LODI-WOODBRIDGE WINEGRAPE COMMISSION
FINAL REPORT
1994 - 1995 Fiscal Year

PROJECT TITLE: Evaluation of different severities of mechanical and hand pruning of Cabernet Sauvignon and Chardonnay grapevines for productivity, fruit composition and wine quality.

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OBJECTIVES:

1. Determine the maximum amount of crop that can be produced per acre without detrimental effects on fruit composition and wine quality.

2. Compare productivity, fruit and wine composition, and quality of mechanically pruned grapevines to different levels of hand pruned grapevines.

3. Compare the effects of hand pruning and mechanical pruning on canopy microclimate, vegetative growth characteristics, and amount of bunch rot of Cabernet Sauvignon and Chardonnay grapevines.

RESULTS:

1994 is the third year that this pruning level trial has been in progress. Nine different pruning level treatments were imposed (see Tables 1 to 5) on six-year-old Chardonnay and Cabernet Sauvignon vines trained to a quadrilateral Cordon GDC type trellis-training system with a distance of 36 inches between the two horizontal fruiting wires. Pruning severities ranged from 24 to 96 buds per vine on vines spur pruned and between 100 and 300 buds per vine on vines mechanically short and long hedged or minimally pruned. Each of the nine treatments are replicated six times with four vines per replication for both varieties.

After budbreak this year, all treatments were crown suckered to the appropriate number of count buds. At flowering, petiole samples were taken from all treatments to check on the mineral status of the vine which is presented in Tables 13 and 14. Vegetative growth characteristics were determined for shoot length, node number, and main and lateral leaf areas at veraison. Shoot number, pruning weight, and averaged shoot weight were determined at pruning in February, 1995. Vegetative growth parameters are presented in Tables 15 through 18. Several berry samples were taken between veraison and harvest to determine the effect of pruning level on total soluble solids, acidity, pH, malate, potassium and fruit coloration. The fruit composition data of the different sampling dates are presented in Tables 1 to 3 for Chardonnay

and Tables 5 to 7 for Cabernet Sauvignon. At harvest, data on crop yields, cluster number, average cluster weight, and % rot or shrivel were collected and is presented in Table 4 for chardonnay and Table 8 for Cabernet Sauvignon. Replicated wines were made from each treatment and analyzed to determine the effect of pruning level on ethanol concentration, wine pH, titratable acidity, phenolics, and wine color. Wines were tasted by a panel of 9 judges using the Davis 20 point scoring system. Data on wine composition and scores are presented in Tables 9 to 12. At pruning, a relationship between pruning level and damage to the vine due to mechanical harvesting was noted and is documented in Table 19.

For Chardonnay, crop yield ranged from 10.6 tons/acre for vines pruned to 24 buds/vine to 22.7 tons/acre for vines hedge pruned (Table 4). Vines minimally pruned produced 20.7 tons/acre, however, the fruit only matured to 20.0°Brix. Fruit from Chardonnay vines pruned to 24, 48, and 72 buds/vines did not differ greatly in the level of total soluble solids sampled on the same date, however, fruit from vines pruned to 24, four bud spurs (96 buds/vine) were markedly lower in sugar as were also hedged pruned and minimally pruned vines compared to vines pruned to less than 72 buds (Tables 1 to 3). The crop yield of vines pruned to 96 or more buds per vine exceeded 20 tons per acre. The reduced level of sugar in fruits of these latter vines is indicative of the large corp that the vines were carrying.

Harvest date ranged from September 12 for the 24 through 76 bud treatments to September 29 for 96 buds or greater. Short and long hedge pruned vines reached an acceptable level of total soluble solids (22.3 to 22.4°Brix) two weeks later than vines traditionally spur pruned to 48 to 72 buds, whereas non-pruned vines (minimal pruned) only matured their fruit to a non-acceptable 20°Brix, even though the crop load of minimal pruned vines was less than the hedge pruned vines. Percent rot best correlated with berry size which was reduced on treatments carrying greater than 100 clusters per vine: the 16x4 bud, the 24x4 bud, the hedge, and minimal pruning treatments.

