Unified Grant Management for Viticulture and Enology
FINAL REPORT

Project Title: Improving Yield and Quality of Sauvignon Blanc

Principal Investigator(s):

Glenn McGourty, Winegrowing and Plant Science Advisor
UCCE Mendocino and Lake Counties
890 North Bush Street
Ukiah, California 95482
(707) 463-4495
Email: gtmcgourty@ucdavis.edu

Cooperator:

David Koball, Vineyard Manager
Fetzer Vineyards
P.O. Box 611
Hopland, California 95449

Summary:

Clonal Trial:

A trial evaluating 12 clones of Sauvignon blanc was conducted from 2009-2012. Clones include: UC FPS# 1, 6, 7, 14, 18, 20, 22, 23, 25, 26, and 27. The experimental design was an ANOVA Randomized Complete Block with 8 replications of 5 vine vines for a total of 480 vines. The trial was planted in 2004 as potted green growing plants in 4 long east –west rows in a certified organic vineyard on Russian River loam in Hopland, Mendocino County, California. The vines were trained on a vertical shoot positioned trellis system(VSP) planted in rows spaced 8 feet apart, and 7 feet between vines in the rows (778 vines per acre). Vines were trained utilizing 4 canes containing an average of 12 buds per cane (48 buds total per vine) tied oppositionally on 2 vertically separated fruiting wires. The vineyard has overhead impact sprinklers for frost protection, and a drip system for irrigation.

Observations were made for phenology (bud break, bloom, veraison and harvest), yield (number of clusters per vine, total yield per vine, average cluster weight, average berry weight), berry weight and fruit chemistry (% brix sugar, titratable acidity), and pruning weights. Fruit/shoot ratios were also calculated for the individual clones.

In general, Sauvignon blanc is an early variety in our region, with bud break occurring between the last week of March and the first week of April most seasons. Target ripeness usually ranges between 21.5 to 22.5 % brix sugar for most wineries. Harvest usually occurs in the end of August to mid-September but may occur in early October with large crops and cool weather. We did not see significant differences in bud break, but clones with smaller clusters and lower yields did ripen sooner (achieving higher sugar levels) that those with large clusters and higher yields (significant differences between many of the clones.) Similarly, there were significant differences in fruit/shoot ratios with higher ratios for the smaller clustered clones compared to those with larger clusters.

In 2009, small batch experimental wine was made by a cooperating winery and evaluated by 30 wine professions. There were significant differences in preferences between the clones in regards to favorable tastes.

In most aspects, FPS 01 performed very well and is still a useful clone that is widely used in the industry. Some clones with smaller clusters and lower yields ripened sooner, and may be useful for shorter growing season areas.

Trellis Trial:

The trellis trial was planted in 2 adjacent rows near the variety trial with the same row spacing and plant density. In the spring of 2004, the vines were planted as dormant bench grafts of Sauvignon blanc FPS 01 on 101-14 rootstock. The experimental design is a randomized complete block, with 4 reps of 10 vines for each treatment. The trellis types were selected with the ability to be mechanically harvested. The following trellis types are being used:

1. Vertical Shoot Positioned Trellis (VSP), bilateral cordon, highway post, fruiting wire at 36 inches, average of 36 buds per vine (common system in the North Coast).
2. VSP, bilateral cordon, fruiting wire at 36 inches, 12 inch cross arm at 48 inches, and 16 inch cross arm at 60 inches to create more pendant growth to help divigorate the vines (a modified California sprawl system), average of 36 buds per vine.
3. VSP, modified cane pruning (continuous fruit curtain), cordon wire at 36 inches, 4 short canes are tied to fruit wire at 44 inches, 4 2 bud renewal spurs paired with each short cane, average of 32 buds.
4. VSP, 4 canes, with 2 pairs stacked on fruiting wires at 36 inches and 44 inches, plus 4 2 bud renewal spurs, average of 48 buds (common system in Lake County).
5. VSP, 4 canes tied to two parallel fruiting wires at 36 inches, two cross arms, one at 48 inches, and one at 66 inches, plus 4 2 bud renewal spurs, average of 48 buds

In most seasons, vines were able to ripen fruit satisfactorily, achieving 21% to 22.5% brix sugar (the goal for many Sauvignon blanc wine making programs). Spur pruned bilateral cordon trained vines had the lowest yields and ripest fruit. Stacked cane pruned vines yielded more fruit, but parallel positioned cane pruned vines most seasons yielded the highest amount (except for 2012) of fruit. Modified cane pruned vines (continuous fruit curtain) were intermediate in yield and ripeness. In the one year that we harvested fruit separately (2010), there were significant differences in ripeness between the upper and lower canes in the stacked cane VSP system, as well as in the north and south sides of the parallel cane system. The extra bud number in the different caned pruned systems compared to a standard VSP system most likely accounts for the increase in yields, but larger crops significantly delayed ripening. Variability in fruit ripeness on the same vine could be a benefit or a problem for winemakers depending on the wine style that is desired.

Introduction

Sauvignon blanc is an important white wine grape variety in California with over 15,600 acres planted in 2013 (California Grape Acreage Report). The majority of the plantings are in the coastal districts of California where it is used to make dry aromatic table wines. Sauvignon blanc is adapted to a range of climates, ranging from Winkler Region II, III and even IV. Wine styles range from tart, herbaceous and lower alcohol when grown in cooler regions to a more ripe, less acidic and rounded white wine when grown in warmer areas.

Growers usually report Sauvingon blanc to be a productive variety. However, in some areas, low production is a problem, particularly cooler coastal areas where vines are not as vigorous as in warmer interior vineyards. Disease and fruit quality are also an issue; as in some years, ripening the crop is slow and rot damage becomes a problem (Sauvignon blanc is very susceptible to botrytis bunch rot.)

Surprisingly, nearly 99% of the plantings are propagated with one clone, UC Foundation Plant Services (UC FPS) 01. Dr. Harold Olmo collected this clone in 1958 from Wente Vineyards in Livermore, and it is believed to have originally been imported from Chateau Yquem in France in the 1880's (Sweet, 2010). Since that time, UC FPS has made many accessions from France and Italy, as well as from older vineyards around the North Coast (Heritage selections). There has been no systematic evaluation of these accessions, and this trial was initiated as a way of comparing selected newer FPS clones to FPS Clone 1, which is the industry standard. Clonal descriptions of the new accessions indicated that some clones had smaller, looser clusters that could perhaps ripen earlier in cooler regions (with less rot) and others had the potential for more production than UC FPS 01.

Sauvignon blanc is considered to be vigorous and capable of producing large crops in warmer regions with fertile soils and adequate soil moisture. In upland sites, the variety yields less fruit and may produce grapes with higher sugar content and less acidity. For many years, the variety was grown on a 3 wire trellis system (California sprawl) consisting of a fruit wire that cordon or canes were trained to, and two parallel foliage catch wires separated laterally by 2- 3 feet, and vertically 1-2 feet above the fruit (cordon) wire. This system proved difficult to manage since the variety grows many sterile shoots from latent buds on the cordon, and if not managed, forms a dense canopy creating an environment that allows infections of powdery mildew and bunch rot. In fact, the earliest research on the practice of leaf pulling was done on vigorous Sauvignon blanc vines as a way to help create an environment in the fruiting zone that would be less favorable to disease development (Gubler and Bledsoe, personal communications).

