Influence of Training Systems, Pruning Practices, and Soil Types on Eutypa Dieback Incidence and Severity, Viticultural Performance, and Wine Quality in Cabernet Sauvignon Grapevines

Annual Report (2000-2001) submitted to

Lodi-Woodbridge Winegrape Commission

Submitted by

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I. Project Title

Influence of Training Systems, Pruning Practices, and Soil Types on Eutypa Dieback Incidence and Severity, Viticultural Performance, and Wine Quality in Cabernet Sauvignon Grapevines

II. Principle Investigators and Cooperators

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III. Summary

Vines grown on the higher capacity soil had greater incidence and severity of Eutypa dieback. There were no symptoms of Eutypa dieback in minimally-pruned treatment. Vines trained to bilateral cordon and Sylvoz with hand spur pruning displayed greater incidence and severity than head trained vines with hand cane pruning or machine-pruned vines either with or without hand follow-up. Soil fertility and training/pruning did not interact to affect the incidence and severity of Eutypa dieback. Vines grown on the low capacity soil had higher level of light in the fruiting zone from the South and North sides of the canopy than those grown on the high capacity soil. Training/pruning systems did not significantly affect the light penetration into fruiting zone from the top of the canopy. Minimal pruning and mechanical pruning produced similar yield which was higher than other training/pruning systems. Fruit Brix, pH, and TA were statistically comparable among the treatments at harvest. High capacity soil supported higher petiole N, Mg, Zn, Mn, Cu, and S but lower P and Ca content at full bloom. Must composition was comparable for both soil types and training/pruning systems. Mechanical and minimal pruning resulted in lower alcohol content in the wines. A higher total phenolics content was found in wines from low capacity soil. Mechanical pruning and head training with cane pruning produced wine of higher sensory

quality in 1999. Sensory evaluation of the 2000 wines will be conducted and result will be reported at a later date upon completion.

IV. Objectives and Experiments Conducted to Meet Stated Objectives

Objectives. It is hypothesized that a reduction in exposure of pruning wounds to Eutypa infection by altering the training systems and pruning practices will result in a lower incidence and severity of Eutypa dieback while maintaining or improving vine growth, productivity, fruit composition, and wine quality. The objectives of the proposed research are 1) to investigate the long term effect of training systems and pruning practices on the incidence and severity of Eutypa dieback, vine growth, petiole mineral nutrition, canopy light penetration, and yield components; 2) to define the potentials and limitations of the training systems and pruning practices by monitoring yield components, fruit composition, fruit maturity, wine chemistry and quality; 3) to examine the interaction between soil types and training systems on the parameters under evaluation; and 4) to identify the training systems and pruning practices that minimize the impact of Eutypa dieback while maintaining or improving vine performance and wine quality.

Experiment Design. This study was conducted with Cabernet Sauvignon/Freedom grapevines planted in 1992 with a spacing of 7 feet between vines and 10 feet between rows of east to west orientation. The experiment consists of a factorial combination of 2 soil types (San Joaquin loam, a low capacity soil and Columbia silt loam, a high capacity soil) and 6 training/pruning systems (bilateral cordon with spur pruning, head-training with cane pruning, Sylvoz with short downward canes, machine pruning with hand follow-up, machine pruning without hand follow-up, and minimal pruning with growing season trimming). The experimental design is a randomized complete block with 3 replications. Fifteen vines in the middle row of each plot are used for data collection. When the experiment began, the vines had received only one training cut and should have been free of 'prior' Eutypa infection.

Incidence of Eutypa Dieback. Shoots showing symptoms of Eutypa dieback and dead spurs were evaluated on May 7, 2000. Disease incidence is expressed as the percentage of vines showing symptoms either as dead spurs or symptomatic leaves. Disease severity is expressed as the number of dead spurs or symptomatic shoots per vine showing symptoms.

Fruiting Zone Light Penetration. Light penetration into the fruiting zone was measured with a quantum/radiometer/photometer (LI-185B, Li-Cor, inc., Lincoln, Nebraska) with the line sensor held parallel to the cordon in the fruiting zone of the canopy facing up, South, and North on July 7 and August 3, 2000.