Ethanol content of Chardonnay wines produced from the various treatments reflected TSS at harvest (Table 9.) No significant differences in overall wine score were observed for Chardonnay wines. However, there were significant differences in the aroma scores with the 16x4 bud treatment (64 buds total) having the lowest score and the 24x1 bud and 24x3 bud having the highest (Table 10).

For Cabernet Sauvignon, 1994 crop yields ranged from 8.1 tons/ac for vines pruned to 24 buds/vine to 23.9 tons/vine for vines pruned to 96 buds (24, 4 bud spurs) (Table 8). Vines short hedged pruned produced 23.8 tons/ac, approximately the same as vines pruned to 96 buds, while yields of vines long hedged pruned and minimally pruned were down somewhat to 20.1 tons/ac and 17.2 tons/ac, respectively. The yields of these latter two treatments were less in 1994 than 1993, whereas the other pruning treatments generally had higher yields in 1994 than in 1993. This suggests that long hedge and minimally pruned vines were overcropped in 1993. A reduction in bud fruitfulness of these two treatments between 1993 and 1994 supports this conclusion. The long hedge and minimal pruned vines had 26 and 46% of their clusters shriveled at harvest, which was three to eight times more than that found in the other pruning treatments. The level of sugar in the fruit of hedge long and minimal pruning treatments barely reached 20°Brix, which was significantly lower than the other treatments (Table 7). These data indicate that vines minimally pruned and hedge long pruned were not capable of producing acceptably quality in their third year of treatment.

The Cabernet Sauvignon fruit composition data of the nine pruning level treatments are presented in Tables 5 to 7. The data shows that with increase in the number of buds per vine left after pruning (and increase in crop/vine) the level of sugar (°Brix), pH, malic acid, potassium, and anthocyanin per berry generally decreased, whereas titratable acidity increased. The level of anthocyanin in fruit expressed as mg/g berry weight, however, was generally higher in the hedge long and minimal pruned vines than in the other treatments. This was likely due to the very small size berries produced from vines hedge long and minimal pruned, which would give a high ratio between the weight of skin and berry pulp.

Harvest date for Cabernet Sauvignon ranged from October 12 to October 20. All treatments up to 76 buds were harvested on October 12 based on brix readings taken 4 days earlier. An untimely irrigation during the interim set back all the treatments with the 24 and 48 bud treatments being most effected. A second harvest was performed from additional vines in each of the replicates of those treatments that returned to their original sugar levels on October 20. For those treatments, wines from the earlier harvest were discarded on new wines made.

Composition of Cabernet Sauvignon wines reflected maturity at harvest providing malolactic fermentation is taken into account (Table 11). The long hedge and minimal prune treatments which had less than 0.5 gm/L malic acid in fruits at harvest produced no pH rise during secondary fermentation leaving wines that were significantly lower in ph and higher in titratable acidity. Both higher anthocyanin content per berry and lower wine ph contributed to improved color density for wines from long hedge and minimal pruned treatments. The most important factor in wine score appeared to be harvest date. The two low scoring wines were the earliest harvested (Table 12).

For both varieties, Calcium, magnesium, and nitrogen content of petioles at bloom were generally reduced and potassium concentration generally increased by treatments with high bud numbers (Tables 13 and 14). In this fertigated vineyard, all mineral nutrients tested were at adequate levels.

All indices of vigor (shoot length, average shoot weight, nodes per shoot, main and lateral leaf areas per shoot, and % lateral leaf area) decreased with increasing shoot number irrespective of variety or pruning method and spur length (Tables 15 through 18). Total leaf area per vine, increased on both varieties with increasing shoot number.

Leaf area per gram of crop on Chardonnay ranged from and average of 8.7 cm^2/gm for traditionally spur pruned vines to an average of 15.1 cm^2/gm for hedge and minimally pruned vines. Chardonnay pruning weights per vine were reduced on the 24x1 bud treatment through reduced shoot number. They reached a maximum at 48 buds per vine and then decrease with bud number due to reduced shoot size.

