

**American Vineyard Foundation  
California Rootstock Commission  
Viticulture Consortium**

Final Report  
March 31, 2002

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

Principal Investigators:

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**Summary**

The attached report presents data for the performance of rootstocks for winegrapes for the past decade of funding. Data are presented in tables for each year as well as for multiple year averages.

As growers are aware, rootstock performance is highly dependent on site, with the most significant component appearing to be soil type, followed by vineyard spacing, and farming practice. When sites have few limitations rootstocks tend to perform more uniformly than when sites or farming practices are marginal. Rooting depth and water availability also seem to play a significant role.

Rootstocks such as 110R and 1103P have performed better than other rootstocks in sites where soil types are coarse-textured and/or where irrigation is sparingly applied. 1103P generally yields about the same as 110R but responds with more growth. Growth of both can be excessive in deep, well drained soils. 110R responds poorly to water-logged soils. The rootstocks 3309C and 101-14Mgt are clearly more moderate in vigor, often about 60 to 70% of 110R. In side-by-side comparisons, 101-14 is generally slightly more vigorous than 3309 but not in all conditions. Both are recommended for moderate to moderately high vigor sites. The rootstock 420A was generally low in vigor. Although it has comparable yield to other rootstocks if pruned to similar bud numbers per vine, the resultant growth is 20 to 50% of the more vigorous rootstocks. It could only be recommended for sites where vigor potential is high or where the vine spacing is very close. The Teleki hybrids 5C and 5BB are moderately vigorous in most sites except where water stress is present. Both tolerate heavy, poorly drained soils better than other rootstocks, provided there is no threat of *Phytophthora*.

Other rootstocks included in the trials were Freedom, Harmony, St George, 1616C and O39-16. Readers are encouraged to consult the full report for in-depth details about the trial sites and the individual rootstock recommendations.

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**Objective of the Proposal:**

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.

**Results:**

In this final report, results are present from all the trials virtually since the project was first funded. It is written as if were to be extracted from this report and distributed as an Extension publication for growers. Historical background is provided in order to put this data into context of rootstock usage over the past 100 years. Rather than a plot-by-plot and year-by-year analysis, an effort was made to synthesize the results into recommendations for specific rootstocks. Experience from other AVF-funded projects as well as grower experience has also been included, if relevant.

# Rootstocks for Coastal and Northern California

2002

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## Introduction

Rootstock use in California has changed dramatically in the past fifteen years, initially due to the loss of vineyards on AXR#1 rootstock to phylloxera but continuing beyond that due to the rapid expansion of winegrape acreage in coastal and northern winegrape regions. Most soils in these regions support a phylloxera infestation. However, with heavy reliance historically on AXR#1 and St. George rootstocks, viticulturists had little experience on which to base their selection of alternative rootstocks.

This paper reviews status of rootstock use in coastal and northern California grape growing regions, with particular emphasis on the database gathered during the past decade of research on rootstock evaluation. It is divided into four sections: 1) Historical overview, intended to provide some context for how rootstock use evolved; 2) Rootstocks considerations; 3) Current rootstock recommendations; and 4) Site description and plot-by-plot data for all AVF sponsored rootstock evaluation trials.

## Historical Overview

The history of rootstock use in California can be divided into several phases: 1) experience pre-1900; 2) the screening work of Bioletti and Husmann; 3) the field trials of Jacob and Lider; and 4) the discovery of type B phylloxera and the shift to alternative rootstocks.

### Experience Pre-1900

Phylloxera was first identified in California in 1873 in a declining vineyard in Sonoma Valley. The discoverers were sure that this was the same insect responsible for the widespread destruction of French vineyards that began only a decade earlier. They believed that the insect must have been responsible for vineyard damage in Sonoma County as early as the late 1860's.

Initial spread was slow due to the geographical isolation of vineyards and to an absence of the above-ground, winged form. In the first annual report of the State Viticultural Commission in 1881 (Wetmore, 1882), four remedies for phylloxera were proposed: planting in sandy soil, winter flooding of the site, insecticides and lastly, resistant rootstocks. As closer attention was paid to European experience, the limitations of the first three control measures were realized. In later reports resistant rootstocks were featured much more prominently.

By the 1893-94 Report of the Board of State Viticultural Commissioners (Doyle, 1894), several lessons had been learned. Firstly, most chemicals or concoctions alleged to have insecticidal activity against phylloxera were proven useless. These purported "cures" for phylloxera in California, as they had in France, ranged from the unusual to the preposterous. What few treatments were effective, such as carbon bisulfide, were found to require annual applications, if not more, and were viewed ultimately as temporary measures against phylloxera's onslaught.

Secondly, in their rush to replant vineyards destroyed by phylloxera, early California viticulturists, like their European counterparts, initially used wild grapevines indiscriminately. It was generally believed that any native grapevine could be used as a rootstock and would be resistant to phylloxera. Huge shipments of cuttings of wild vines were made from the Mississippi River Valley. Early viticulturists were particularly fond of *Vitis riparia* and *V. rupestris* but considered at least a half-dozen other species. They soon learned that not all *Vitis* species were equally resistant to phylloxera.