Fruit Composition and Yield Components. Samples of 100 berries were collected for analysis of berry weight, Brix, titratable acidity (TA), and pH prior to and at harvest. Cluster number and yield were determined at harvest on September 30, 2000.

Vine Growth. Pruning weight, number of shoots, and nodes retained were measured to determine treatment effects on vine growth during the dormant season, except vines on mechanical pruning which will be pruned after bud break. Data on these training/pruning systems will be reported upon completion at a later date.

Wine Chemistry and Sensory Characteristics. Wine lots were made from 4 training/pruning systems on both San Joaquin loam and Columbia silt loam soils in 2000. Wines were analyzed for general chemistry. A sensory evaluation will be conducted to reveal the effect of soil fertility and training/pruning system on wine sensory characteristics. The sensory evaluation of 1999 wines were completed and is reported herein.

V. Summary of Major Research Accomplishments and Results

In general, Eutypa dieback symptoms continue to increase in the vineyard. Vines grown on the higher capacity soil had greater incidence and severity of Eutypa dieback. Vines trained to bilateral cordon and Sylvoz with hand spur pruning displayed greatest incidence and severity of Eutypa dieback. Head trained vines with hand cane pruning or machine-pruned vines either with or without hand follow-up displayed lower level of Eutypa dieback development. Hand follow-up did not alter the response of mechanically pruned vines to Eutypa infection. There were no symptoms of Eutypa dieback in the minimally-pruned treatment. Soil fertility and training/pruning system did not interact to affect the incidence and severity of the Eutypa dieback (Table 1 and Figs. 1 and 2).

Light penetration into the fruiting zone was affected by soil fertility and training/pruning systems. Vines grown on San Joaquin loam (a low capacity soil) had higher level of light in fruiting zone from the top and South side of the canopy than those grown on Columbia silt loam (a high capacity soil). Training/pruning systems did not significantly affect the light penetration into the fruiting zone from the top of the canopy. However, light penetration into the fruiting zone from both South and North sides of the canopy was significantly influenced by training/pruning systems. Soil capacity and training/pruning did not interact to affect light penetration into the fruiting zone from any direction (Table 2).

Training/pruning systems had a significant effect on yield and yield components while soil capacity did not significantly influence yield and yield components. Minimally-pruned vines produced the greatest number of clusters per vine. Mechanically-pruned vines produced fewer clusters than minimally-pruned vines but more clusters than head training, Sylvoz, and bilateral cordon training with hand pruning. Mechanical pruning and minimal pruning produced similar size of clusters which were smaller than that of other training/pruning systems.

Minimal pruning and mechanical pruning produced similar yield which was higher than other training/pruning systems. Hand follow-up did not affect yield and yield components significantly. Minimal pruning produced the most while Sylvoz, bilateral cordon, and head training produced the least shoots per vine. Mechanically-pruned vines had moderate number of shoots per vine. Pruning weight is comparable among the three treatments with which pruning weight has been collected (Table 3). Pruning weight of mechanically-pruned vines will be collected at the time of pruning. It will be reported at a later date upon completion.

Fruit Brix, pH, and TA were affected by soil capacity and training/pruning systems at various times during maturation. However, all the fruit composition measurements were statistically comparable among the treatments at harvest (Table 4).

Soil fertility affected petiole N, P, Mg, Ca, Zn, Mn, Cu, and S content at full bloom significantly. High capacity soil supported higher N, Mg, Zn, Mn, Cu, and S but lower P and Ca content. Training/pruning systems had no significant effect on petiole mineral nutrients at full bloom (Table 5).

Must composition was comparable for both soil types and training/pruning systems. Wine alcohol content was affected significantly by training/pruning systems. Mechanical and minimal pruning resulted in lower alcohol content in the wines. A significantly higher content of total phenolics was found in wines from fruit on San Joaquin loam, compared to that on Columbia silt loam. Other wine chemistry measurements were not significantly influenced by either soil types or training/pruning systems (Table 6). Sensory evaluation on 1999 wines indicated that mechanical pruning with or without hand follow-up produced wines of higher sensory quality, comparable to that of head-trained vines with cane pruning, while minimal pruning and Sylvoz produced wines of lower sensory quality (Fig. 3). Wines produced in 2000 will be evaluated upon the completion of wine making process. Results will be reported at a late date.

