American Vineyard Foundation
California Rootstock Commission
California Competitive Grant Program for Viticulture and Enology
Viticulture Consortium

Final Report
February 1, 2001

Project Title: **Field Evaluation of Winegrape Rootstocks**

Principal Investigators:

James Wolpert
Viticulture and Enology
University of California
One Shields Ave
Davis, CA 95616
530-752-0381
FAX: 752-0382
jawolpert@ucdavis.edu

M. Andrew Walker
Viticulture and Enology
University of California
One Shields Ave
Davis, CA 95616
530-752-0902
FAX: 752-0382
awalker@ucdavis.edu

LOCAL COORDINATORS:

Larry Bettiga, Farm Advisor, Monterey County
Mary Bianchi, Farm Advisor, San Luis Obispo County
Donna Hirschfelt, Farm Advisor, Amador County
Glenn McGourty, Farm Advisor, Mendocino, County
Rhonda Smith, Farm Advisor, Sonoma County
Ed Weber, Farm Advisor, Napa County

Objective of the Proposal:

1. To continue rootstock evaluation for winegrape performance in a wide range of coastal and foothill production areas, and in sites which are infested with phylloxera, nematodes or both, or which have important site/soil conditions or limitations.

Significant Results and Accomplishments to Date:

Trials that are presented here are Amador 1 and 2, Napa 3, 4 and 5, San Luis Obispo 1 and Sonoma 2. Data for Monterey 4-6 were not available at the time this report was prepared. **A revised Final Report will be submitted when the additional data is available.**

Table 1. Description of rootstock plots including PI, cooperator, scion variety, on-site pest problem(s) and comments justifying inclusion and priority of the plot.

Location	PI	Cooperator	Var	Pest	Comments
Amador 1	DH/JW	Fox Creek Vnyds	Z	P	Hillside, dry-farmed trial
Amador 2	DH/JW	Montevina Wny	Z	P	Important rootstocks not present in Amador 1 site
Mendocino 1	GM/JW	Husch Vineyards	CS	P, RK, L	Only Mendocino site Only North Coast site with ring nematode
Monterey 4	LB	Sleepy Hollow Vnyds	C	P, RK	Additional Monterey location
Monterey 5	LB	San Bernabe Vnyds	CS	RK	Additional Monterey location
Monterey 6	LB	Doctors Vnyd	CS		Additional Monterey location
Napa 2	JW	Oakville Expt Vnyd	CS	P	14 Rootstocks, Type B area
Napa 3	JW/EW	Duckhorn Vnyd	M	P	Additional Napa location
Napa 4	EW/JW	Beringer Vnyd	C	P	Only Napa Carneros location
Napa 5	EW/JW	Johnson Vnyd	CS	P	Calistoga location
Sonoma 2	RS/JW	Sangiacomo Vnyd	Pn	P	Additional Sonoma site
San Luis Ob 1	MB/JW	York Mountain Vnyd	Pn	none	Dry farmed site, only SLO site

PI = Principal Investigator(s):
LB = Larry Bettiga, Farm Advisor, Monterey County; DH = Donna Hirschfelt, Farm Advisor, Amador;; RS = Rhonda Smith, Farm Advisor, Sonoma County; EW = Ed Weber, Farm Advisor, Napa County; AW = Andy Walker, Professor, UC Davis; JW = Jim Wolpert, Extension Specialist, UC Davis;

Variety: C = Chardonnay; CS = Cabernet Sauvignon; M= Merlot, Pn=Pinot noir; TS = Thompson Seedless; Z = Zinfandel; Pest problems: P = phylloxera; Rk = rootknot nematode; L = lesion nematode.

Amador 2. Sutter Home. Mean plot yield in 2000 (3.9 kg vine^{-1}) was sharply reduced from the long-term average of 1994-2000 (6.1 kg vine^{-1}). The 2000 yield data (Table 2a) followed the 7-year trend (Table 3a) with 5BB having the greatest yield and O39-16 the least. The yield difference was driven by differences in both berries per cluster and cluster number. There were also differences in berry weight but they did not contribute significantly to yield differences. Rootstocks with yields falling between 5BB and O39-16 yielded some interesting results. Several rootstocks had yield performances in 2000 that were markedly lower than relative past performances would predict, these included Harmony, Freedom and Ramsey all of which have *champinni* parentage.

Differences of fruit chemistry were also investigated (Table 2b). While differences in Brix have been somewhat inconsistent from year to year consistent differences in pH and TA stand out.

O39-16 has the lowest TA and highest pH for both the 2000 season and the 7-year average (Table 3b). In contrast 420A has the highest TA and the lowest pH for the same periods.

Table 2a. Amador County - Montevina Zinfandel - (2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	Pruning Weight ($kg \cdot vine^{-1}$)	Shoots per Vine	Yield: Pruning Weight
5C	3.49 e			
5BB	5.27 a			
420A	4.60 abc			
110R	5.09 ab			
1103P	4.38 bcd			
101-14	3.80 cde			
3309	3.45 e			
St. George	3.57 de			
44-53	3.61 de			
1616	3.23 e			
O39-16	2.49 f			
Harmony	3.94 cde			
Freedom	3.88 cde			
Ramsey	3.71 de			
Signif. Level	***			

Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
5C	17 bcd	211 de	99 cde	2.14 abc
5BB	20 a	270 a	127 a	2.14 abc
420A	20 a	232 bcd	103 cde	2.24 a
110R	20 a	255 ab	123 ab	2.07 abcd
1103P	18 abc	245 abc	112 abcd	2.19 ab
101-14	17 abc	222 cde	114 abc	1.96 d
3309	18 abc	196 ef	94 ef	2.09 abcd
St. George	18 abc	203 def	97 de	2.09 abcd
44-53	18 abc	200 def	93 ef	2.17 ab
1616	16 cd	196 ef	96 de	2.06 bcd
O39-16	14 d	176 f	80 f	2.21 ab
Harmony	18 abc	218 cde	111 bcd	1.99 cd
Freedom	19 ab	203 def	96 de	2.14 abc
Ramsey	17 abcd	219 cde	98 cde	2.25 a
Signif. Level	**	***	***	**

Table 2b. Amador County - Montevina Zinfandel - (2000)

Rootstock	Shoot Weight (g)	Clusters per Shoot
5C		
5BB		
420A		
110R		
1103P		
101-14		
3309		
St. George		
44-53		
1616		
O39-16		
Harmony		
Freedom		
Ramsey		
Signif. Level		

Rootstock	^{o}Brix	TA ($g \cdot l^{-1}$)	pH
5C	23.6 ab	6.1 cde	3.55 cd
5BB	23.2 ab	6.3 ab	3.57 bcd
420A	23.3 ab	6.7 a	3.45 e
110R	23.5 ab	6.3 bc	3.51 de
1103P	22.8 b	6.2 cd	3.56 cd
101-14	24.2 a	5.5 fg	3.62 bc
3309	24.1 a	5.8 ef	3.62 bc
St. George	24.1 a	5.8 ef	3.62 bc
44-53	24.3 a	6.0 cde	3.66 ab
1616	22.9 b	6.0 cde	3.58 bcd
O39-16	24.1 a	5.4 g	3.73 a
Harmony	23.6 ab	5.8 ef	3.60 bcd
Freedom	23.6 ab	6.6 ab	3.52 cd
Ramsey	23.2 ab	5.9 de	3.64 bc
Signif. Level	*	***	***

Missing measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Duncan's Multiple Range Test.