Some growers have understood the importance of increasing bud number during pruning to increase yields, and often on cordon spur pruned vines they would leave additional short canes ("kicker canes" or "boot jacks") of 6 to 8 buds to increase yields and balance prune the vines.

Uneven ripeness and bunch rot problems are common with this approach, since Sauvignon blanc clusters tend to be large and have a short peduncle. Fruit touching fruit often creates a spot that retains free moisture if rain occurs near harvest. This creates an ideal environment for botrytis bunch rot to start. Cane pruning and divided canopy systems help alleviate some of this problem, since fruit is more spaced apart, and these systems been used by growers during the last 20 years as a way of improving yield and quality. True divided canopy systems (lyre, Geneva double curtain) are expensive to install, train and maintain, and until recently, it was not possible to mechanically harvest these vineyards. There are now machines with large enough heads that can accommodate some divided canopy systems, but they are not the most common mechanical harvesters in use. When this trial was initiated, growers were interested in training systems based on a Vertical Shoot Positioned (VSP) trellis, as material costs and installation of these systems are not as expensive as divided canopy systems. Additionally, the vines can be mechanically harvested with equipment that is more commonly available.

This project was initiated to investigate whether alternative clonal selection and vine training systems could improve fruit quality (ripeness and sound fruit) and yield compared to most of the vineyards presently in production in California.

<u>Summary of Major Research Accomplishments and Results (by Objective):</u>

***Objective 1*. Compare growth, yield and fruit characteristics of 12 Sauvignon Blanc Clones:**

A trial containing 12 clones of Sauvignon blanc was planted in the summer of 2004 in a commercial 25 acre Sauvignon blanc vineyard. Clones include: UC FPS# 1, 6, 7, 14, 18, 20, 22, 23, 25, 26, and 27 (see Appendix 1 for clonal information). The experimental design is an ANOVA Randomized Complete Block with 8 replications of 5 vine vines for a total of 480 vines. The potted "green grower " vines were planted in 4 long east –west rows in a certified organic vineyard on Russian River loam in Hopland, Mendocino County, California. The vines were trained on a vertical shoot positioned trellis system (VSP) planted in rows spaced 8 feet apart, and 7 feet between vines in the rows (778 vines per acre). Vines were trained utilizing 4 canes with an average of 10 buds per cane plus 4 2 bud renewal spurs (48 buds total per vine) tied in opposite directions on 2 vertically separated fruiting wires ("stacked cane" system). This system is representative of local grower practices. The vineyard has overhead impact sprinklers for frost protection, and a drip system for irrigation with 2 emitters that deliver 1 gallon of water per hour. The vineyard is irrigated beginning when shoot tips slow in growth (tendrils fall) most years towards the end of June. Water is applied normally in 2 sets per week of 3-5 hours per set, for a total of about 60 to 100 gallons per vine per season depending on the year (approximately 0.15-0.25 acre feet per acre per year).

Data taken included vine yield and cluster counts for each vine, average cluster weight (calculated); fruit chemistry (pH, titratable acidity, and % brix) and average berry size (calculated) from 100 berry samples from each 5 vine replication. When the vines were pruned in February, pruning weights were taken for each vine, and fruit/pruning weight ratios calculated. Plot harvest was scheduled to coincide with commercial harvest of the surrounding vineyard. Observations were made for phenology (bud break, bloom, veraison and harvest).

The data were statistically analyzed and means comparisons were made using Duncan's Multiple range test. The following tables are summaries of all data gathered from 2009-2012:

Table 1: Average yield per vine in kilograms, 2009-2012

Clone	2009	2010	2011	2012	Average kg/ 4 years	Average Tons/ Acre 4 years
FPS 01	7.72	9.86	13.3	9.13	10.01	8.5
FPS 06	6.16	7.55	8.75	9.11	7.89	6.7
FPS 07	4.17	5.81	5.81	6.07	5.46	4.7
FPS 14	3.91	3.69	5.12	7.52	5.06	4.3
FPS 17	5.44	6.15	7.42	8.14	6.78	5.8
FPS 18	6.47	7.66	10.55	6.79	7.86	6.7
FPS 20	5.75	8.32	11.32	7.76	9.0	7.7
FPS 22	5.13	6.31	7.7	6.22	6.34	5.4
FPS 23	4.8	7.56	8.15	4.83	6.36	5.4
FPS 25	7.3	8.44	11.48	8.79	8.75	7.7
FPS 26	5.6	6.9	9.87	7.5	7.47	6.4
FPS 27	5.08	7.67	9.74	6.61	7.27	6.2
Total Experiment Average Tons/Acre	**4.8**	**6.13**	**7.8**	**6.3**	**7.36**	**6.3**

Table 2: Average cluster weight, grams, 2009-12

Clone	2009	2010	2011	2012	Average/ 4 years
1	133.2	151.1	166.0	91.6	**135.5**
6	122.8	132.6	157.7	92.7	**126.4**
7	88.7	100.2	106.3	94.5	**97.4**
14	81.2	103.7	148.5	96.0	**107.3**
17	92.0	99.6	110.4	100.8	**100.7**
18	117.2	131.5	152.8	100.8	**125.6**
20	113.3	146.1	158.3	108.0	**131.4**
22	91.1	103.3	114.0	112.0	**105.1**
23	126.1	144.7	134.7	112.2	**129.4**
25	123.2	141.3	147.2	112.9	**131.2**
26	101.23	118.6	141.4	114.7	**119.0**
27	100.4	132.0	148.8	117.4	**124.6**
Experiment Average/year	**107.5**	**125.4**	**140.5**	**104.5**	**127.8**

Table 3: Average number of clusters per vine, 2009-2012

Clone	2009	2010	2011	2012	Average/ 4 years
1	59	65	80	81	**71**
6	30	56	57	78	**55**
7	35	59	59	65	**54**
14	13	31	40	66	**37**
17	38	62	67	76	**61**
18	40	57	68	65	**57**
20	38	57	73	68	**59**
22	39	60	67	66	**58**
23	40	50	54	47	**48**
25	40	61	78	77	**64**
26	31	55	68	74	**57**
27	38	57	65	68	**57**
Experiment Average/year	**37**	**56**	**65**	**69**	57

Table 4: Averages of Fruit Characteristics, 2009-2012

FPS Clone	Berry weight grams	% Brix	pH	Titratable Acidity, g/l
1	1.40	21.4	3.42	6.1
6	1.39	21.5	3.51	5.4
7	1.35	22.4	3.51	5.8
14	1.32	21.6	3.53	4.0
17	1.33	22.0	3.55	5.4
18	1.37	21.4	3.56	5.3
20	1.48	21.8	3.58	5.2
22	1.34	22.5	3.54	5.8
23	1.33	20.4	3.58	5.0
25	1.46	21.5	3.54	5.2
26	1.39	22.3	3.5	5.1
27	1.36	21.8	3.6	5.2
Experiment Average	**1.37**	**21.7**	**3.53**	**5.3**