VI. Outside Presentations of Research

Unified Grape and Wine Symposium. Sacramento, California. January 25, 2000.

VII. Research Success Statements

Experiment conducted so far demonstrated that minimal pruning and mechanical pruning eliminate or delay dormant pruning and Eutypa dieback infection. This research has provided essential understanding of the relationship between training/pruning systems and Eutypa dieback infection and possible tools to control the disease.

VIII. Funds Status

The research project is funded jointly by the American Vineyard Foundation, the Lodi-Woodbridge Winegrape Commission, and the California State University - Agricultural Research Initiative. The funds have being used for Technical Support, Student Assistantships, Supplies, Travel, and Outside Services as proposed. The project is in a good financial health and it is expected to be completed without difficulties.

The proposal was incorporated into a large scale study funded by the American Vineyard Foundation at a level of $275,000 for 2000-2001, titled “Development of Control Methods for Eutypa Dieback Disease”. The Objective II of the study “Evaluate Viticultural Practices for Improved Control of Eutypa Disease” was funded at $24,600 for 2000-2001 under the direction of Dr. Sanliang Gu. The proposal was also funded by the California State University-Agricultural Research Initiative at $20,000.

The project has also been linked to a California State University - Agricultural Research Initiative funded project to evaluate the effects of various vineyard management practices on leaf nitrogen, juice arginine, and wine ethyl carbamate concentration for 2000-2002.

IX. List of Tables and Figures

X. Acknowledgement

The investigators and cooperators of this research project wish to thank the Lodi-Woodbridge Winegrape Commission, the American Vineyard Foundation, and the California State University - Agricultural Research Initiative for their continued financial support. We would also like to thank the Vino Farms, Inc. for their help on vineyard management and data collection, and staff and students at the Viticulture and Enology Research Center for their administrative and technical assistance.