Table 3a. Amador County - Montevina Zinfandel - (1994-2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	*Pruning Weight* *($kg \cdot vine^{-1}$)*	*Shoots per Vine*	*Yield: Pruning Weight*
5C	6.3 abc	*1.16 ab*	*13.0 ab*	*6.6 abc*
5BB	7.7 a	*1.30 a*	*13.0 ab*	*6.9 abc*
420A	6.9 ab	*1.03 ab*	*12.8 ab*	*8.0 a*
110R	6.8 ab	*1.07 ab*	*12.8 ab*	*7.2 ab*
1103P	6.6 abc	*1.20 ab*	*13.1 ab*	*6.2 bcd*
101-14	5.2 bcd	*1.00 b*	*12.5 ab*	*6.1 bcd*
3309	5.4 bcd	*1.08 ab*	*12.6 ab*	*6.1 bcd*
St. George	5.8 bcd	*1.14 ab*	*12.7 ab*	*5.8 bcd*
44-53	5.7 bcd	*1.04 ab*	*11.5 c*	*6.4 bc*
1616	5.8 bcd	*1.20 ab*	*12.8 ab*	*5.7 cd*
O39-16	4.6 d	*1.10 ab*	*12.8 ab*	*4.8 d*
Harmony	6.2 abc	*1.08 ab*	*12.5 ab*	*6.6 abc*
Freedom	6.1 abc	*1.21 ab*	*13.2 a*	*5.9 bcd*
Ramsey	6.0 bcd	*1.06 ab*	*13.0 ab*	*6.6 abc*
Signif. Level	***	*	***	***

Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
5C	22 abc	279 abcd	135 abc	2.10 a
5BB	24 a	318 a	150 a	2.16 a
420A	22 abcd	313 ab	146 ab	2.16 a
110R	23 abc	289 abc	142 ab	2.10 a
1103P	23 abc	288 abc	138 abc	2.12 a
101-14	20 cd	259 cd	142 abc	1.87 b
3309	21 bcd	260 cd	134 abc	2.12 a
St. George	22 abcd	267 cd	134 abc	2.04 ab
44-53	21 bcd	271 bcd	134 abc	2.10 a
1616	21 abcd	269 cd	134 abc	2.03 ab
O39-16	19 d	236 d	115 d	2.12 a
Harmony	22 abcd	283 abc	144 ab	2.02 ab
Freedom	24 ab	256 cd	125 cd	2.10 a
Ramsey	21 abcd	277 abcd	131 bcd	2.16 a
Signif. Level	***	***	***	***

Table 3b. Amador County - Monetvina Zinfandel - (1994-2000)

Rootstock	*Shoot Weight* (g)	*Clusters per Shoot*
5C	*91 a*	*1.9 ab*
5BB	*101 a*	*1.9 a*
420A	*80 a*	*1.8 abc*
110R	*84 a*	*1.9 ab*
1103P	*93 a*	*1.8 ab*
101-14	*81 a*	*1.7 bc*
3309	*87 a*	*1.7 bc*
St. George	*91 a*	*1.8 abc*
44-53	*93 a*	*1.9 ab*
1616	*95 a*	*1.7 abc*
O39-16	*87 a*	*1.6 c*
Harmony	*88 a*	*1.8 abc*
Freedom	*93 a*	*1.9 ab*
Ramsey	*82 a*	*1.8 abc*
Signif. Level	*ns*	***

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
5C	24.1 cde	6.4 bcd	3.57 cde
5BB	23.6 e	6.9 a	3.58 cde
420A	23.7 e	6.6 ab	3.53 e
110R	24.3 abc	6.5 abc	3.53 de
1103P	23.5 e	6.6 ab	3.53 e
101-14	25.0 a	6.0 de	3.66 ab
3309	24.8 abc	6.3 bcde	3.63 bc
St. George	24.7 abcd	6.0 e	3.69 ab
44-53	24.9 ab	6.5 ab	3.68 ab
1616	24.1 bcde	6.4 bcde	3.63 bc
O39-16	24.5 abcd	6.0 e	3.72 a
Harmony	24.0 de	6.1 cde	3.63 bc
Freedom	24.6 abcd	6.4 bcde	3.62 bc
Ramsey	24.1 de	6.5 abc	3.62 bcd
Signif. Level	***	***	***

Italicized measurements have not been collected for 2000.
*, **, ***, ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Amador 1. Fox Creek. The 2000 yield data (Table 3) favored putative drought resistant rootstock 1103P over the rootstock 3309C. This data continues from 1999 (Fig. 1) where, in terms of relative performance, we saw 1103P begin to distance itself from the other rootstocks and 3309C begin to fall behind. This yield difference was largely attributable to a greater number of berries per cluster and while not significant, 1103P had more clusters than any other rootstock. There are no significant yield differences in the multi-year data (Table 4). It appears that under the dry-farmed conditions of this site the individual rootstocks have been slow to establish themselves enough to fully express their characteristics. This highlights the value and uniqueness of this trial. Fruit chemistry in 2000 differed significantly for °Brix, TA and pH. The multi-year data however, show significant differences for only pH. Fruit from St. George vines had significantly higher and pH and while this difference is small it is worth mentioning in that it exists in both the multi-year and 2000 data indicating that it is persistent over time.