Thirdly, they found that the significant natural variability within a species affected the viticultural performance of native vines. It was not enough simply to have "true-to-type" species. For satisfactory results, these wild species had to be examined and selected for superior production and vineyard uniformity. By the end of the century, Hayne (1898) strongly recommended utilizing clonal rootstock selections. The pure species rootstocks Riparia Gloire and Rupestris St. George (syn = Rupestris du Lot) are examples of this selection effort and are still being used today.

### **Work of Bioletti and Husmann**

After the turn of the century, efforts in California were conducted on two fronts: one led by the USDA's George Husmann, and the other at the University of California under the leadership of Frederick Bioletti.

From 1904 through about 1920, Husmann tested rootstocks at 12 USDA field stations, including sites near Oakville, Sonoma, Lodi, and Fresno. The Oakville site is the same vineyard used for research today by the UC Davis Department of Viticulture and Enology. In the final report, Husmann and co-workers highlighted the rootstocks 1202C, 1613C, St. George, Dog Ridge, and AXR#1 for their "wide adaptability and also resistance to the attack of phylloxera." No distinction was made about the relative phylloxera resistance of rootstocks in this group.

Bioletti and co-workers (1921) did most of their rootstock experimentation at UC Davis (then called the University Farm) and at the original UC Kearney Field Station near Fresno, although they utilized grower-cooperators as well. Bioletti preferred the rootstocks 3309C, St. George, 420A, 1616C, Riparia Gloire, AXR#1, and 1202C, among others. He described AXR#1 by saying that "...unlike most crosses containing vinifera, its resistance to Phylloxera is quite sufficient..." Several of the rootstocks suggested by Bioletti for specific conditions never reached significant commercial importance, including 157-11C, 106-8 Mgt, and 3306C. In a later report, Bioletti and co-workers recommended primarily 3309C and 41B. Although they were quite satisfied with the field performance of 420A, they rejected it because it was difficult to propagate.

The work of both Husmann and Bioletti can best be described as screening trials in that they attempted to sort through a large number of European hybrids. They also utilized a wide variety of scions which had commercial potential at that time. Both researchers, by the nature of their screening efforts, were able to draw only general conclusions. But despite the lack of a clear recommendation, St. George became the preferred rootstock used by North Coast growers from the turn of the century until Prohibition (H.P. Olmo, personal communication).

### **Jacob-Lider trials.**

When the USDA stopped its work on winegrapes and phylloxera after Prohibition, the University of California took up the effort. In 1929, UC Davis viticulturist Harry Jacob commenced what was to become the most comprehensive series of rootstock trials in California's history. Over the course of two decades he eventually conducted more than 100 trials. Jacob appeared to have gleaned lessons from his predecessors Husmann and Bioletti in that he recognized the importance of site conditions. His trials were not located at university field stations, but rather with growers in the production areas. His were not the screening trials of Bioletti and Husmann; these were trials from which firm recommendations could be made.

In 1943, Jacob issued a preliminary report summarizing the results of his ongoing project. He accepted the fact that AXR#1 was less resistant to phylloxera than St. George, and even failed in dry sites "where phylloxera attacks are likely to be most severe." But, nevertheless, he did not

reject it and even reported that it produced the most vigorous and productive vines in non-nematode sites. In addition, he also favored 99R, 1202C, and 420A for specific site conditions. Jacob had apparently concluded that no one rootstock would suffice for all vineyards.

After Jacob's untimely death in 1949, Lloyd Lider at UC Davis carried on and concluded the work. Of the Jacob's original 100 trials, Lider selected 17 for a summary report in which he stated that, on average, AXR#1 out-performed all other rootstocks in terms of growth and yield (Lider, 1958). He concluded that AXR#1 was a good choice for coastal winegrape production. The phylloxera resistance of AXR#1 was described by Lider as only "moderate" while other *vinifera* x *rupestris* hybrids, such as 93-5C, were rejected as insufficiently resistant.

In his report, Lider referred to foreign experience in which the phylloxera resistance of AXR#1 had proved inadequate. In the mid-1890's AXR#1 had been recommended by French nurseries but it soon fell into disfavor, failing to phylloxera. Other AXR#1 failures were known to have occurred in South Africa and Italy. Lider, apparently like Bioletti and Jacob before him, did not see enough problems with AXR#1 to reject it in California despite its failure elsewhere.

During the 25 years which followed Lider's publication, AXR#1 performed consistently well in California vineyards. Many of these sites were sites replanted because of phylloxera infestation. Preferred by nurseries for its ease of propagation and valued by viticulturists because of its adaptability to a wide range of sites, AXR#1 became the predominant rootstock in North Coast vineyards. Any of the original concern about the questionable phylloxera resistance was forgotten or ignored. In fact, in 1974, Lider and co-workers returned to six of the original trials from the 1958 report and concluded that AXR#1 continued to perform adequately (Lider et al, 1978). In the 1980's, however, the picture changed dramatically.