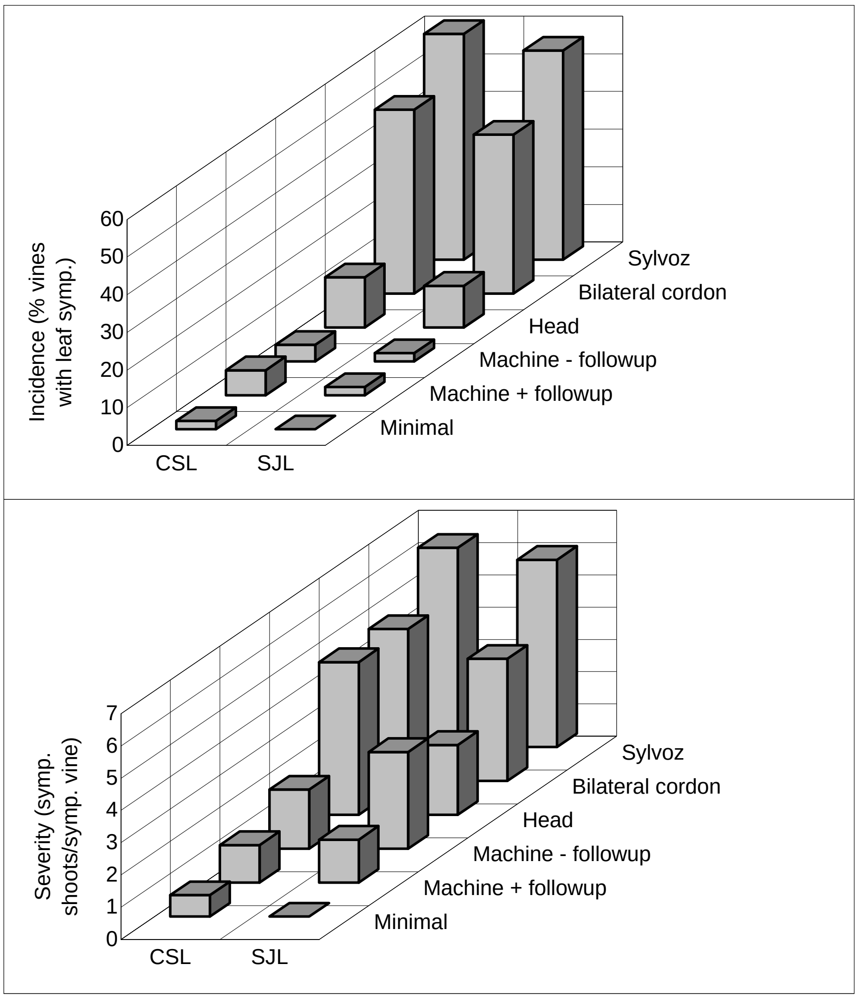

Fig. 1. Incidence and severity of Eutypa dieback (symptomatic shoots) in Cabernet Sauvignon grapevines on various training/pruning systems and grown in San Joaquin loam (SJL, a low capacity soil) and Columbia silt loam (CSL, a high capacity soil).

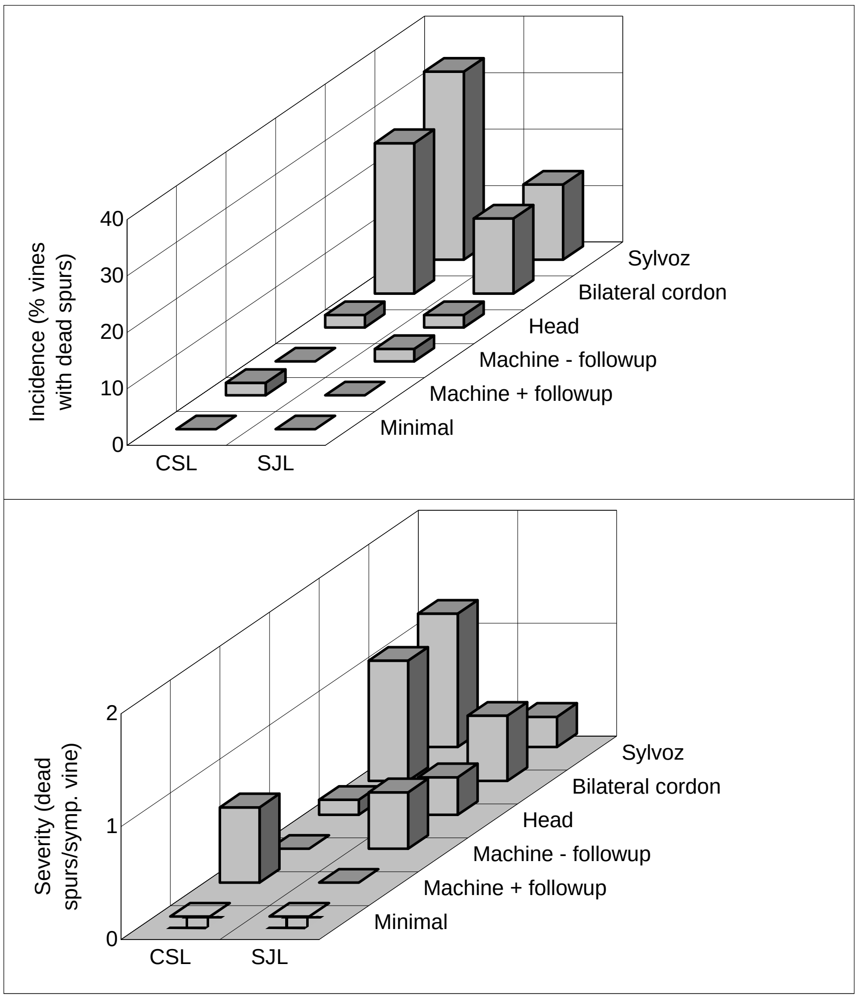

Fig. 2. Incidence and severity of Eutypa dieback (dead spurs) in Cabernet Sauvignon grapevines on various training/pruning systems and grown in San Joaquin loam (SJL, a low capacity soil) and Columbia silt loam (CSL, a high capacity soil).