Table 5: Individual clone fruit characteristics

FPS 01

Year	Berry weight g	% Brix	pH	Titratable acidity, g/l
2009	1.53	22.6	3.59	6.7
2010	1.33	22.6	3.49	6.5
2011	1.52	20.0	3.16	5.5
2012	1.22	20.5	3.45	5.9
Average	**1.4**	**21.4**	**3.42**	**6.15**

FPS 06

Year	Berry weight g	% Brix	pH	Titratable acitiy, g/l
2009	1.52	22.0	3.72	4.6
2010	1.32	22.6	3.54	5.6
2111	1.5	21.7	3.28	5.1
2012	1.22	19.8	3.51	6.3
Average	**1.39**	**21.5**	**3.51**	**5.4**

FPS 07

Year	Berry weight g	% Brix	pH	Titratable acidty, g/l
2009	1.43	20.0	3.57	2.5
2010	1.17	24.5	3.67	5.5
2111	1.57	21.7	3.29	3.3
2012	1.13	20.4	3.59	5.0
Average	**1.32**	**21.6**	**3.53**	**4.0**

FPS 14

Year	Berry weight g	% Brix	pH	Titratable acidity, g/l
2009	1.38	22.5	3.69	6.2
2010	1.27	23.0	3.59	7.1
2011	1.53	21.8	3.24	4.1
2012	1.24	22.3	3.53	6.0
Average	**1.35**	**22.4**	**3.51**	**5.8**

FPS 17

Year	Berry weight g	% Brix	pH	Titratable acidity, g/l
2009	1.43	22.5	3.77	6.4
2010	1.31	22.8	3.55	5.1
2011	1.48	22.4	3.30	5.2
2012	1.13	20.4	3.59	5.0
Average	**1.33**	**22.0**	**3.55**	**5.4**

FPS 18

Year	Berry weight g	%Brix	pH	Titratable acidity, g/l
2009	1.49	22.0	3.73	6.1
2010	1.38	22.7	3.63	5.7
2011	1.50	19.5	3.31	4.6
2012	1.14	21.6	3.58	4.8
Average	**1.37**	**21.4**	**3.56**	**5.3**

FPS 20

Year	Berry weight g	%Brix	pH	Titratable acidity, g/l
2009	1.49	21.9	3.72	6.0
2010	1.46	22.9	3.73	5.5
2011	1.70	20.4	3.25	4.6
2012	1.29	21.9	3.63	4.6
Average	**1.48**	**21.8**	**3.58**	**5.2**

FPS 22

Year	Berry weight g	%Brix	pH	Titratable acidity, g/l
2009	1.43	22.67	3.67	6.7
2010	1.27	23.1	3.66	6.5
2011	1.51	21.6	3.26	4.7
2012	1.17	22.7	3.58	5.3
Average	**1.34**	**22.5**	**3.54**	**5.8**

FPS 23

Year	Berry weight g	%Brix	pH	Titratable acidity, g/l
2009	1.55	20.0	3.7	5.8
2010	1.27	20.8	3.53	5.0
2011	1.36	18.1	3.15	4.6
2012	1.14	22.6	3.57	4.6
Average	**1.33**	**20.4**	**3.58**	**5.0**

FPS 25

Year	Berry weight g	%Brix	pH	Titratable acidity, g/l
2009	1.47	22.0	3.74	6.0
2010	1.46	22.8	3.65	5.0
2011	1.67	20.3	3.22	5.0
2012	1.27	21.0	3.56	4.8
Average	**1.46**	**21.5**	**3.54**	**5.2**

FPS 26

Year	Berry weight g	Brix	pH	Titratable acidity, g/l
2009	1.40	22.4	3.7	5.3
2010	1.36	23.6	3.7	5.1
2011	1.61	21.5	3.3	4.9
2012	1.20	21.9	3.5	5.0
Average	**1.39**	**22.3**	**3.5**	**5.1**

FPS 27

Year	Berry weight g	Brix	pH	Titratable acidity, g/l
2009	1.46	21.9	3.7	6.5
2010	1.34	22.9	3.7	5.2
2011	1.49	20.5	3.3	4.8
2012	1.15	21.8	3.7	4.5
Average	**1.36**	**21.8**	**3.6**	**5.2**

Table 6: Fruit/Shoot pruning ratios, Sauvignon blanc clonal trial:

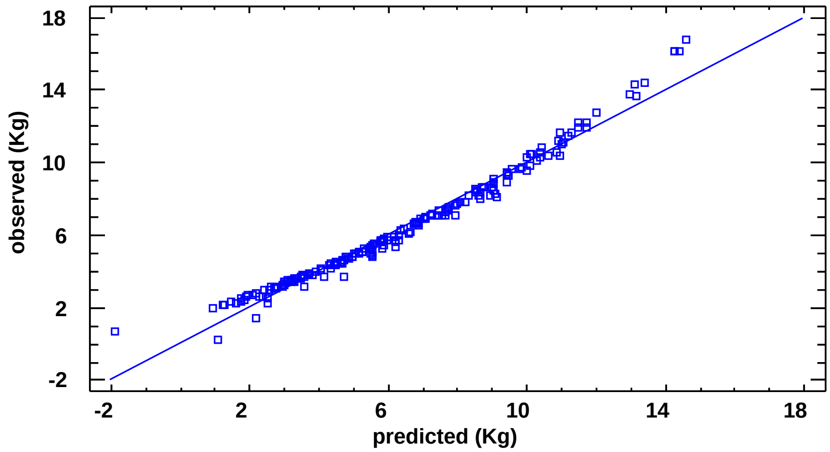
Clone	2009	2010	2011	2012	Experiment Average
FPS 01	5.48	7.09	9.76	10.52	8.21
FPS 06	4.99	7.83	8.19	16.12	9.28
FPS 07	2.57	3.21	3.15	5.95	3.72
FPS 14	2.81	4.54	5.65	10.06	4.63
FPS 17	3.42	3.95	4.24	9.25	5.21
FPS 18	5.17	7.79	9.56	10.02	8.13
FPS 20	4.01	6.0	7.81	8.29	6.52
FPS 22	3.05	4.17	4.64	6.75	4.65
FPS 23	6.46	10.19	12.15	9.12	9.48
FPS 25	4.90	5.81	8.24	10.52	7.37
FPS 26	4.99	4.54	6.06	7.86	5.86
FPS 27	3.83	5.24	7.61	7.36	6.0

Results and Discussion:

