Shoot morphology characteristics of Pinot noir grapevines trained to five trellis systems.

Year	Trellis	LAI	% Main leaf area	% Lateral leaf area	Shoot length(cm)	Shoot diam. (mm)	Fruit Set (%)
1996	Cordon	1.19 a	64 a	36 a	126 a	7.31 a	44 a
	GDC	1.15 a	70 a	30 a	123 a	8.04 a	38 a
	Guyot	0.60 b	59 a	41 a	132 a	7.75 a	46 a
	Lyre	1.06 a	62 a	38 a	130 a	7.72 a	42 a
	Scott Henry	1.11 a	67 a	33 a	118 a	8.14 a	42 a
	Significant F	*** ¹	ns	ns	ns	ns	ns
1997	Cordon	1.31 ab	73 a	27 a	134 a	7.48 a	44 a
	GDC	1.04 ab	81 a	19 a	117 b	7.78 a	43 a
	Guyot	1.09 ab	70 a	30 a	136 a	7.82 a	45 a
	Lyre	0.92 b	75 a	25 a	137 a	7.94 a	47 a
	Scott Henry	1.50 a	82 a	18 a	126 ab	7.89 a	42 a
	Significant F	***	ns	ns	*	ns	ns

¹ns, *, **, *** indicate not significant and statistically significant at the 0.05, 0.01 and 0.001 levels. Values followed by the same letters do not differ significantly.

Double Canopy Comparisons

Geneva Double Curtain

Table 5 summarizes the yield and yield components from the north and south facing canopies of the GDC harvested in 1996 and 1997. There were no significant differences in yield and yield components in the two canopies of the GDC in 1996 or 1997. There were no significant differences in fruit composition between the two canopies in either year (Table 6). In 1996 the GDC had a higher percentage of main leaf area in the north facing canopy and a higher percentage of lateral leaf area in the south-facing canopy (Table 7). The north facing canopy also had a significantly longer shoot length in 1996. In 1997 there were no significant differences in shoot morphology between the two canopies of the GDC.

Table 5: Yield component canopy comparisons of Pinot noir vines trained to three double canopy trellis systems.

Year	Trellis System	Canopy	Yield (Kg/m ²)	Yield (tons/A)	Cluster wt. (g)	Clusters/m ²	Clusters/shoot
1996	GDC	North	0.41 a	1.81 a	105.3 a	5 a	1 a
		South	0.46 a	2.02 a	102.7 a	5 a	2 a
			ns ¹	ns	ns	ns	ns
	Lyre	North	0.56 a	2.46 a	103.3 a	4 a	2 a
		South	0.49 a	2.17 a	99.3 a	4 a	2 a
			ns	ns	ns	ns	ns
	Scott Henry	Bottom	0.58 a	2.53 a	108.0 a	5 a	2 a
		Top	0.50 a	2.22 a	103.3 a	5 a	2 a
			ns	ns	ns	ns	ns
	1997	GDC	North	0.29 a	1.28 a	92.0 a	3 a
South			0.29 a	1.28 a	100.3 a	3 a	1 a
			ns	ns	ns	ns	ns
Lyre		North	0.33 a	1.50 a	97.7 a	3 a	1 a
		South	0.34 a	1.60 a	109.1 a	3 a	1 a
			ns	ns	ns	ns	ns
Scott Henry		Bottom	0.30 a	1.36 a	103.9 a	3 a	1 a
		Top	0.36 a	1.62 a	109.8 a	3 a	1 a
			ns	ns	ns	ns	ns

¹ns, *, ** indicate not significant and statistically significant at the 0.05 and 0.01 levels. Values followed by the same letters do not differ significantly.

Table 6: Fruit composition canopy comparisons of Pinot noir vines trained to three double canopy trellis systems.

Year	Trellis System	Canopy	Berry wt. (g)	Berries/cluster	Brix	pH	TA
1996	GDC	North	0.92 a	116 a ¹	19.1 a ¹	3.04 a	8.60 a
		South	0.90 a	117 a	18.9 a	3.08 a	8.32 a
			ns ¹	ns	ns	ns	ns
	Lyre	North	0.89 a	115 a	19.3 a	3.10 a	8.58 a
		South	0.96 a	104 a	19.2 a	3.10 a	8.64 a
			ns	ns	ns	ns	ns
	Scott Henry	Bottom	0.89 a	113 a	18.9 a	3.04 a	8.42 a
		Top	0.88 a	118 a	19.1 a	3.08 a	8.68 a
			ns	ns	ns	ns	ns
	1997	GDC	North	0.97 a	96 a	20.5 a ¹	3.15 a
South			0.96 a	107 a	21.0 a	3.14 a	7.33 a
			ns	ns	ns	ns	ns
Lyre		North	1.02 a	96 a	21.5 a	3.17 a	7.14 a
		South	1.03 a	107 a	22.0 a	3.20 a	6.8 a
			ns	ns	ns	ns	ns
Scott Henry		Bottom	1.07 a	99 b	20.7 a	3.18 a	6.87 b
		Top	1.06 a	107 a	21.4 a	3.14 a	7.52 a
			ns	**	ns	ns	*

¹ns, *, ** indicate not significant and statistically significant at the 0.05 and 0.01 levels. Values followed by the same letters do not differ significantly.