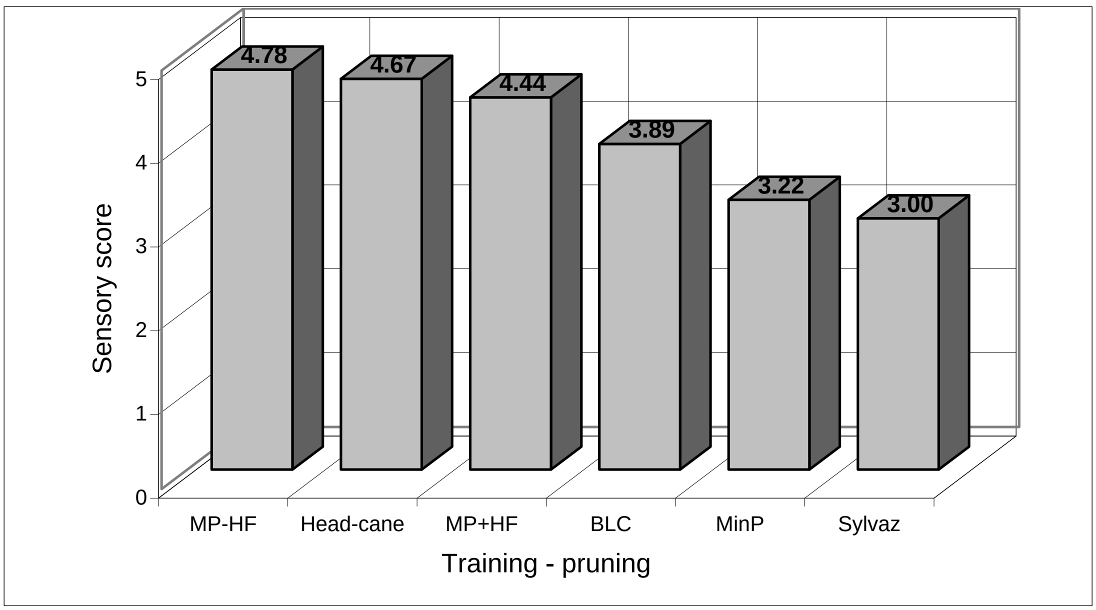

Fig. 3. Sensory quality of 1999 Cabernet Sauvignon wines from grapevines on various training/pruning systems and grown in San Joaquin loam (SJL, a low capacity soil).

Table 1. Effect of soil type and training/pruning system on incidence and severity of Eutypa dieback in Cabernet Sauvignon grapevines

Treatment	Incidence (%) Vines with leaf symptoms	Incidence (%) Vines with dead spurs	Severity (per symp. vine) Dead spurs	Severity (per symp. vine) Symp. shoots
Soil (S)				
Columbia silt loam	24.1	1.611 a	0.51	3.22
San Joaquin loam	18.9	0.778 b	0.28	2.68
Training (T)				
Sylvoz	62.2 a	3.5 a	0.73 ab	5.99 a
Bilateral cordon	45.6 a	3 a	0.82 a	4.25 ab
Head-cane	12.2 b	0.333 b	0.23 bc	3.45 bc
Machine + hand follow-up	4.4 b	0.167 b	0.33 bc	1.25 cd
Machine - hand follow-up	3.3 b	0.167 b	0.25 bc	2.42 bcd
Minimal	0.0 b	0 b	0.00 c	0.00 d
Significance				
S	NS	0.0484	NS	NS
T	0.0000	0.0000	0.0306	0.0025
S x T	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.

Table 2. Effect of soil type and training/pruning system on light penetration into the fruiting zone in Cabernet Sauvignon grapevines