Table 3. Amador County - Fox Creek Zinfandel - (2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	Pruning Weight ($kg \cdot vine^{-1}$)	Shoots per Vine	Yield: Pruning Weight
5C	8.7 ab			
5BB	9.8 ab			
420A	8.5 ab			
110R	9.8 ab			
1103P	12.3 a			
3309	7.7 b			
St. George	9.3 ab			
Signif. Level	ns			

Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
5C	46.5 a	185 a	80 b	1.75 a
5BB	47.1 a	208 a	96 ab	2.18 a
420A	46.7 a	183 a	91 ab	2.04 a
110R	49.2 a	198 a	90 ab	2.21 a
1103P	53.8 a	228 a	112 a	2.07 a
3309	44.0 a	175 a	82 b	2.12 a
St. George	47.0 a	196 a	93 ab	2.10 a
Signif. Level	ns	ns	*	ns

Rootstock	Shoot Weight (g)	Clusters per Shoot
5C		
5BB		
420A		
110R		
1103P		
3309		
St. George		
Signif. Level		

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
5C	23.3 ab	5.9 b	3.41 ab
5BB	22.7 b	6.0 b	3.45 ab
420A	22.4 b	5.6 c	3.38 b
110R	23.6 ab	6.1 b	3.42 ab
1103P	23.1 ab	6.4 a	3.37 b
3309	24.6 a	5.6 c	3.43 ab
St. George	23.4 ab	5.7 c	3.49 a
Signif. Level	**	***	*

Italicized measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Table 4. Amador County - Fox Creek Zinfandel - (1995-2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	*Pruning Weight ($kg \cdot vine^{-1}$)*	*Shoots per Vine*	*Yield: Pruning Weight*
5C	7.0 a	*1.06 ab*	*20 a*	*6.4 ab*
5BB	7.8 a	*1.20 a*	*21 a*	*6.3 ab*
420A	6.4 a	*0.87 b*	*19 a*	*7.0 ab*
110R	8.2 a	*1.10 ab*	*20 a*	*7.3 a*
1103P	8.5 a	*1.27 a*	*18 a*	*6.3 ab*
3309	6.4 a	*1.05 ab*	*19 a*	*6.4 ab*
St. George	7.8 a	*1.24 a*	*19 a*	*6.0 b*
Signif. Level	ns	*	*ns*	*ns*

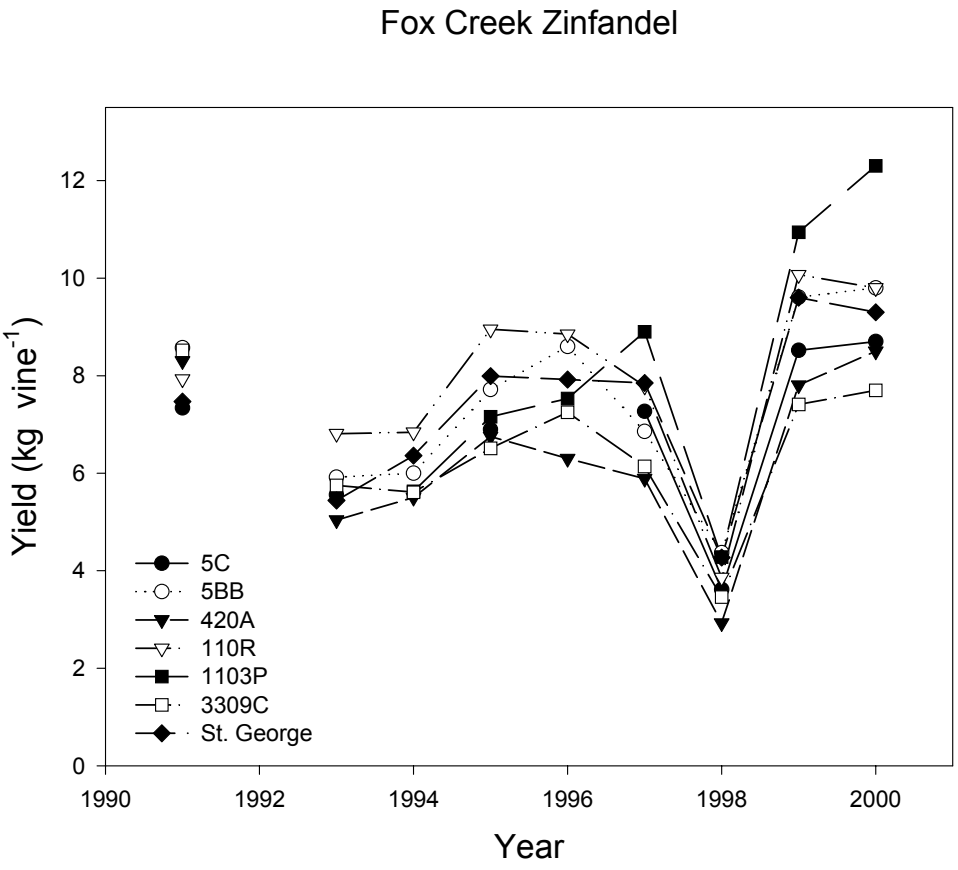
Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
5C	33 a	207 a	119 a	1.79 a
5BB	34 a	224 a	119 a	1.94 a
420A	31 a	206 a	122 a	1.72 a
110R	36 a	226 a	113 a	2.05 a
1103P	36 a	235 a	123 a	1.94 a
3309	32 a	202 a	110 a	1.87 a
St. George	35 a	221 a	114 a	1.95 a
Signif. Level	ns	ns	ns	ns

Rootstock	*Shoot Weight (g)*	*Clusters per Shoot*
5C	*31 bc*	*1.6 cd*
5BB	*35 ab*	*1.6 cd*
420A	*27 c*	*1.5 d*
110R	*33 bc*	*1.8 abc*
1103P	*39 a*	*1.8 a*
3309	*32 bc*	*1.6 bcd*
St. George	*38 ab*	*1.8 ab*
Signif. Level	*	**

Rootstock	^{o}Brix	TA ($g \cdot l^{-1}$)	pH
5C	23.9 a	6.4 a	3.58 ab
5BB	23.8 a	6.4 a	3.59 ab
420A	23.9 a	6.0 a	3.59 b
110R	24.4 a	6.4 a	3.55 ab
1103P	23.8 a	6.5 a	3.59 ab
3309	25.0 a	6.1 a	3.59 ab
St. George	24.1 a	6.2 a	3.61 a
Signif. Level	ns	ns	*

Italicized measurements have not been collected for 2000.
*, **, ***, ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Figure 1. Amador - Dry-Farmed Zinfandel yield over years.