On Cabernet Sauvignon leaf areas per gram of crop were of similar magnitudes to those found on Chardonnay except for the 24x1 bud treatment which produced 17.1 cm^2/gm due to disproportionately high lateral leaf areas and low yields. Like those of Chardonnay, pruning weights per vine on Cabernet Sauvignon also were reduced on the lowest pruning levels but reached a maximum at about 70 shoots per vine rather than 48 before declining. The very high vigor and low pruning weight of the 24x1 bud treatment indicate that pruning level was substantially below the capacity of the vines.

Yield to pruning weight ratios increase with increasing yields. For Chardonnay they ranged from 9.2 to 20.6 for 24x1 bud and long hedge treatments respectively and from 6.0 to 16.0 on Cabernet Sauvignon.

At time of pruning a relationship between pruning method and damage done to the vine by mechanical harvesting was noted (Table 19). Traditionally pruned vines had numerous spur position broken off by the harvester. The condition was aggravated by treatments which produced the largest shoots. The 24x1 bud treatment was missing 27% of its arm positions. Because potential replacements had been removed at suckering, none of the traditionally pruned treatments were fully sustainable given the GDC trellis and mechanical harvesting practices used. Hedge pruning treatments did not appear to have been affected. Damage to minimally pruned vines was deemed negligible.

It is concluded that Chardonnay and Cabernet Sauvignon can tolerate short mechanical hedge pruning (up to about 140 shoots/vine) but not long hedge or minimal pruning. It is further concluded that the lowest pruning level, 24x1 buds per vine, was substantially below the capacity of the vines for both varieties.

TABLE 1: Influence of pruning level on fruit composition of Chardonnay sampled September 6, 1994, grown at Sheldon, CA.

Pruning Level	Berry Wt (g)	TSS (°Brix)	pH	Titratable Acidity (g/L)	Potassium (ppm)
24, 1 bud spurs	1.33	22.0	3.25	8.6	1519
24, 2 bud spurs	1.46	22.2	3.23	8.8	1371
24, 3 bud spurs	1.41	21.8	3.22	8.3	1355
24, 4 bud spurs	1.27	20.3	3.17	9.1	1257
16, 3 bud spurs	1.44	22.4	3.24	9.0	1399
16, 4 bud spurs	1.39	21.3	3.22	9.0	1331
Hedge, short	1.24	19.7	3.14	8.7	1158
Hedge, long	1.21	20.1	3.14	8.8	1201
Minimal	0.85	17.8	3.11	9.2	1261
Signif. Level	0.0001	0.0001	0.0001	NS	0.0001

TABLE 2: Influence of pruning level on fruit composition of Chardonnay sampled on September 12, 1994, grown at Sheldon, CA.

Pruning Level	Berry Wt (g)	TSS (°Brix)	pH	Titratable Acidity (g/L)	Potassium (ppm)
24, 1 bud spurs	1.46	23.6	3.33	8.6	1543
24, 2 bud spurs	1.44	22.9	3.29	8.4	1429
24, 3 bud spurs	1.43	22.6	3.30	8.4	1410
24, 4 bud spurs	1.34	21.1	3.22	8.4	1228
16, 3 bud spurs	1.48	22.9	3.31	8.5	1447
16, 4 bud spurs	1.33	21.7	3.26	8.3	1320
Hedge, short	1.29	21.0	3.23	8.5	1262
Hedge, long	1.18	20.6	3.18	8.2	1173
Minimal	0.91	18.6	3.15	8.4	1175
Signif. Level	0.0001	0.0001	0.0001	NS	0.0001

TABLE 3: Influence of pruning level on fruit composition of Chardonnay at harvest, 1994 season, grown at Sheldon, CA.

Pruning Level	Harvest Date	Berry Wt (g)	TSS (°Brix)	pH	Titratable Acidity (g/L)	Potassium (ppm)
24, 1 bud spurs	9/12	1.46	23.6	3.33	8.6	1543
24, 2 bud spurs	9/12	1.44	22.9	3.29	8.4	1429
24, 3 bud spurs	9/12	1.43	22.6	3.30	8.4	1410
24, 4 bud spurs	9/26	1.26	22.8	3.36	6.5	1353
16, 3 bud spurs	9/12	1.48	22.9	3.31	8.5	1447
16, 4 bud spurs	9/12	1.23	22.5	3.38	6.3	1367
Hedge, short	9/26	1.22	22.3	3.32	6.5	1282
Hedge, long	9/29	1.14	22.4	3.28	7.1	1392
Minimal	9/29	0.87	20.0	3.24	7.0	1389
Signif. Level		0.0001	0.0001	0.0001	0.0001	0.0006

TABLE 4: Influence of pruning level on crop yield and yield components of Chardonnay grapevines, 1994 season, grown at Sheldon, CA.