Treatment	Light, uE m^{-2} s^{-1} Vertical	South	North	% of ambient light Vertical	South	North
			July 7, 2000			
Soil (S)						
Columbia silt loam	936 a[z]	273 a	66	53.49 a	15.58 a	3.78
San Joaquin loam	646 b	192 b	70	36.89 b	10.96 b	3.98
Training and pruning (TP)						
Machine + hand follow-up	1110	336 a	72 b	63.43	19.19 a	4.11 b
Minimal	903	197 d	89 a	51.62	11.26 d	5.07 a
Machine - hand follow-up	743	237 bc	67 b	42.48	13.51 bc	3.80 b
Head-cane	713	288 b	60 b	40.76	16.47 b	3.45 b
Sylvoz	698	129 d	59 a	39.90	7.34 d	3.34 a
Bilateral cordon	577	207 cd	62 b	32.95	11.84 cd	3.51 b
Significance						
S	0.0182	0.0040	NS	0.0182	0.0040	NS
T	NS	0.0017	0.0430	NS	0.0017	0.0430
S x T	NS	NS	NS	NS	NS	NS
			August 3, 2000			
Soil (S)						
Columbia silt loam	543 a	54 a	231	35.27 a	3.52 a	14.98
San Joaquin loam	453 b	85 b	207	29.42 b	5.49 b	13.46
Training (T)						
Head-cane	645	73	227	41.88	4.74	14.73
Bilateral cordon	525	63	226	34.09	4.08	14.69
Minimal	519	74	237	33.71	4.77	15.37
Machine - hand follow-up	483	70	288	31.39	4.51	18.67
Machine + hand follow-up	420	57	147	27.29	3.72	9.51
Sylvoz	396	80	190	25.71	5.22	12.34
Significance						
S	NS	0.0050	NS	NS	0.0050	NS
T	NS	NS	NS	NS	NS	NS
S x T	NS	NS	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.

Table 3. Effect of soil type and training/pruning system on yield components and vine vigor in Cabernet Sauvignon grapevines

Treatment	Clusters no./vine	Cluster weight lb	Yield lb/vine	Yield T/A	Shoots /vine	Pruning weight, lb
Soil (S)						
Columbia silt loam	236	0.164	33.2	10.3	104	4.30
San Joaquin loam	214	0.217	42.5	13.2	104	3.60
Training (T)						
Minimal	383 a[z]	0.127 b	43.8 ab	13.6 a	227 a	
Machine - hand follow-up	283 b	0.160 b	45.5 a	14.1 a	105 b	
Machine + hand follow-up	263 b	0.147 b	38.7 ab	12.0 a	109 b	
Sylvoz	158 c	0.222 a	35.2 bc	10.9 b	63 bc	3.16
Bilateral cordon	146 c	0.240 a	35.0 bc	10.9 b	71 bc	4.76
Head-cane	119 c	0.246 a	28.9 c	9.0 b	48 c	3.93
Significance						
S	NS	NS	NS	NS	NS	NS
T	0.0000	0.0005	0.0000	0.0000	0.0000	NS
S x T	NS	NS	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.

Table 4. Effect of soil type and training/pruning system on fruit maturity in Cabernet Sauvignon grapevines

Treatment	Berry weight, g	Brix	pH	TA g/L	Berry weight, g	Brix	pH	TA g/L
	August 30, 2000				September 11, 2000			
Soil (S)								
Columbia silt loam	1.14 b[z]	18.7 b	3.31	8.23	1.12 b	19.8 b	3.32 a	7.55
San Joaquin loam	1.34 a	19.5 a	3.28	8.19	1.24 a	20.9 a	3.23 b	8.33
Training and pruning (TP)								
Head-cane	1.37 a	19.4	3.36 a	7.69	1.33 a	20.5	3.29	7.36
Bilateral cordon	1.37 a	19.5	3.36 a	7.94	1.27 ab	20.6	3.37	7.36
Sylvoz	1.35 a	19.2	3.29 b	8.60	1.22 ab	20.7	3.26	8.07
Machine + hand follow-up	1.16 b	19.0	3.27 b	8.15	1.18 ab	20.1	3.27	7.89
Machine - hand follow-up	1.11 b	18.4	3.24 b	8.47	1.05 b	19.8	3.21	8.74
Minimal	1.06 b	18.9	3.24 b	8.43	1.01 b	20.3	3.24	8.24
Significance								
S	0.0008	0.0018	NS	NS	0.0147	0.0001	0.0056	0.0288
TP	0.0025	NS	0.0018	NS	0.0032	NS	NS	NS
S x TP	NS	NS	NS	NS	0.0211	NS	NS	NS
	September 21, 2000				September 30, 2000			
Soil (S)								
Columbia silt loam	1.17	21.1	3.41	6.46 b	1.07	21.5	3.50	5.83
San Joaquin loam	1.23	21.9	3.35	6.88 a	1.13	22.3	3.50	5.64
Training and pruning (TP)								
Head-cane	1.39 a	21.7	3.49	6.39	1.07	22.0	3.55	5.76
Sylvoz	1.32 a	21.6	3.39	6.89	1.23	21.6	3.52	5.93
Bilateral cordon	1.27 ab	21.7	3.39	6.39	1.19	22.2	3.56	5.31
Machine + hand follow-up	1.11 bc	21.6	3.32	6.76	0.93	22.2	3.51	5.41
Machine - hand follow-up	1.06 c	21.1	3.32	6.83	1.25	21.8	3.45	5.94
Minimal	1.04 c	21.4	3.35	6.76	0.94	21.8	3.43	6.06
Significance								
S	NS	0.0047	NS	0.0439	NS	NS	NS	NS
TP	0.0034	NS	NS	NS	NS	NS	NS	NS
S x TP	NS	NS	NS	NS	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.