Napa 3. Duckhorn Vineyards. This trial is located near the Silverado Trail, mid Napa valley, with well-drained, quite cobbly soil. This is only the second year in which we have collected data in this trial. Often in the initial years of data collection we need to look at year-to-year data to establish developmental stability. Yield and pruning weight data are good indicators of developmental stability. What we are looking for is data that shows consistent relationships between treatments over a period of years. Yield data at this trial appear to indicate that this trial has not yet stabilized (Fig 2). Four of the 6 rootstocks (3309C, St. George, 110R and 1103P) show yield declines that we can easily interpret as normal year-to-year differences. Rootstocks 140 Ru and 101-14 however, show fairly strong yield increases. The 2000 data (Table 5) show that 3309C is out-yielding other rootstocks by from 0.3 to 0.9 kg vine^{-1}. This compares to last year when 3309C also out yielded the other rootstocks but by a larger margin ranging from 0.4 to 1.3 kg vine^{-1}. Yield differences were driven primarily by significant differences in cluster number in 2000 as well as for the 1999-2000 mean (Table 6). The performance of 3309C continues to be a little surprising because 3309C does not have a reputation for strong growth or yield. Given the youth of this trial it is difficult to draw any concrete conclusions of performance.

Analysis of fruit chemistry has failed to show differences in maturity as measured by °Brix or in pH. Measurements of TA have however, shown significant differences. For both the 2000 and the two year mean data 101-14 shows the lowest TA while 140Ru shows the highest. The range between these values is rather large as shown by the 2000 data where 101-14 has TA of 4.6 g l^{-1} verses that of 140Ru at 6.5 g l^{-1}.

Table 5. Napa County - Duckhorn Melot - (2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	Yield 2000 - 1999 ($kg \cdot vine^{-1}$)	Shoots per Vine	Yield: Pruning Weight
1103P	1.9 b	-0.1		
140Ru	2.1 ab	0.4		
110R	2.1 ab	-0.2		
101-14	2.4 ab	0.4		
3309C	2.8 a	-0.2		
St. George	2.5 ab	-0.1		
Significance Level	**			

Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
1103P	17 c	111 a	93 a	1.20 ab
140Ru	18 c	116 a	95 a	1.23 a
110R	19 bc	106 a	88 a	1.20 a
101-14	23 ab	107 a	100 a	1.07 b
3309C	24 a	116 a	102 a	1.14 ab
St. George	23 ab	111 a	92 a	1.21 a
Significance Level	***	ns	ns	**

Rootstock	Shoot Weight (g)	Clusters per Shoot
1103P		
140Ru		
110R		
101-14		
3309C		
St. George		
Significance Level		

Table 5 cont. Napa County - Duckhorn Melot - (2000)

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
1103P	24.9 a	5.9 ab	3.8 a
140Ru	24.4 a	6.5 a	3.8 a
110R	24.7 a	5.8 ab	3.8 a
101-14	25.6 a	4.6 c	3.9 a
3309C	25.1 a	5.0 bc	3.9 a
St. George	24.5 a	5.1 bc	3.8 a
Significance Level	ns	***	ns

Missing measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Table 6. Napa County - Duckhorn Melot - (1999-2000)

Rootstock	Yield (kg · vine^{-1})	*Pruning Weight (kg · vine^{-1})*	*Shoots per Vine*	*Yield: Pruning Weight*
1103P	1.95 b	*0.83 a*	*14 a*	*2.5 c*
140Ru	1.89 b	*0.63 ab*	*13 a*	*2.7 bc*
110R	2.17 ab	*0.82 a*	*14 a*	*2.9 bc*
101-14	2.23 ab	*0.47 b*	*14 a*	*4.1 b*
3309C	2.93 a	*0.46 b*	*13 a*	*6.8 a*
St. George	2.58 ab	*0.75 a*	*15 a*	*3.6 bc*
Significance Level	**	***	*ns*	***

Rootstock	Clusters per Vine	Cluster Weight (g)	Berries per Cluster	Berry Weight (g)
1103P	18.2 bc	106 ab	83 b	1.30 a
140Ru	16.8 c	107 ab	82 b	1.33 a
110R	19.7 abc	108 ab	83 b	1.31 a
101-14	22.2 ab	97 b	85 ab	1.16 b
3309C	23.7 a	121 a	98 a	1.22 ab
St. George	22.9 a	111 ab	87 ab	1.16 ab
Significance Level	***	ns	*	**

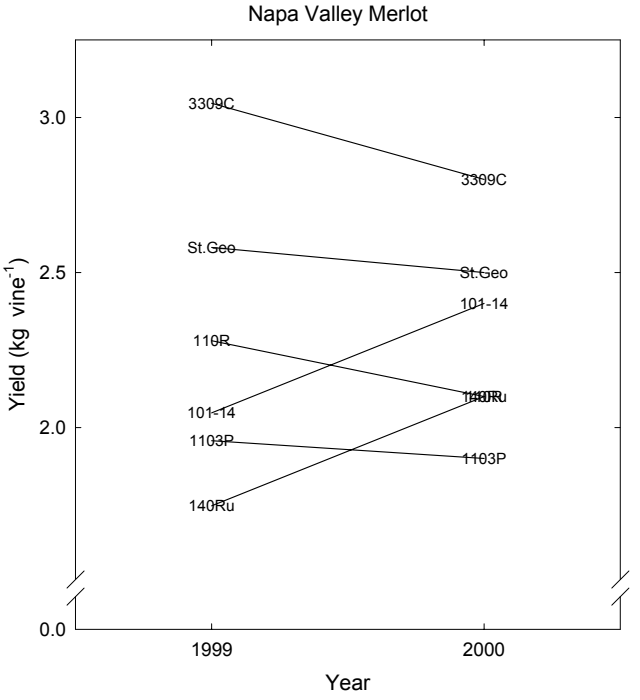
Rootstock	*Shoot Weight (g)*	*Clusters per Shoot*
1103P	*60 a*	*1.4 b*
140Ru	*51 a*	*1.3 b*
110R	*58 a*	*1.4 b*
101-14	*35 b*	*1.6 ab*
3309C	*34 b*	*1.8 a*
St. George	*52 a*	*1.6 ab*
Significance Level	***	***

Table 6 cont. Napa County - Duckhorn Melot - (1999-2000)

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
1103P	25.1 a	6.0 ab	3.82 a
140Ru	24.6 a	6.4 a	3.83 a
110R	25.0 a	6.1 ab	3.78 a
101-14	25.3 a	4.9 c	3.87 a
3309C	24.7 a	5.5 bc	3.83 a
St. George	24.6 a	5.2 c	3.79 a
Significance Level	ns	***	ns

Italicized measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$, not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Figure 2. Duckhorn Merlot yield over years.