Table 7: Shoot morphology canopy comparisons of Pinot noir vines trained to three double canopy trellis systems.

Trellis System	Canopy	LAI	% Main leaf area	% Lateral leaf area	Diameter (mm)	Shoot length(cm)	Shoots/m ²
1996	GDC North	0.46 a	68 a	32 b	8.16 a	129.0 a	2 a
	GDC South	0.45 a	60 b	40 a	7.93 a	117.3 b	2 a
		ns ¹	*	*	ns	*	ns
	Lyre North	0.53 a	63 a	37 a	7.72 a	135.5 a	3 a
	Lyre South	0.64 a	65 a	35 a	7.72 a	125.0 b	3 a
		ns	ns	ns	ns	*	ns
	Scott Henry Bottom	0.57 a	64 a	36 a	8.25 a	135.4 a	3 a
	Scott Henry Top	0.46 a	69 a	31 a	8.04 a	100.9 a	3 a
	ns	ns	ns	ns	ns	ns	
1997	GDC North	0.35 a	84 a	16 a	7.51 a	115.6 a	2 a
	GDC South	0.33 a	93 a	7 a	8.05 a	118.8 a	3 a
		ns	ns	ns	ns	ns	ns
	Lyre North	0.59 a	79 a	21 a	8.06 a	135.6 a	3 a
	Lyre South	0.57 a	81 a	19 a	7.81 a	138.5 a	3 a
		ns	ns	ns	ns	ns	ns
	Scott Henry Bottom	0.40 a	87 a	13 a	7.73 a	135.5 a	2 b
	Scott Henry Top	0.46 a	83 a	17 a	8.03 a	118.0 a	3 a
	ns	ns	ns	ns	ns	**	

¹ns, *, ** indicate not significant and statistically significant at the 0.05 and 0.01 levels. Values followed by the same letters do not differ significantly.

Lyre

Table 5 summarizes the yield and yield components from the north and south facing canopies of the Lyre in 1996 and 1997. There were no significant differences in yield and yield components in the two canopies of the Lyre in 1996 or 1997. There were no significant differences in fruit composition in the two canopies in either year (Table 6). In 1996 the north-facing canopy of the Lyre had a significantly longer shoot length than did the south facing canopy (Table 7). There were no differences in shoot morphology between the two canopies of the Lyre in 1997.

Scott Henry

The yield and yield components from the bottom and top canopies of the Scott Henry system in 1996 and 1997 are summarized in Table 5. In 1996 there were no significant differences between top and bottom canopies in yield, fruit composition (Table 6), or shoot morphology (Table 7) between the two canopies of the Scott Henry system. In 1997 the top canopy had a significantly higher titratable acidity, more berries per cluster, and more shoots per square meter than did the bottom canopy.

CONCLUSIONS

In 1996 the most significant differences were seen in yield and yield components. The double canopy systems had a higher yield, cluster weight, more berries per cluster, and higher skin anthocyanins than did the single canopy systems. In 1997 there were no significant differences seen in yield, cluster weight or berries per cluster between the five trellis systems. This may be a result of continued balance pruning (vines were pruned to 28 buds per Kg of wood for the past three years), weather, or both. Overall yield decreased in 1997, and there were fewer berries per cluster, but higher berry weights. The result was an overall lower average cluster weight in 1997. Several factors may have contributed to this. First, there was some cool, wet weather during the 1997 bloom. There was also a period of rainfall after veraison, followed by a very hot period, which resulted in some berry shriveling. Also, in 1997, due to the shallow rooting depth in part of the trial, some of the vines suffered from water stress late in the summer. In the double canopy comparisons, the only significant differences seen in either year were the higher titratable

acidity and more berries per cluster seen in the top canopy of the Scott Henry system in 1997. After this two-year study, on the OSU trellis trial site, there appeared to be no definite trends related to trellis system. This may indicate that other factors such as site, weather, clone or rootstock can enhance or, as in this case, overcome some of the trellis system influence on factors such as yield, fruit composition, fruit set, or shoot morphology.

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