Pruning Level	Crop Yield		Clusters per Vine	Berry Weight (g)	Cluster Weight (g)	Berries per Cluster	Clusters per Shoot	Rot (%)
	kg/vine	Tons/ac						
24, 1 bud spurs	13.3	10.6	42	1.46	322	220	1.90	5.9
24, 2 bud spurs	19.3	15.4	73	1.44	268	187	1.50	9.1
24, 3 bud spurs	22.9	18.3	91	1.43	259	181	1.72	8.7
24, 4 bud spurs	25.4	20.3	129	1.26	203	162	1.65	3.4
16, 3 bud spurs	20.0	16.0	73	1.48	276	187	1.65	6.8
16, 4 bud spurs	22.3	17.8	111	1.23	202	165	1.90	3.5
Hedge, short	25.4	20.3	163	1.22	160	131	1.12	2.1
Hedge, long	28.5	22.7	234	1.14	128	112	1.44	2.2
Minimal	25.9	20.7	318	0.87	83	97	0.83	2.0
Signif. Level	0.007	0.007	0.0001	0.0001	0.0001	0.0001	0.0001	0.006

TABLE 5: Influence of pruning level on fruit composition of Cabernet Sauvignon sampled on September 29, 1994, grown at Sheldon, CA.

Pruning Level	Berry Wt (g)	TSS (°Brix)	pH	TA (g/L)	K (ppm)	Malic Acid (g/L)
24, 1 bud spur	1.11	22.2	3.41	6.0	1371	0.82
24, 2 bud spurs	1.17	21.3	3.36	6.4	1499	0.69
24, 3 bud spurs	1.08	20.9	3.31	6.4	1413	0.61
24, 4 bud spurs	1.06	19.9	3.28	7.0	1362	0.30
16, 3 bud spurs	1.08	21.3	3.31	6.6	1456	0.54
16, 4 bud spurs	1.13	20.8	3.31	6.5	1481	0.81
Hedge Short	0.94	19.3	3.23	7.2	1453	0.78
Hedge Long	0.78	18.9	3.22	7.4	1429	0.53
Minimal	0.64	18.2	3.17	7.8	1365	0.53
Signif. Level	0.0001	0.0001	0.0001	0.0001	NS	NS (8%)

TABLE 6: Influence of pruning level on fruit composition of Cabernet Sauvignon sampled on October 12, 1994, grown at Sheldon, CA.

Pruning Level	Berry Wt (g)	TSS (°Brix)	pH	TA (g/L)	Malic Acid (g/L)	K (ppm)	Anthocyanin	
							mg/berry	mg/g
24, 1 bud spur	1.19	22.8	3.46	6.0	0.57	1643	0.91	0.77
24, 2 bud spurs	1.26	21.9	3.37	6.4	0.63	1656	0.91	0.74
24, 3 bud spurs	1.14	21.5	3.37	6.4	0.64	1605	0.83	0.72
24, 4 bud spurs	1.09	20.8	3.32	6.9	0.69	1628	0.78	0.72
16, 3 bud spurs	1.18	22.2	3.40	6.3	0.63	1679	0.86	0.73
16, 4 bud spurs	1.26	21.5	3.39	6.3	0.67	1683	0.83	0.68
Hedge Short	1.02	20.1	3.30	7.3	0.70	1609	0.69	0.70
Hedge Long	0.82	19.4	3.21	7.7	0.64	1554	0.66	0.83
Minimal	0.65	18.9	3.18	8.1	0.66	1510	0.53	0.82
Signif. Level	0.0001	0.0001	0.0001	0.0001	NS	0.05	0.0001	0.05

TABLE 7: Influence of pruning level on fruit composition of Cabernet Sauvignon at harvest, 1994 season, Sheldon, CA.