Napa 4. Beringer Vineyards - Stanley Lane. This trial is in the Carneros region of the Napa Valley near the junction of highways 29 and 12. This is our first year of data collection at this trial. Mean yield was 6.9 kg vine^{-1}. The range of yield was 1.5 kg vine^{-1} from the high of 110R of 7.7 kg vine^{-1} to the low of 101-14 of 6.2 kg vine^{-1} (Table 7). Cluster number and berry weight appear to be the important factors in determining yield. There were no significant differences in juice chemistry.

Table 7. Napa County - Beringer Chardonnay - (2000)

Rootstock	Yield (kg · vine^{-1})	Pruning Weight (kg · vine^{-1})	Shoot per Vine	Yield: Pruning Weight
110R	7.7 a			
1103P	7.4 ab			
101-14	6.2 b			
3309C	7.0 ab			
5C	6.9 ab			
5BB	6.8 ab			
SO4	6.8 ab			
420A	6.8 ab			
Significance Level	($p \leq 0.073$)			

Rootstock	Cluster per Vine	Cluster Weight (g)	Berry per Cluster	Berry Weight (g)
110R	50 a	157 a	98 ab	1.60 abc
1103P	47 ab	157 a	97 b	1.63 abc
101-14	42 ab	147 a	97 b	1.52 bcd
3309C	49 ab	144 a	96 b	1.49 cd
5C	40 b	173 a	107 ab	1.61 abc
5BB	42 ab	165 a	98 ab	1.68 a
SO4	42 ab	162 a	97 b	1.67 ab
420A	43 ab	160 a	113 a	1.43 d
Significance Level	**	($p \leq 0.065$)	*	***

Table 7 cont. Napa County - Beringer Chardonnay - (2000)

Rootstock	***Shoot Weight*** (g)	Cluster per Shoot
110R		
1103P		
101-14		
3309C		
5C		
5BB		
SO4		
420A		
Significance Level		

Rootstock	^{o}Brix	TA ($g \cdot l^{-1}$)	pH
110R	23.1 a	9.4 a	3.19 a
1103P	23.3 a	9.6 a	3.20 a
101-14	23.6 a	8.8 ab	3.20 a
3309C	23.3 a	8.7 ab	3.20 a
5C	23.1 a	9.2 a	3.20 a
5BB	23.2 a	9.1 ab	3.21 a
SO4	23.1 a	9.4 a	3.19 a
420A	22.9 a	8.2 b	3.18 a
Significance Level	ns	ns	ns

Missing measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test

Napa 5. Johnson Vineyards. This trial is near Calistoga adjacent to the Silverado Trail at the upper end of the Napa Valley. This is only the first year of data collection at this trial. Yield in this initial year was very light. Mean yield across rootstocks was only 0.93 kg vine^{-1}. Yield within rootstocks was wide ranging (Table 8). The spread between the highest (110R) and lowest (St. George) yielding rootstock was 3x. The rootstocks 110R and St George also represent the high and low numbers of clusters per vine, a difference of 1.8x. While other yield parameters show significant differences across rootstocks cluster number appears to be the major contributor to yield differences. It is anticipated that as this trial matures yield will increase and cluster number will be come similar. Juice chemistry was examined (table 8) and a significant effect of rootstock on pH was found. The apparent immaturity of this trial prevents us from drawing any conclusions from the 2000 data.

Table 8. Napa County - Johnson Cabernet Sauvignon - (2000)

Rootstock	Yield (kg · vine^{-1})	Pruning Weight (kg · vine^{-1})	Shoot per Vine	Yield: Pruning Weight
110R	1.5 a			
140Ru	0.8 cd			
1103P	0.8 cd			
3309C	1.2 ab			
St. George	0.5 d			
Borner	1.0 bc			
44-53	0.7 cd			
Signif. Level	***			

Rootstock	Cluster per Vine	Cluster Weight (g)	Berry per Cluster	Berry Weight (g)
110R	25 a	59 ab	61 ab	0.97 a
140Ru	17 bc	49 abc	52 bcd	0.94 ab
1103P	17 bc	48 bc	52 bc	0.92 ab
3309C	20 ab	60 a	67 a	0.89 b
St. George	14 c	35 d	40 d	0.90 ab
Borner	19 bc	53 abc	58 abc	0.92 ab
44-53	16 bc	42 cd	47 cd	0.87 b
Signif. Level	***	***	***	**

Table 8 cont. Napa County - Chris Johnson Cabernet Sauvignon - (2000)

Rootstock	*Shoot Weight* (g)	Cluster per Shoot
110R		
140Ru		
1103P		
3309C		
St. George		
Borner		
44-53		
Signif. Level		

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
110R	26.4 a	5.6 ab	3.62 ab
140Ru	26.4 a	6.2 a	3.61 ab
1103P	26.0 a	5.9 ab	3.56 b
3309C	26.0 a	4.7 b	3.68 a
St. George	25.9 a	5.6 ab	3.61 ab
Borner	26.1 a	5.7 ab	3.65 a
44-53	26.0 a	5.2 ab	3.63 a
Signif. Level	ns	($p \leq 0.079$)	***

Missing measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Mendocino 1. Husch Vineyards. The effect of nematodes at this site is an important factor in interpreting the data. The effect of the nematodes and their populations often increases over time. This requires us to make periodic assessment of both vine performance and nematode populations. It is important that both vine performance and nematode population be assessed at similar times to understand the effect of nematodes populations on vine performance. We last collected vine performance data at this site in 1998 and nematode data in 1993. We felt that it was important to revisit this trial and collect current the data. Nematode and phylloxera sampling will take place this spring and be reported next year.

Yield in 2000 (Table 9) was the lowest we have seen at this site (Fig 3) but followed the same pattern we have seen previously. The highest yielding rootstock found in 2000 as well as in the multi year data (Table 9) was 110R with 8.6 and 13.4 kg vine^{-1} respectively and the lowest in 2000 and in the multi year data was 101-14 with 1.8 and 5.8 kg vine^{-1} respectively. This is a range in yield of nearly 5 fold in 2000. Yield differences here are largely attributable to cluster number. In 2000 there was more than a 3-fold difference in cluster number between 110R (97 clusters vine^{-1}) and 101-14 (30 clusters vine^{-1}).

Brix does not seem well correlated with yield. The high yielding 110R also has the highest Brix for both the 2000 data (23.0) and the multiyear data (23.1) and 3309C has the lowest Brix in both 2000 (21.8) and in the multi year data (21.9).

It is anticipated that we will collect vine performance data again in 2001 to bracket the nematode and phylloxera data with yield and fruit chemistry data.