Statistical analysis showed that there are significant differences in virtually all aspects of the clones that we tested, demonstrating that Sauvignon blanc has a wide genetic base with considerable variability in its phenotypic expression (appendix 2). This is not completely surprising, as clonal selection has gone on in many different environments with many different objectives. Older heritage selections (FPS #22, 23) were not necessarily selected for productivity. Consider that UC FPS Clone #1 was the highest yielding clone in the trial, averaging 8.5 tons per acre, and is very productive with a large number of clusters with the greatest mass. It was selected for yield and vine health. UC FPS #20 and #25 were similar, and are also productive clones. By contrast, UC FPS #14 yielded the least amount of fruit (average of 4.3 tons per acre) but on average had the second greatest amount of sugar (22.4% brix). This clone would be useful in cooler regions where larger clustered clones might be more difficult to ripen and more prone to rot. UC FPS #14 had an average shoot/fruit ratio of 4.63 compared to UC FPS#1, which had an average fruit/shoot ratio of 8.2. This indicates that UC FPS#14 had more leaf surface area relative to fruit load than UC FPS# 1 in our trial, and most likely could ripen fruit more efficiently because of this. Again, this quality would be useful in cooler regions with shorter growing seasons where it might be more challenging to ripen larger clustered clones with higher shoot/fruit ratios.

Not surprisingly, there is a strong correlation between yield, cluster number, and cluster weight (R^2 = .95.5). If high yields are desired, choosing clones with large clusters and large cluster number is a strategy to engage for that purpose.

Figure 1: Relationship between yield, cluster count and cluster weight:



Yield (Kg) = -6.32094 + 0.11596*Cluster Count + 0.0556087*Avg Cluster Wt

$\mathbf{R^2}$ =.95

It is clear that there is a wide range of performance by these clones in terms of ripening, yield, cluster size and fruit chemistry. Winegrowers interested in having multiple clones for complexity and increasing or decreasing their harvest periods have many choices.

Phenological events are summarized in Appendix 4 Table H. There were no obviously perceptible differences between the clones regarding bud break, bloom, or veraison. Harvests occurred at the same time to coincide with commercial harvest of the vineyard, and there were differences in levels of ripeness of the clones.

Fruit Tasting Evaluation:

Tasting fruit before harvest allows winemakers to conduct a sensory analysis on factors such as acidity, sweetness, vegetative tastes, fruit and aromas as a way of determining when to schedule harvest depending on the outcome of what flavors are desired in the wine. In 2008, 4 wine makers and 3 growers plus the author evaluated fruit from 10 randomly selected clusters sampled at harvest time (August 28th) from vines and made these observations:

Table 7: Observations and tasting of ripe clusters, 2008

Clone	Skin Color	Cluster Characteristics	Fruit taste and aromas
SB FPS 01	Very green	Very tight, large	Average
SB FPS 06	Green	Tight, large	Mature, melon
SB FPS 07	Green to yellow green	Loose, small	Less acid, more mature seeds
SB FPS 14	Green	Medium loose cluster	Ripe flavors, peach and melon. Ripe seeds.
SB FPS 17	Green to yellow green	Medium to small clusters, compact	Very ripe seeds
SB FPS 18	Green	Small loose clusters	Astringent, ripe seeds and skin
SB FPS 20	Yellow green	Medium tight, large cluster	Ripe skins, less ripe seeds
SB FPS 22	Green	Loose, medium size cluster	Ripe skins
SB FPS 23	Green	Large cluster, tight	Less sweet, ripe skins and seeds
SB FPS 25	Green	Small cluster, less sweet	Ripe skins and seeds
SB FPS 26	Yellow green	Medium sized, loose cluster	Nice flavor, lower acid, ripe skins and seeds
SB FPS 27	Yellow green	Medium sized loose cluster	Pleasant flavors, medium ripe skins and ripe seeds

Experimental wines:

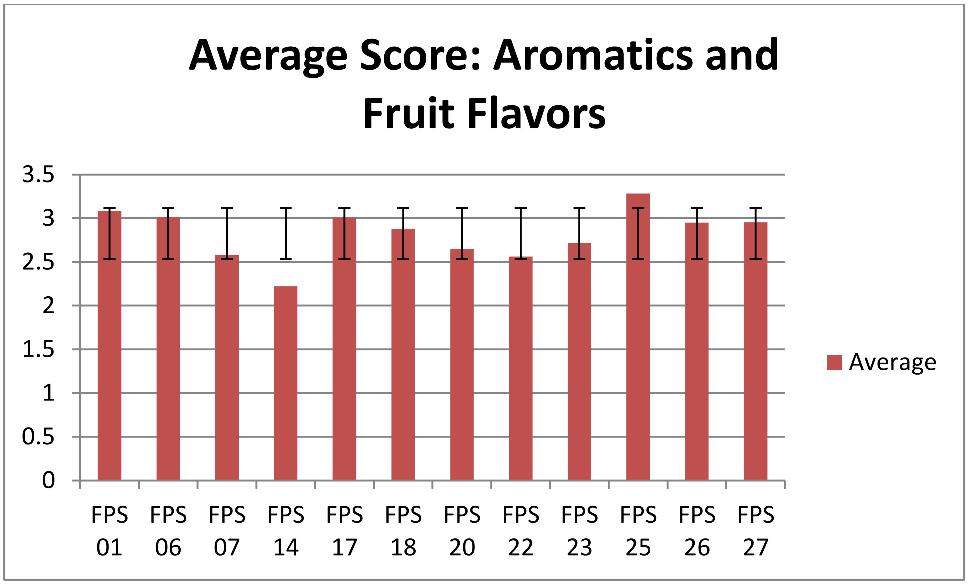
Although not funded as part of this trial, experimental wines were made in 2009 in small batches with a cooperating winery. The clones were picked for a target of 22.5 brix, although it was difficult to achieve this level of ripeness, and subsequently, some wines were more alcoholic than was desirable. Musts were adjusted with sugar and acid to result in wines with similar characteristics to minimize those factors as affecting flavor. Following is the chemistry of the experimental wines:

Table 8: Chemistry of experimental wines, 2009

Clone	Alcohol %	Reducing Sugar g/100ml	Malic Acid mg/l	pH	Titratable Acidity g/100ml	Volatile Acidity g/100ml
FPS 01	13.96	0.09	1251	3.3	0.59	0.004
FPS 06	13.92	0.12	1470	3.4	0.59	0.005
FPS 07	13.86	0.07	1172	3.3	0.6	0.004
FPS 14	13.81	None detected	1342	3.2	0.65	0.003
FPS 17	13.88	0.12	1201	3.3	0.59	0.004
FPS 18	13.95	0.13	1229	3.3	0.59	0.005
FPS 20	13.88	0.09	1181	3.3	0.59	0.006
FPS 22	13.87	0.06	1154	3.2	0.59	0.008
FPS 23	13.37	0.8	1021	3.2	0.58	0.004
FPS 25	13.88	None detected	1273	3.2	0.59	0.005
FPS 26	13.78	0.06	1206	3.3	0.6	0.004
FPS 27	13.83	0.09	1231	3.2	0.59	0.005