Pruning Level	Harvest Date	TSS (°Brix)	pH	TA (g/L)	Malic Acid (g/L)	K (ppm)	Anthocyanin	
							mg/berry	mg/g
24, 1 bud spur	10/20	23.7	3.45	6.2	0.62	1948	0.79	0.72
24, 2 bud spurs	10/20	22.9	3.40	6.4	0.64	1976	0.78	0.67
24, 3 bud spurs	10/12	21.5	3.37	6.4	0.64	1605	0.83	0.73
24, 4 bud spurs	10/19	21.5	3.27	7.3	0.57	1585	0.66	0.68
16, 3 bud spurs	10/20	22.9	3.37	6.4	0.59	1928	0.75	0.68
16, 4 bud spurs	10/12	21.5	3.39	6.3	0.67	1683	0.83	0.67
Hedge Short	10/19	21.2	3.25	7.6	0.62	1591	0.66	0.71
Hedge Long	10/19	20.3	3.18	7.9	0.44	1483	0.64	0.88
Minimal	10/19	20.1	3.17	8.3	0.43	1412	0.48	0.84
Signif. Level		0.0001	0.0001	0.0001	0.007	0.0001	0.0001	0.0001

TABLE 8: Influence of pruning level on crop yield and yield components of Cabernet Sauvignon grapevines, 1994 season, Sheldon, CA.

Pruning Level	Crop Yield		# Clusters/ vine	Berry Wt (g)	Cluster Wt (g)	# Berries/ cluster	# Clusters/ shoot	Amount of shriveled clusters (%)
	kg/vine	tons/ac						
24, 1 bud spur	10.2	8.1	59	1.10	184	167	1.96	3.7
24, 2 bud spurs	18.8	15.0	91	1.18	208	177	1.89	4.3
24, 3 bud spurs	27.3	21.8	151	1.14	184	162	1.87	4.5
24, 4 bud spurs	29.9	23.9	190	0.99	159	162	1.81	3.2
16, 3 bud spurs	17.6	14.2	92	1.11	192	174	1.94	6.2
16, 4 bud spurs	21.9	17.5	130	1.26	169	137	1.93	3.3
Hedge Short	29.8	23.8	259	0.95	116	124	1.86	7.2
Hedge Long	25.1	20.0	307	0.74	82	112	1.58	25.8
Minimal	21.5	17.2	551	0.58	40	69	1.21	45.8
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

TABLE 9: Influence of pruning level on composition of wine from Chardonnay vines grown at Sheldon, CA. 1994 season.

Pruning Level	Ethanol (%)	Phenolics (ppm)	pH	Titratable Acid (g/L)
24, 1 bud spurs	13.0	177	3.15	6.4
24, 2 bud spurs	12.3	201	3.11	6.9
24, 3 bud spurs	12.0	202	3.11	7.0
24, 4 bud spurs	12.2	204	3.12	7.0
16, 3 bud spurs	12.0	191	3.11	6.9
16, 4 bud spurs	12.3	203	3.15	7.2
Hedge, short	12.2	204	3.12	7.0
Hedge, long	12.4	200	3.12	6.6
Minimal	11.0	191	3.09	6.1
Signif. Level	0.002	NS	0.0001	NS

TABLE 10: Influence of pruning level on wine scores for Chardonnay grown at Sheldon, CA. 1994 season. Judging was done using the Davis 20 point system.

Pruning Level	Total Score	Aroma Score
24, 1 bud spurs	13.1	1.8 a
24, 2 bud spurs	13.4	1.5 abc
24, 3 bud spurs	13.4	1.8 a
24, 4 bud spurs	13.3	1.4 bc
16, 3 bud spurs	13.2	1.6 abc
16, 4 bud spurs	13.2	1.3 c
Hedge, short	13.0	1.4 bc
Hedge, long	13.6	1.7 ab
Minimal	13.1	1.7 abc
Signif. Level	NS	0.02

TABLE 11: Influence of pruning level on composition of wine from Cabernet Sauvignon vines grown at Sheldon, CA. 1994 season.