Table 5. Effect of soil types and training/pruning systems on petiole mineral nutrients at full bloom in Cabernet Sauvignon grapevines

Treatment	NO_3-N ppm	P %	K %	Mg %	Ca %	Zn ppm	Mn ppm	Fe ppm	Cu ppm	B ppm	Na %	Cl %	S %
Soil (S)													
Columbia silt loam	543 a[z]	0.32 b	3.82	0.49 a	1.29 b	29 a	142 a	55	7 a	40	0.04	0.08	0.19 a
San Joaquin loam	115 b	0.79 a	4.05	0.32 b	1.63 a	25 b	119 b	49	6 b	39	0.03	0.08	0.15 b
Training and pruning (TP)													
Bilateral cordon	316	0.63	3.73	0.46	1.51	25	126	53	6	40	0.04	0.07	0.17
Head-cane	468	0.74	3.91	0.44	1.72	27	123	66	6	44	0.03	0.07	0.19
Machine - hand follow-up	221	0.49	4.08	0.40	1.34	27	129	49	7	37	0.03	0.09	0.17
Machine + hand follow-up	264	0.50	3.87	0.39	1.31	25	112	53	7	36	0.04	0.07	0.17
Minimal	213	0.41	4.03	0.35	1.49	30	158	45	6	41	0.03	0.08	0.18
Sylvoz	494	0.56	3.99	0.39	1.38	30	134	47	7	40	0.04	0.09	0.15
Significance													
S	0.0018	0.0000	NS	0.0000	0.0037	0.0321	0.0399	NS	0.0001	NS	NS	NS	0.0002
TP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x TP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.

Table 6. Effect of soil types and training/pruning systems on must composition and wine chemistry in Cabernet Sauvignon grapevines

System	Must composition			Wine chemistry						
	Brix	pH	TA, g/L	pH	TA, g/L	VA, g/L	Alcohol, %	TP, mg/L	$A_{420}+A_{520}$	K, ppm
Soil (S)										
Columbia silt loam	21.7	3.76	4.63	3.67	7.86	0.508	11.9	191 b	4.55	1032
San Joaquin loam	22.1	3.77	4.46	3.78	8.60	1.049	11.6	227 a	5.20	1126
Training and pruning (TP)										
Bilateral cordon	22.1	3.78	4.46	3.75	8.56	0.893	12.1 a[z]	203	4.76	1131
Head-cane	22.0	3.87	4.49	3.84	7.91	0.531	12.0 a	208	4.48	1242
Machine + hand follow-up	22.0	3.74	4.47	3.66	8.31	0.795	11.9 b	207	5.27	995
Minimal	21.4	3.69	4.77	3.66	8.14	0.894	10.9 b	218	4.98	949
Significance										
S	NS	NS	NS	NS	NS	NS	NS	0.0037	NS	NS
TP	NS	NS	NS	NS	NS	NS	0.0130	NS	NS	NS
S x TP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z]Means within columns for each factor followed by different letters are significantly different by Fisher's LSD at P=0.05 level.