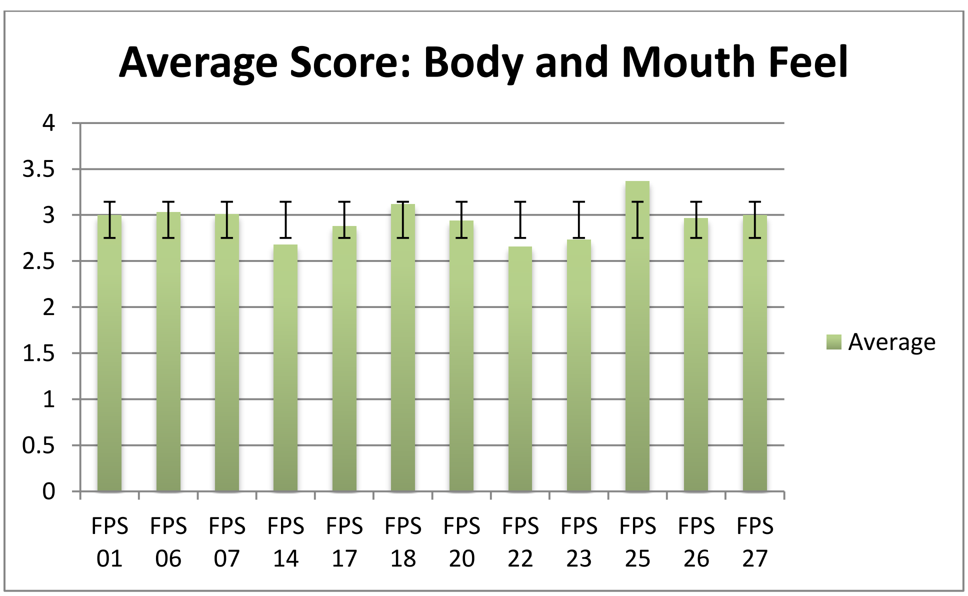
Wines were poured together and evaluated by 30 selected industry professionals on two occasions in May, 2010. Following are summaries of their impressions:

Figure 2: Sensory analysis, impression of aromatics and fruit flavors, 2010*



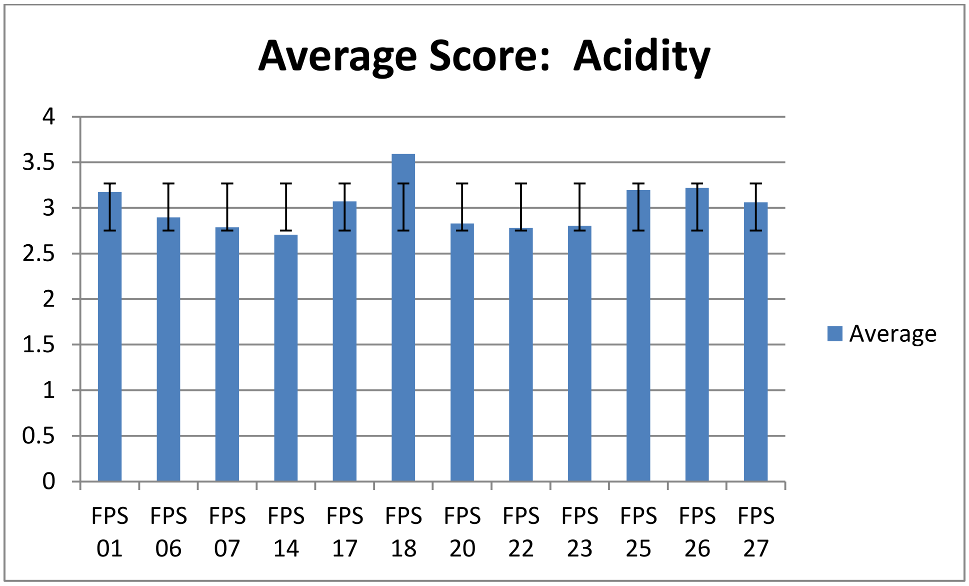
*N= 30, Score of 0 = poor, score of 5= exceptional

Figure 3: Sensory analysis, impressions of body and mouth feel



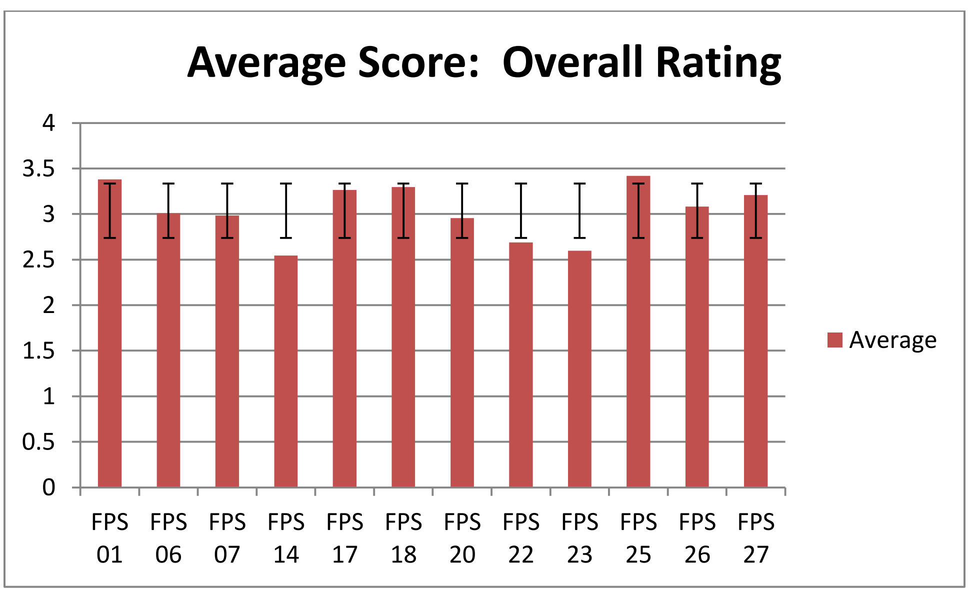
*N= 30, Score of 0 = poor, score of 5= exceptional

Figure 4: Sensory analysis, impression of acidity



*N= 30, Score of 0 = poor, score of 5= exceptional

Figure 5: Sensory analysis, overall rating of wine



*N= 30, Score of 0 = poor, score of 5= exceptional

It is interesting to note that there were significant differences in perceived flavors. UC FPS Clones 1, 17, 18, 25 and 27 were much appreciated by the tasters. Small lot wines are difficult to make uniformly, but these results are still helpful to anyone interested in selecting clones for wine complexity or flavors. Interestingly, no one detected a "muscat" flavor in wine made from FPS# 27, which is named the Sauvignon musqué clone. Most likely the clone was originally misidentified as "Savignin musqué" (Sweet, 2010) and subsequently has mistakenly been assumed to have a muscat scent and flavor.