Pruning Level	Ethanol (%)	pH	Titratable Acidity (g/L)	Color Density (A520)	Hue (A520/A420)
24, 1 bud spurs	13.8	3.70	5.9	4.73	0.70
24, 2 bud spurs	13.5	3.56	6.3	3.96	0.68
24, 3 bud spurs	12.6	3.40	6.4	4.45	0.58
24, 4 bud spurs	12.6	3.40	6.6	5.44	0.56
16, 3 bud spurs	13.9	3.54	6.5	5.39	0.64
16, 4 bud spurs	12.6	3.50	5.9	3.81	0.64
Hedge, short	12.0	3.33	6.7	6.04	0.52
Hedge, long	12.0	3.20	8.1	9.45	0.48
Minimal	10.8	3.16	8.2	8.55	0.50
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.0001

TABLE 12: Influence of pruning level on wine scores for Cabernet Sauvignon grown at Sheldon, CA. 1994 season. Judging was done using the Davis 20 point system.

Pruning Level	Wine Score
24, 1 bud spurs	13.7 bc
24, 2 bud spurs	13.3 cd
24, 3 bud spurs	12.5 e
24, 4 bud spurs	13.6 bc
16, 3 bud spurs	14.0 ab
16, 4 bud spurs	13.0 de
Hedge, short	13.6 bc
Hedge, long	14.3 a
Minimal	13.6 bc
Signif. Level	0.004

TABLE 13: Influence of pruning level on petiole mineral composition at bloom of Chardonnay vines grown at Sheldon, CA. bloom (5/18/94).

Pruning Level	Potassium (%)	Calcium (%)	Magnesium (%)	Ca/Mg Ratio	Nitrate Nitrogen (ppm)
24, 1 bud spurs	1.89	2.27	0.73	3.11	2200
24, 2 bud spurs	1.78	1.80	0.63	2.90	2060
24, 3 bud spurs	2.16	1.70	0.67	2.53	2290
24, 4 bud spurs	2.08	1.60	0.63	2.60	2080
16, 3 bud spurs	2.09	2.00	0.69	2.90	1900
16, 4 bud spurs	2.00	1.79	0.70	2.55	1940
Hedge, short	2.51	1.40	0.49	2.83	1800
Hedge, long	2.32	1.39	0.59	2.34	1700
Minimal	2.48	1.30	0.57	2.31	1820
Signif. Level	0.002	0.0001	0.0003	0.0007	NS

TABLE 14: Influence of pruning level on petiole mineral composition at bloom for Cabernet Sauvignon vines grown at Sheldon, CA. (6/06/94).

Pruning Level	Potassium (%)	Calcium (%)	Magnesium (%)	Ca/Mg Ratio	Nitrate Nitrogen (ppm)
24, 1 bud spurs	1.52	1.81	0.55	3.35	2940
24, 2 bud spurs	1.43	1.87	0.57	3.29	2180
24, 3 bud spurs	1.62	1.80	0.54	3.30	2570
24, 4 bud spurs	1.82	1.86	0.52	3.58	2430
16, 3 bud spurs	1.45	1.97	0.60	3.31	2380
16, 4 bud spurs	1.55	1.84	0.54	3.42	2090
Hedge, short	1.70	1.67	0.51	3.32	2000
Hedge, long	2.15	1.95	0.58	3.46	2000
Minimal	1.88	1.56	0.52	3.02	1957
Signif. Level	0.008	NS	NS	NS	0.008

TABLE 15: Influence of pruning level on leaf areas of Chardonnay vines grown at Sheldon, CA, 1994 season.

Pruning Level	Main Leaf Area Per Shoot (cm^2)	Lateral Leaf Area Per Shoot (cm^2)	% Leaf Area From Laterals	Total Leaf Area Per Vine (m^2)	Leaf Area Per Gram of Crop (cm^2/g)
24, 1 bud spurs	2755	2413	46.7	11.6	8.7
24, 2 bud spurs	2469	1377	35.8	16.0	8.3
24, 3 bud spurs	2406	1169	32.7	19.8	8.7
24, 4 bud spurs	2188	1015	31.7	25.4	10.2
16, 3 bud spurs	2481	1399	36.1	16.0	8.0
16, 4 bud spurs	2263	946	29.5	20.5	9.4
Hedge, short	2087	872	29.5	34.6	13.3
Hedge, long	1965	801	28.9	49.0	16.7
Minimal	910	68	6.9	37.4	15.4
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.0001

TABLE 16: Influence of pruning level on shoot growth and pruning weight of Chardonnay vines grown at Sheldon, CA. 1994 season.