Table 9. Mendocino County - La Ribera Cabernet Sauvignon - (2000)

Rootstock	Yield ($kg \cdot vine^{-1}$)	Pruning Weight ($kg \cdot vine^{-1}$)	Shoots per Vine	Yield: Pruning Weight
AXR#1	2.94 cd			
110R	8.59 a			
3309C	3.07 cd			
5C	3.62 cd			
420A	2.64 c			
101-14	1.78 d			
O39-16	7.58 ab			
O43-43	7.34 ab			
Harmony	3.85 cd			
Freedom	5.20 bc			
Signif. Level	***			

Rootstock	Clusters per Shoot	Clusters per Vine	Cluster Weight (g)	Berries per Cluster
AXR#1		48 cd	61 d	75 a
110R		97 a	88 ab	87 a
3309C		44 cd	69 cd	87 a
5C		55 cd	65 d	73 a
420A		38 c	70 bcd	84 a
101-14		30 c	57 d	74 a
O39-16		88 ab	86 abc	83 a
O43-43		82 ab	90 a	95 a
Harmony		56 cd	71 bcd	77 a
Freedom		69 bc	76 abcd	76 a
Signif. Level		***	***	*

Mendocino County – La Ribera Cabernet Sauvignon – (2000)

Rootstock	Berry Weight (g)	Shoot Weight (g)
AXR#1	0.82 bcd	
110R	1.01 ab	
3309C	0.80 cd	
5C	0.89 abcd	
420A	0.84 bcd	
101-14	0.77 d	
O39-16	1.05 a	
O43-43	0.95 abcd	
Harmony	0.92 abcd	
Freedom	0.99 abc	
Signif. Level	***	

Rootstock	^{o}Brix	pH	**TA** ($g \cdot l^{-1}$)
AXR#1	22.0 cd	3.65 a	5.2 b
110R	23.0 a	3.67 a	6.5 a
3309C	21.8 d	3.71 a	6.1 ab
5C	22.1 bcd	3.69 a	6.1 ab
420A	22.4 abcd	3.64 a	6.2 ab
101-14	22.2 bcd	3.63 a	6.0 ab
O39-16	22.8 ab	3.67 a	6.9 a
O43-43	22.8 ab	3.65 a	6.8 a
Harmony	22.8 abc	3.72 a	5.9 ab
Freedom	22.7 abc	3.71 a	6.4 ab
Signif. Level	***	ns	**

Italicized measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Table 9. Mendocino County - La Ribera Cabernet Sauvignon - (1995-2000)

Rootstock	Yield (kg · vine^{-1})	*Pruning Weight (kg · vine^{-1})*	*Shoots per Vine*	*Yield: Pruning Weight*
AXR#1	6.5 de	*0.90 e*	*41 d*	*7.1 ab*
110R	13.4 a	*2.94 a*	*55 a*	*4.2 d*
3309C	8.7 bcd	*1.17 cde*	*45 cd*	*7.5 abd*
5C	9.0 bc	*1.62 cde*	*47 bcd*	*5.9 bc*
420A	7.2 cde	*0.95 e*	*42 d*	*7.6 a*
101-14	5.8 e	*0.88 e*	*40 d*	*6.5 abc*
O39-16	12.8 a	*2.54 ab*	*52 ab*	*4.8 cd*
O43-43	10.9 ab	*2.51 bc*	*50 abc*	*5.0 cd*
Harmony	9.6 cd	*1.50 cde*	*49 abc*	*6.2 abc*
Freedom	10.0 b	*1.86 bcd*	*50 abc*	*5.3 cd*
Signif. Level	***	***	***	***

Rootstock	*Clusters per Shoot*	Clusters per Vine	Cluster Weight (g)	Berries per Cluster
AXR#1	*1.63 bc*	61 de	101 e	111 c
110R	*1.84 a*	95 a	139 ab	137 a
3309C	*1.69 ab*	68 cd	123 bcd	135 a
5C	*1.61 bc*	72 cd	122 cd	125 abc
420A	*1.57 bc*	60 de	113 de	127 ab
101-14	*1.50 c*	53 e	102 e	115 bc
O39-16	*1.68 ab*	89 ab	143 a	137 a
O43-43	*1.58 bc*	81 bc	135 abc	135 a
Harmony	*1.64 bc*	75 c	123 bcd	132 a
Freedom		78 bc	125 abcd	128 ab
Signif. Level	***	***	***	***

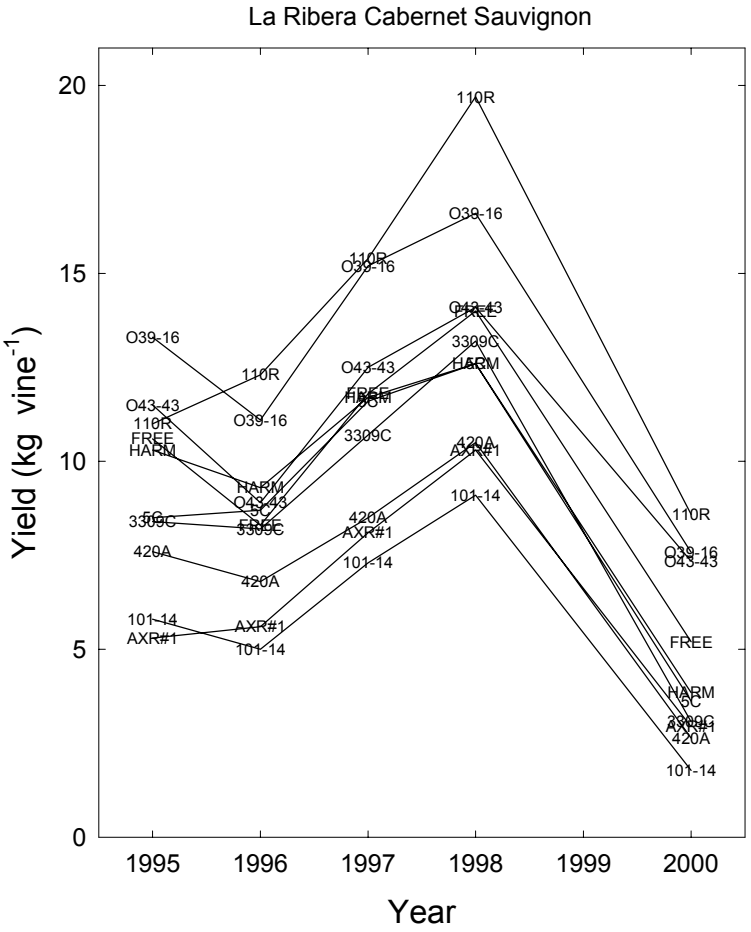
Mendocino County – La Ribera Cabernet Sauvignon – (1995-2000)