Objective 2: Evaluating different trellis and training systems

Five training systems for Sauvignon blanc were compared in this study:

1. Vertical Shoot Positioned Trellis (VSP), bilateral cordon, highway post, fruiting wire at 36 inches (this is a common system in the region), 14 spurs with 3 buds.
2. VSP, bilateral cordon, spur pruned, 3 buds per spur,14 spurs with 3 buds, fruiting wire at 36 inches, 12 inch cross arm at 48 inches, and 16 inch cross arm at 60 inches to create more pendant growth to help devigorate the vines (a modified California sprawl system).
3. VSP, modified cane pruning (continuous fruit curtain), cordon wire at 36 inches, 4 short canes are tied to fruit wire at 44 inches all bent the same direction (to the west) and 4 renewal spurs.
4. VSP, 4 canes, with 2 pairs stacked on fruiting wires at 36 inches and 44 inches (this system is widely used in Lake County) and 4 renewal spurs.
5. VSP, 4 canes tied to two parallel fruiting wires at 36 inches, two cross arms, one at 48 inches, and one at 66 inches, and 4 renewal spurs.

A randomized complete block ANOVA was used. Each training system utilizes 10 vines replicated 4 times (200 vines total). Training began in 2007, and harvest data were taken beginning 2010. Data collected include vine yield, cluster count, berry weight, fruit chemistry, and pruning weights. Harvests occurred at the same time as the clonal trial, to schedule with the commercial harvest of the vineyard in which they were planted. Vines were irrigated similar to the adjacent clonal trial. Vines were harvested on Oct. 11, 2010; Oct. 11, 2011; and Sept. 20, 2012. Following dormancy, vines were pruned and cut canes were weighed immediately. Following is a summary of bud numbers that the trial was pruned to:

Figure 6: Average bud counts, 2010-2012, Sauvignon blanc trellis trial

Treatment	Avg. Bud Count (Total)	Avg. # of Spurs
Treatment 1: Bilateral cordon	42	14
Treatment 2: Bilateral cordon with cross arm: "flop"	42	14
Treatment 3: Short cane/ continuous fruit curtain	42	4.5
Treatment 4: 4 Canes, stacked	52	4.5
Treatment 5: : Four parallel canes	48	4.5

Results and Discussion:

During the course of the experiment, there were significant differences in yield, fruit/pruning ratios, and all aspects of fruit chemistry between treatments. Spur pruning on cordon trellis systems did not produce as much fruit as the other systems, although they tended to produce riper fruit due to a smaller crop load. The hybrid cane system produced higher yields than either of the spur cordon treatments, was able to adequately ripen fruit, but had a higher fruit / pruning ratio. The cane systems were the highest yielding of the trellis designs, but sugar ripeness was lower on average than the other systems. (Performance for individual years are presented in in Appendix 4). Regardless, the 4 cane stacked system was the trellis system used by Fetzer Vineyards in the surrounding field and this system was able to meet target ripeness goal of 21.5 in all years of the trial (see Table 9; Appendix 4: d, e,f). Picking was scheduled based on reaching those target % brix sugar goals for ripeness.

Table 8: Average of Vine Performance in Trellis Trial: 2010--2012

Trellis	Cluster Count	Yield (Kg) per vine	Av Cl Wt (g)	Yield per meter of cordon (kg)	kg Fruit/ Pruning Ratio	Tons per Acre
Bilateral cordon	54	6.8	132	3.2	5.8	5.8
Bilateral cordon, flop	51	6.4	129	3.0	6.8	5.5
Hybrid cane system, continuous fruit curtain	74	8.9	127	4.1	9.4	7.6
4 canes, stacked	77	11.1	127	5.2	10.8	9.5
4 parallel canes	84	10.5	133	4.9	13.3	9.1

Table 9: Comparison of fruit chemistry in Trellis Trial: 2010--2012

Trellis System	Berry Weight	Sugar % Brix	pH	Titratable acidity, g/100 ml
Bilateral cordon	1.47	23.2	3.50	0.51
Bilateral cordon, flop	1.46	22.6	3.50	0.53
Hybrid cane system continuous fruit curtain	1.45	23.2	3.46	0.44
Four canes stacked	1.42	21.9	3.50	0.47
Four parallel canes	1.25	20.7	3.48	0.48

In 2010, we harvested the different zones of the 4 cane systems. Data is presented in Appendix 4 table c. There were significant differences in fruit grown in the different zones of the multi-cane systems. In the 4 cane stacked system, the average sugar level in the upper pair of canes was 20.3% brix, and the lower pair of canes' average sugar level was 22.7% brix. The 4 parallel cane system had an average sugar level of 21% brix on the south side of the canopy, and an average sugar level of 18.8% brix on the north side. This means that to achieve target sugar levels for harvest, some fruit will be over ripe and some will be under ripe. Some wine makers actually like those qualities for Sauvignon blanc, as they feel that a more complex wine can be made where the combination of "grassiness" (high pyrazine content fruit with good acidity) and ripeness (more peach/melon aromas) make an interesting wine.

All systems can be machine harvested. If the place where the vineyard is planted has a long enough growing season, and high yields are desired, cane pruning offers the opportunity to significantly increase productivity compared to spur/ cordon systems.

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Acknowledgements:

This project would not have been possible without the generous cooperation of Fetzer Vineyards and their staff that allocated space, management and labor to allow these trials to occur. Dr. Deborah Golino of UC Davis Foundation Plant Services assisted in making selections for the clonal trial and donated all of the propagation material. Eckhard and Benjamin Kaesekamp of Lake County Grape Vine Nursery provided all of the plant material for the clonal trial. Funding for the trial was provided by the Viticulture Consortium West, California Competitive Grants Program for Viticulture and Enology (CCGPVE), and the American Vineyard Foundation. Finally, UCCE Mendocino County office Agriculture Technicians Jim Nosera and Ryan Keiffer were instrumental in collecting and analyzing data for these studies.

Appendix 1: Sauvignon Selections in Clonal Trial

Sauvignon blanc FPS 01	Originally from Chateau d'Yquem in Sauternes, Gironde region, France in 1884 via Wente Vineyards in Livermore, CA; to FPS in 1958
Sauvignon blanc FPS 06	Sauvignon FPS 03; originally ISV-CPF-5 from the Instituto Sperimentale per la Viticoltura, Conegliano, Italy, in 1988
Sauvignon blanc FPS 07	Sauvignon FPS 04; originally ISV-CPF-2 from the Istituto Sperimentale per la Viticoltura, Conegliano, Italy, in 1988
Sauvignon blanc FPS 14	Reported to be French clone 316, from the Chambre d'Agriculture de la Gironde, France, in 1989
Sauvignon blanc FPS 17	ISV Congeliano 1, from the Instituto Sperimentale per la Viticoltura, Conegliano, Italy, in 1988
Sauvignon blanc FPS 18	Reported to be French clone 317, from the Chambre d'Agriculture de la Gironde, France, in 1989
Sauvignon blanc FPS 20	Reported to be French clone 242, from the Chambre d'Agriculture de la Gironde, France, in 1989
Sauvignon blanc FPS 22	From very old head trained, gnarled and neglected vine in the SE corner of UC Davis Oakville field station in 1990; recommended by Phil Freese
Sauvignon blanc FPS 23	Kendall-Jackson's Howell Mountain vineyard, Napa, in 1999
Sauvignon blanc FPS 25	Sauvignon blanc FPS 04; reported to be French clone 378 from the Chambre d'Agriculture de la Gironde, France, in 1989
Sauvignon blanc FPS 26	Napa County heritage clone introduced to FPS in 1997
Sauvignon blanc FPS 27	'The musque clone'; from the viticulture station at Pont-de-Maye, Gironde region, France, in 1962; originally known at FPS at Savagnin musque; DNA identification as Sauvignon blanc 1999