Pruning Level	# Shoots per Vine	Shoot Length (cm)	Nodes per Shoot	Shoot Weight (g)	Pruning Weight (kg/vine)	Yield/Pruning Wt Ratio
24, 1 bud spurs	23	146	30	66	1.47	9.2
24, 2 bud spurs	42	131	28	50	2.07	9.5
24, 3 bud spurs	56	127	27	25	1.60	15.6
24, 4 bud spurs	80	116	26	21	1.65	15.9
16, 3 bud spurs	41	131	28	42	1.72	11.8
16, 4 bud spurs	65	120	27	25	1.62	14.0
Hedge, short	113	111	25	15	1.54	16.9
Hedge, long	173	104	24	9	1.46	20.6
Minimal	367	49	16	8	---	---
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.02	0.02

TABLE 17: Influence of pruning level on leaf areas of Cabernet Sauvignon vines grown at Sheldon, CA, 1994 season.

Pruning Level	Main Leaf Area Per Shoot (cm^2)	Lateral Leaf Area Per Shoot (cm^2)	% Leaf Area From Laterals	Total Leaf Area Per Vine (m^2)	Leaf Area Per Gram of Crop (cm^2/g)
24, 1 bud spurs	2855	2422	46	15.8	17.1
24, 2 bud spurs	2292	942	29	15.7	8.3
24, 3 bud spurs	2128	587	22	22.5	8.0
24, 4 bud spurs	1895	396	17	23.9	8.0
16, 3 bud spurs	2272	956	30	15.2	8.7
16, 4 bud spurs	2307	922	29	22.5	10.0
Hedge, short	1741	259	13	28.2	9.4
Hedge, long	1669	268	14	37.6	15.3
Minimal	826	38	4	39.2	18.2
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.0001

TABLE 18: Influence of pruning level on shoot growth and pruning weight of Cabernet Sauvignon vines grown at Sheldon, CA. 1994 season.

Pruning Level	# Shoots per Vine	Shoot Length (cm)	Nodes per Shoot	Shoot Weight (g)	Pruning Weight (kg/vine)	Yield/Pruning Wt Ratio
24, 1 bud spurs	31	167	28	63	1.74	6.0
24, 2 bud spurs	49	134	24	55	2.56	7.5
24, 3 bud spurs	82	124	22	37	2.90	9.4
24, 4 bud spurs	105	111	21	27	2.81	10.8
16, 3 bud spurs	47	133	24	45	2.14	8.4
16, 4 bud spurs	68	135	24	43	2.89	7.6
Hedge, short	140	102	20	16	2.14	14.1
Hedge, long	195	98	19	8	1.62	16.0
Minimal	455	48	14	5	---	---
Signif. Level	0.0001	0.0001	0.0001	0.0001	0.02	0.02

TABLE 19: Influence of pruning level on number of 2 year old positions broken by mechanical harvesting and subsequent number of positions of proper length, including renewals, available at time of pruning for vines grown at Sheldon, CA. 1994 season.[a]

Pruning Level	Broken Positions (# per Vine)	Broken Positions (%)	# Positions Available at Pruning
24, 1 bud spurs	6.5	27	19.0
24, 2 bud spurs	2.4	10	22.0
24, 3 bud spurs	3.1	13	22.3
24, 4 bud spurs	1.9	8	21.4
16, 3 bud spurs	1.0	6	14.6
16, 4 bud spurs	1.4	9	15.0
Hedge, short	--(b)	--	--
Hedge, long	--	--	--
Minimal	--	--	--
Signif. Level	0.0001	0.0001	0.0001

(a) Data represents the average for Chardonnay and Cabernet Sauvignon.
(b) The effect of mechanical harvesting on hedge and minimal pruning treatments was not discernable due to the nature of the 2 year old wood. It is the authors perception that the effect was negligible on hedge and minimal pruned vines.