Rootstock	Berry Weight (g)	*Shoot Weight (g)*
AXR#1	0.90 cd	*24 de*
110R	1.02 ab	*54 a*
3309C	0.91 cd	*28 cde*
5C	0.97 abcd	*39 abcde*
420A	0.89 d	*23 e*
101-14	0.88 d	*23 e*
O39-16	1.05 a	*49 ab*
O43-43	1.00 ab	*44 abc*
Harmony	0.94 bcd	*32 bcde*
Freedom	0.98 abc	*40 abcd*
Signif. Level	***	***

Rootstock	^{o}Brix	pH	**TA** ($g \cdot l^{-1}$)
AXR#1	22.0 d	3.47 d	5.4 d
110R	23.1 a	3.56 abc	6.0 ab
3309C	21.9 d	3.54 bc	5.8 bc
5C	22.5 bcd	3.56 abc	5.6 cd
420A	22.3 cd	3.48 d	5.9 cd
101-14	22.6 abc	3.53 c	5.6 cd
O39-16	23.0 ab	3.60 a	6.3 a
O43-43	23.0 ab	3.60 a	6.1 ab
Harmony	22.7 abc	3.58 abc	5.8 bc
Freedom	23.0 ab	3.58 ab	5.8 bc
Signif. Level	***	***	***

Italicized measurements have not been collected for 2000.
*, **, *** , ns represent $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant, respectively.
Mean separation with Tukey's Studentized Range Test.

Figure 3. Mendocino Cabernet Sauvignon yield over years.



San Luis Obispo 1. York Mountain Vineyards. The 2000 season is the first year we have reported data from this dry-farmed trial. None of the yield components (Table 10) varied significantly. The yield data show quite a bit of variability within the rootstocks. The yield per vine standard error of the mean ranged from a little more than 7% (140Ru) to more than 22% (1103P) of the mean for each rootstock. This is indicative of a trail that may not yet be mature enough to provide conclusive data or on that is on a site with a great deal of variability. Data from future years will be required to understand this site. As we have seen at our other dry-farmed trial (Amador 1) the time required for vines to mature in dry-farmed vineyards is often longer than for irrigated vineyards. Data taken while vines establish themselves is however, valuable for providing insight into the time required and ability of different rootstocks to establish themselves under dry-farmed conditions.

Nutritional status of these vines as represented by both bloom (Table 11) and veraison (Table 12) petiole analysis was studied in 2000. In California bloom time samples are traditionally relied on to assess nutritional status. None of the measured elements showed significant differences across rootstocks in the bloom sample at this trial. Significant differences were however, found in the veraison sample for 5 of the 9 elements assayed. This indicates that rootstocks may have differing abilities to maintain vine nutrient status over the course of a season. Also indicated is that bloom time samples may not tell the whole story. As with other data from this trial this will be watched as the vineyard matures.

Table 10. San Luis Obispo County – York Mountain Pinot noir - (2000)
Data are ± standard error of the mean

Rootstock	Yield ($kg \cdot vine^{-1}$)	Pruning Weight ($kg \cdot vine^{-1}$)	Bud per vine	Yield: Pruning Weight
110R	3.0 ± 0.4		26 ± 2	
140Ru	3.1 ± 0.2		26 ± 2	
225Ru	2.3 ± 0.4		22 ± 2	
779P	2.5 ± 0.5		27 ± 2	
1103P	2.1 ± 0.5		23 ± 2	

Rootstock	Cluster per Vine	Cluster Weight (g)	Berry per Cluster	Berry Weight (g)
110R	41 ± 5	71 ± 5	56 ± 3	1.3 ± 0.0
140Ru	42 ± 4	75 ± 5	56 ± 4	1.3 ± 0.0
225Ru	33 ± 3	68 ± 8	51 ± 5	1.3 ± 0.0
779P	43 ± 7	60 ± 7	48 ± 4	1.2 ± 0.0
1103P	29 ± 3	72 ± 9	53 ± 6	1.3 ± 0.1

Rootstock	°Brix	TA ($g \cdot l^{-1}$)	pH
110R	23.3 ± 0.5	6.5 ± 0.1	3.22 ± 0.03
140Ru	23.0 ± 0.3	6.5 ± 0.2	3.25 ± 0.02
225Ru	23.8 ± 0.2	6.8 ± 0.2	3.25 ± 0.01
779P	23.7 ± 0.2	6.6 ± 0.1	3.25 ± 0.01
1103P	23.7 ± 0.6	7.0 ± 0.1	3.24 ± 0.03

Table 11. San Luis Obispo County – York Mountain Pinot noir - (2000) Bloom Petiole analysis.

Rootstock	NO_3 ppm	P %	K %	Ca %	Mg %	Na ppm	Cl %	B ppm	Zn ppm
110R	25	0.30	0.89	2.51	0.77	391	0.012	40	66
140Ru	70	0.25	0.82	2.52	0.78	396	0.016	40	69
225Ru	27	0.28	1.20	2.73	0.71	401	0.022	39	72
779P	67	0.29	1.03	2.29	0.72	352	0.010	39	67
1103P	46	0.33	0.93	2.48	0.69	393	0.016	40	82
p>F	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 12. San Luis Obispo County – York Mountain Pinot noir - (2000) Veraison Petiole analysis.

Rootstock	NO_3 ppm	P %	K %	Ca %	Mg %	Na ppm	Cl %	B ppm	Zn ppm
110R	14	0.17	0.63	1.49	0.82	516	0.077	25	33
140Ru	14	0.14	0.84	1.39	0.90	420	0.046	26	33
225Ru	18	0.12	0.76	1.75	0.60	455	0.058	22	35
779P	17	0.14	0.82	1.30	0.63	456	0.046	23	33
1103P	16	0.13	0.81	1.26	0.71	465	0.048	19	37
p>F	ns	0.0456	ns	0.0001	0.0004	ns	0.0013	0.0069	ns

Treatment means followed by like letters not different at 0.05% by DMRT

Sonoma 2. Sangiacomo Vineyards Chardonnay. This vineyard was planted in 1997 and this is the first year we have reported data from this trial. There was significant effect of rootstock on yield (Table 13). Yield was bracketed by 110R on the low end (6.4 kg vine^{-1}) and 1616 on the high end (7.7 kg vine^{-1}). The dominant yield component was cluster number. A regression of yield to cluster number (Fig 10) shows both 110R and 101-14 below the regression line of all rootstocks. This is indicative that their yield is being affected by another yield component to a greater extent than the other rootstocks are. Indeed, the plot of berries per cluster (Fig. 10) shows 110R and 101-14 having the fewest berries per cluster in the trial and that this yield component is contributing to their relative yield more than for the other stocks.