Appendix 2: Images of Sauvignon blanc clones in this trial

*Photo by Tom Liden Photography, Ukiah , California

Appendix 3: Summary of clonal harvest data by year, 2009—2012
(note: Means followed by the same letter are not significantly different at the .05 level of significance)

a.2009 Harvest Date: September 10

Clone	Cluster Count	Groups*	Yield (Kg)	Groups*	Av. Cluster Weight (g)	Groups*	Tons Per Acre	Groups*	Kg per Meter of Cordon	Groups*
FPS 01	30	c	4.20	a	159.5	f	3.6	f	1.95	f
FPS 06	25	bc	4.06	def	138.1	def	3.5	cde	1.88	cde
FPS 07	28	b	2.52	ab	119.4	ab	2.2	a	1.12	a
FPS 14	28	b	2.74	ef	115.5	a	2.3	a	1.27	a
FPS 17	29	bc	3.59	abc	131.6	abc	3.1	bcd	1.66	bcd
FPS 18	22	bc	4.05	de	138.5	de	3.5	de	1.88	de
FPS 20	35	bc	4.09	d	149.0	d	3.5	bcd	1.90	bcd
FPS 22	25	bc	3.00	abc	122.9	abc	2.6	abc	1.40	abc
FPS 23	31	a	4.92	ef	180.2	ef	4.2	ab	2.28	ab
FPS 25	29	c	6.30	def	180.3	def	5.4	ef	2.92	ef
FPS 26	28	bc	3.00	c	125.9	c	2.6	bcd	1.40	bcd
FPS 27	26	bc	3.54	bc	128.0	bc	3.0	abc	1.64	ab

b. 2010 Harvest date: October 8

Clone	Cluster Count	Groups*	Yield (Kg)	Groups*	Av. Cluster Weight	Groups*	Tons Per Acre	Groups*	Kg per Meter of Cordon	Groups*
FPS 01	65	d	9.86	g	151.1	e	8.5	g	4.62	g
FPS 06	56	bcd	7.55	cdef	132.6	cd	6.5	cdef	3.54	cdef
FPS 07	59	bcd	5.81	b	100.2	a	4.8	b	2.64	b
FPS 14	31	a	3.69	a	103.7	a	3.2	a	1.73	a
FPS 17	62	cd	6.15	bc	99.6	a	5.3	bc	2.88	bc
FPS 18	57	bcd	7.66	def	131.5	c	6.6	def	3.59	def
FPS 20	57	bcd	8.32	ef	146.1	e	7.1	ef	3.89	ef
FPS 22	60	bcd	6.31	bcd	103.3	a	5.4	bcd	2.94	bcd
FPS 23	50	b	7.56	cdef	144.7	de	6.5	cdef	3.54	cdef
FPS 25	61	cd	8.44	fg	141.3	cde	7.2	fg	3.96	fg
FPS 26	55	bc	6.90	bcde	118.6	b	5.9	bcde	3.23	bcde
FPS 27	57	bcd	7.67	def	132.0	c	6.6	def	3.59	def

c. 2011 Harvest date: Sept. 28

Clone	Cluster Count	Groups*	Yield (Kg)	Groups*	Av. Cluster Weight (g)	Groups*	Tons Per Acre	Groups*	Kg per Meter of Cordon	Groups*
FPS 01	80	f	13.31	g	166.0	e	11.4	h	6.24	i
FPS 06	57	bc	8.75	cde	157.7	de	7.5	cdef	4.10	cdef
FPS 07	59	bc	5.81	ab	106.3	a	5.0	ab	2.72	ab
FPS 14	40	a	5.12	a	148.5	bcd	4.4	a	2.40	a
FPS 17	67	cd	7.42	bc	110.4	a	6.4	bc	3.48	bc
FPS 18	68	cde	10.55	ef	152.8	cde	9.0	fg	4.94	fgh
FPS 20	73	def	11.32	f	158.3	de	9.4	g	5.17	gh
FPS 22	67	cde	7.70	bc	114.0	a	6.6	bcd	3.61	bcd
FPS 23	54	b	8.15	cd	134.7	b	7.0	cde	3.82	cde
FPS 25	78	ef	11.48	fg	147.2	bcd	9.8	gh	5.52	hi
FPS 26	68	cde	9.87	def	141.5	bc	8.2	defg	4.51	defg
FPS 27	65	bcd	9.74	def	148.8	bcd	8.3	efg	4.57	efg

d. 2012 Harvest date: Sept. 19

Clone	Cluster Count	Groups*	Yield (Kg)	Groups*	Av. Cluster Weight (g)	Groups*	Tons Per Acre	Groups*	Kg per Meter of Cordon	Groups*
FPS 01	81	e	9.13	f	91.6	a	7.8	d	4.28	d
FPS 06	78	de	9.11	f	92.7	a	7.8	d	4.27	d
FPS 07	65	b	6.07	ab	94.5	a	5.2	b	2.85	b
FPS 14	66	bc	7.52	cde	96.0	a	6.1	bc	3.35	bc
FPS 17	76	cde	8.14	def	100.8	ab	7.0	cd	3.81	cd
FPS 18	65	b	6.79	bc	100.8	ab	5.8	b	3.18	b
FPS 20	68	bcd	7.76	cde	108.0	bc	6.3	bc	3.45	bc
FPS 22	66	b	6.22	b	112.0	c	5.3	b	2.91	b
FPS 23	46	a	4.83	a	112.2	c	4.0	a	2.21	a
FPS 25	77	de	8.79	ef	112.8	c	7.5	d	4.12	d
FPS 26	74	bcde	7.5	cd	114.7	c	6.3	bc	3.43	bc
FPS 27	68	bcd	6.61	bc	117.1	c	5.4	b	2.94	b

Illustration 1: Typical vine in the Sauvingnon Blanc Clonal trial

Appendix 4: Trellis system trial data presented by year: 2010, 2011, 2012

a. 2010

Treatment	Cluster Count	Groups*	Yield (Kg)	Groups*	Av Cl Wt (g)	Groups*	Tons per Acre	Groups*	Kg per meter of trellis	Groups*
1 - Bilateral cordon	57	a	8.51	a	147.9	bc	7.29	a	3.99	a
2 – 4 Canes stacked, total	89	b	12.9	a	144.5	b	7.93	a	4.33	a
3 - Bilateral flop system	56	a	9.25	a	151.6	c	7.34	a	4.01	a
4 - Continuous fruit curtain	102	c	14.28	b	139.4	bc	12.24	b	6.69	b
5 - Four parallel canes, total	116	d	15.66	b	135.9	ab	13.43	b	7.34	b

b. 2011

Treatment	Cluster Count	Groups	Yield (Kg)		Av Cl Wt (g)		Tons per Acre		Yield per Meter Cordon kg	
1: Bilateral cordon	70	bc	9.55	b	137.7	ab	8.2	bc	4.47	bc
2: 4 Canes, stacked	67	abc	10.76	c	161.3	c	9.2	c	5.04	c
3: Bilateral, flop system	73	c	11.08	bc	152.8	b	9.5	c	5.19	c
4: Continuous fruit curtain	60	a	7.92	a	131.0	a	6.8	a	3.71	a
5: Four ‖ canes	62	ab	8.82	ab	136.2	bc	7.6	ab	4.14	ab

c. 2012

Treatment	Cluster Count	Groups	Yield (Kg)	Groups	Av Cl Wt (g)	Groups	Tons per Acre	Groups	Yield per Meter Cordon	Groups
1: Bilateral cordon	34	a	3.66	a	106.69	a	3.05	a	1.67	a
2: 4 Canes, stacked	76		8.65		110.97	ab	3.65	ab	4.0	
3: Bilateral, flop system	40	b	4.45	b	110.60	a	3.81	b	2.09	b
4: Continuous fruit curtain	62	c	6.72	c	109.56	a	5.61	c	3.07	c
5: 4 canes, parallel	74		8.6		111.02		3.63		3.98	

d. Fruit Chemistry, Trellis Trial 2010

TRELLIS	Berry Weight (g)	Groups*	Brix	Groups*	pH	Groups*	Titratable Acidity (g/100ml)	Groups*
1 - Bilateral cordon	1.43	a	24.3	a	3.63	a	0.36	bcd
2 – Bilateral cordon flop system	1.36	a	24.7	a	3.54	a	0.35	abc
3- Stacked Cane System Upper Fruit Zone	1.29	a	20.3	cd	3.54	ab	0.36	abc
3-Stacked Cane System Lower Fruit Zone	1.44	a	22.7	bc	3.62	ab	0.36	de
4 – Hybrid Cane System--Continuous fruit curtain	1.31	a	23.0	b	3.50	bc	0.35	a
5 - Four Parallel Canes System—South Side	1.28	a	21.0	de	3.50	c	0.35	ab
5 - Four Parallel Canes System –North Side	1.28	a	18.8	e	3.67	c	0.37	e

e. Fruit Chemistry, Trellis Trial 2011

Treatment	Avg Berry Weight (g)	Groups	Percent Brix	Groups	pH	Groups	Titratable Acidity	Groups
1: Bilateral cordon	1.43	ab	20.8	ab	3.23	a	0.53	a
2: 4 canes, stacked	1.41	ab	21.7	bc	3.34	a	0.49	a
3: Bilateral, flop system	1.62	b	20.3	a	3.27	a	0.5	a
4. Continuous fruit curtain	1.46	ab	22.5	c	3.33	a	0.35	a
5: 4 parallel canes	1.27	a	21.4	abc	3.21	a	0.47	a

f. Fruit chemistry, trellis Trial 2012

Treatment	Avg Berry Weight (g)	gr	Percent Brix	Groups	pH	groups	Titratable Acidity	Groups
1: Bilateral cordon	1.54	a	24.5	b	3.65	a	0.57	a
2: 4 Canes, stacked	1.48	a	21.4	a	3.52	a	0.56	a
3: Bilateral, flop system	1.31	a	24.5	b	3.69	a	0.57	a
4: Continuous fruit curtain	1.93	b	22.4	a	4.18	a	0.57	a
5: Four parallel canes	1.21	a	21.5	a	3.52	a	0.60	a

g. **Yield to Pruning Weights, Trellis Trial**

2009

Treatment	Average Yield Kg	Yield to Pruning Weight
1: Bilateral cordon	9.5a	6.5a
2. Bilateral cordon flop	8.7a	6.2a
3: Modified cane pruning	9.0b	6.8a
4: 4 stacked canes	7.8a	6.6a
5: Four parallel canes	10.8b	9.0b

2010

Treatment	Average Yield kg	Yield to Pruning Weight
1: Bilateral cordon	8.5 a	6.8a
2: Bilateral, flop system	8.6a	6.2a
3: Modified cane pruning	14.3b	12.8b
4: 4 canes stacked	9.3a	8.1a
5: 4 parallel canes	15.7b	12.3b

2011

Treatment	Average Yield kg	Yield to Pruning Weight
1: Bilateral cordon	21.0a	10.1a
2: Bilateral, flop system	24.4a	11.1a
3: Modified cane pruning	17.4b	15.3b
4. 4 canes stacked	23.7a	18.6bc
5: Four parallel canes	19.5b	20.9c

2012

Treatment	Average Yield kg	Yield to Pruning Weight
1: Bilateral cordon	3.7a	2.7a
2: Bilateral, flop system	4.5a	3.8a
3: Modified cane pruning	6.8b	8.3b
4. 4 canes stacked	8.5c	10.9c
5: Four parallel canes	8.5c	10.8c

h. Phenological data for trial:

Year	Phenology	Date Range	Degree Hours Accumulated
2009	Bud Break	1/1/2009-4/13/2009	436
	Bud Break- Bloom	4/13/2009-5/6/2009	206
	Bloom- Bloom End	5/7/2009-5/20/2009	194
	Bloom End- Harvest	5/21/2009-9/10/2009	2097
	Total	**1/1/2009-9/10/2009**	**2933**
2010	Bud Break	1/1/2010-4/20/2010	395
	Bud Break- Bloom	4/20/2010-6/4/2010	353
	Bloom- Bloom End	6/5/2010-6/18/2010	207
	Bloom End- Harvest	6/19/2010-10/8/2010	1974
	Total	**1/1/2010-10/8/2010**	**2929**
2011	Bud Break	1/1/2011-4/14/2011	385
	Bud Break- Bloom	4/14/2011-5/28/2011	329
	Bloom- Bloom End	5/29/2011-6/10/2011	102
	Bloom End- Harvest	6/11/2011-9/28/2011	2094
	Total		**2910**
2012	Bud Break	1/1/2012-4/12/2012	316
	Bud Break- Bloom	4/12/2012-5/21/2012	459
	Bloom- Bloom End	5/22/2012-6/3/2012	172
	Bloom End- Harvest	6/4/2012-9/19/2012	1980
	Total		**2927**

Note: Summary of hours > 50° F and < 90° F from CIMIS Station at the UC Hopland Research and Extension Center

Illustration 2: Spur/ cordon pruning, Treatments 1 and 2

Illustration 3: 4 stacked canes, Treatment 4

Illustration 4: 4 parallel canes, Treatment 5

Illustration 5: Modified cane pruning (continuous fruit curtain)