Analysis of juice chemistry (Table 13) shows a full °Brix range between the high value of 24.3 (110R) and the low of 23.3 (5C). Figure 10 shows a poor relationship between crop load (yield) and °Brix across rootstocks. While this relationship is poor across rootstocks it is easy to see that 110R has both the lowest yield and the highest °Brix. The range of °Brix for the rootstocks exclusive of 110R is only 0.5. This may not be a sufficiently large range to allow us to see a crop load to °Brix relationship.

Bloom petiole analysis was preformed on samples from this site (Table 14). The low yielding 110R had both the lowest levels of total N (1.46 % dry weight) and NO3 –N (2998 ppm). It must be noted that these nitrogen levels are more than what is considered sufficient. Indeed, all the levels in table 14 can be considered at least adequate. It is however, interesting to note the effect rootstock can have on vine nutrient status. The petiole content of several elements can easily be seen as being affected by rootstock. A striking example is phosphorus where the range is almost 4x between the 3309 and 110R.

Table 13. Sonoma County – Sangiacomo Chardonnay - (2000)
Data are ± standard error of the mean

Rootstock	Yield ($kg \cdot vine^{-1}$)	Pruning Weight ($kg \cdot vine^{-1}$)	Bud per vine	Yield: Pruning Weight
110R	6.4 ± 0.2			
3309	7.4 ± 0.2			
1103P	7.5 ± 0.3			
5C	7.1 ± 0.3			
101-14	7.0 ± 0.2			
1616	7.7 ± 0.3			

Rootstock	Cluster per Vine	Cluster Weight (g)	Berry per Cluster	Berry Weight (g)
110R	45 ± 1	143 ± 3	109 ± 1	1.3 ± 0.0
3309	49 ± 2	150 ± 2	114 ± 3	1.3 ± 0.0
1103P	49 ± 2	154 ± 2	114 ± 2	1.4 ± 0.0
5C	47 ± 2	152 ± 3	113 ± 3	1.3 ± 0.0
101-14	51 ± 1	135 ± 2	105 ± 2	1.3 ± 0.0
1616	52 ± 1	149 ± 3	111 ± 2	1.3 ± 0.0

Rootstock	^{o}Brix	TA ($g \cdot l^{-1}$)	pH
110R	24.3 ± 0.1	9.8 ± 0.1	3.33 ± 0.01
3309	23.6 ± 0.1	9.7 ± 0.1	3.33 ± 0.01
1103P	23.8 ± 0.1	10.3 ± 0.1	3.32 ± 0.01
5C	23.3 ± 0.1	9.5 ± 0.1	3.31 ± 0.01
101-14	23.7 ± 0.1	9.3 ± 0.1	3.33 ± 0.01
1616	23.6 ± 0.1	9.9 ± 0.2	3.31 ± 0.01

Table 14. Sonoma County – Sangiacomo Chardonnay - (2000) Bloom Petiole analysis.

Rootstock	Blades N-total		Petioles N-Total		Petioles P		Petioles K	
	%	s.e.	%	s.e.	%	s.e.	%	s.e.
110R	3.12	0.08	1.46	0.03	0.97	0.20	3.6	0.1
3309	2.99	0.08	1.87	0.08	0.25	0.02	4.9	0.2
1103P	2.99	0.17	1.69	0.06	0.64	0.04	3.4	0.1
5C	3.03	0.06	1.70	0.04	0.47	0.05	4.2	0.1
101-14	2.84	0.16	1.61	0.09	0.33	0.04	4.6	0.2
1616	2.89	0.18	1.76	0.05	0.51	0.06	4.1	0.2

Rootstock	Blades Mg		Petioles B		Petioles Zn		Petioles NO_3	
	%	s.e.	ppm	s.e.	ppm	s.e.	ppm	s.e.
110R	0.3	0.0	51	1	36	1	2998	90
3309	0.2	0.0	54	4	30	1	4714	379
1103P	0.4	0.0	50	1	40	2	4056	230
5C	0.3	0.0	43	1	33	1	4396	82
101-14	0.3	0.0	48	1	35	2	4130	295
1616	0.3	0.0	39	2	40	2	4380	337

Figure 10. Yield components at Sangiacomo Vineyards Chardonnay rootstock trial, 2000.

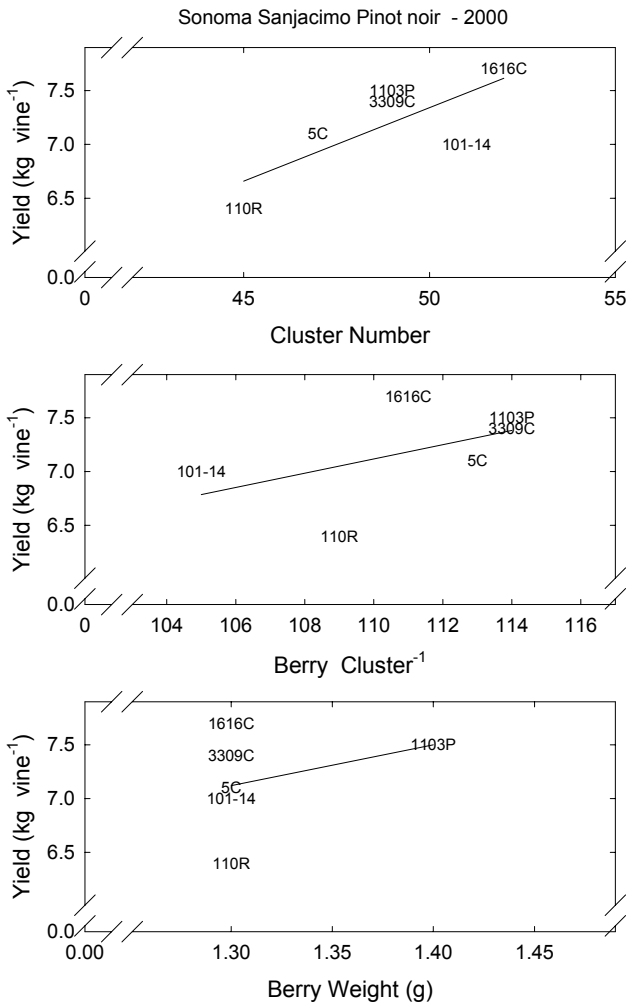


Figure 11. Relationship of yield to °Brix, Sangiacomo Vineyards Chardonnay rootstock trial, 2000.