### **Type B phylloxera and alternative rootstocks**

The first documented case of failure of a California vineyard grafted on AXR#1 occurred in the Napa Valley in 1983. The grower had reported seeing signs of depressed growth two or three years earlier. Investigation led to the identification of a new strain of phylloxera, designated type B, in 1985. This aggressive form of phylloxera showed an ability to reproduce on AXR#1 roots at a much faster rate than the more common phylloxera, called type A.

At first, it was not clear that the problem was entirely due to a new biotype. Questions surfaced about whether the rootstock was truly AXR#1, or whether recent drought played a role. Common to the early sites of type B discovery was the presence of non-AXR#1 rootstocks mixed in the vineyard, clouding the issue of whether the decline was "true" AXR#1 or these off-types. However, by the end of 1988, additional discoveries of declining AXR#1 vineyards had been made, indicating that the problem had spread considerably. By December 1989, after further research, the UC Phylloxera Task Force determined that the data were clear: AXR#1 rootstock was failing and failing fast. The Task Force recommended that AXR#1's use be discontinued immediately.

In many respects, the California experience with AXR#1 closely parallels that of South Africa as detailed by Perold (1927) more than 50 years earlier.

"For over twenty years Aramon Nos. 1 [AXR#1] and 2 have been used everywhere as stocks at the Cape with conspicuous success...Now hundreds of acres of these vineyards have been uprooted and replanted with 101-14 and 1202. The vines on Aramon were evidently killed by phylloxera...The Aramon roots of the suffering vines show numerous nodosities and tuberosities to almost the same extent as *Vinifera* vines. Why the Aramons

should have collapsed so badly is not yet known. I am inclined to believe that a *new biological race of phylloxera* [Perold's emphasis] has evolved on Aramon roots in Helderberg, where Aramon has been the almost exclusive stock"

In the midst of our current transition to alternative rootstocks, one question persists: How could AXR#1 have survived in California through 50 years of trials by Husmann, Bioletti, Jacob and Lider? The answer may be revealed when phylloxera's genetic diversity is better understood. The fact that AXR#1 flourished gave Californians a reason to ignoring the AXR#1 failures worldwide. In fact, a strong contributing factor was the enduring belief that growing conditions in California were different enough from those in Europe to permit AXR#1 to escape damage. In the earliest literature on phylloxera, it was recognized that the life cycle of phylloxera in California was different from that in Europe in that the winged form was rarely observed and no aerial leaf galls developed. Phylloxera in California apparently reproduced only asexually so therefore the winged form could not contribute to spread.

Furthermore, from the early viticultural reports through the works of Bioletti, Husmann and Lider runs the thread of a belief, presumably based on a combination of experiment and experience, that phylloxera's ability to overcome resistant rootstocks was to a great degree dependent on soil type. So, rootstocks listed as susceptible to phylloxera on dry, shallow soils were nevertheless recommended for deep, alluvial soils well supplied with water. The list of rootstocks with a site specific phylloxera rating included AXR#1, 1202C and 93-5C, none of which would be recommended for use today.

## Rootstock Considerations

### Rootstock Species Parentage

When selecting any rootstock, it is important to consider the parentage. Most rootstocks are hybrids of American species and often display characteristics of their parents. Knowledge of these parental characteristics may help in making your final rootstock selection.

Most phylloxera-resistant rootstocks were bred by making crosses between *Vitis riparia*, *V. rupestris* and *V. berlandieri*. These species are native to North America. They grow in areas where phylloxera are also native and have evolved mechanisms to defend against this insect.

*Vitis riparia* was named stream-side, or riparian, habitat. It is found throughout the central and eastern U.S. from Canada to Texas. It has shallow roots and grows locations where the supply of moisture is uninterrupted. Many rootstocks with *V. riparia* as a parent reflect this shallow rooting habit and the need for moist soils. They do not perform well under dry conditions. *V. riparia* has very high resistance to phylloxera.

*Vitis rupestris* is named after "Rupes," Latin for rocks which describes its usual habitat, rocky creek beds. Its roots grow deep for anchorage where they can explore for water as creek beds dry up in summer. This ability to avoid drought is reflected in many of the hybrids of *V. rupestris*. This species also resists phylloxera damage, although small populations can be found on its roots.

*Vitis berlandieri* was named after the Swiss botanist Berlandier who first collected it. It is found on central Texas limestone soils ranging from shallow to relatively deep. Many of these locations are subject to drought. This species has deeply penetrating roots which allow it to survive dry periods. Although this species has strong phylloxera resistance, it roots very poorly from dormant cuttings. It was crossed with *V. riparia* and *V. rupestris* to produce hybrids with improved rootability without

sacrificing phylloxera resistance.

### **Rootstock Selection for New Plantings**

Rootstock selection is the key to phylloxera control in the future. In this regard, rootstock choices should be limited to those bred from North American *Vitis* species without *V. vinifera* in their parentage. In the regions California where phylloxera is the predominant soil pest, the choice of rootstocks should be limited to those selections or hybrids of *V. riparia*, *V. rupestris*, and *V. berlandieri* which have been used successfully in Europe and other grape growing regions. Table 1 lists rootstocks which can be recommended for phylloxera resistance as well as those which cannot, or those for which more information is needed. The rootstocks listed as "Recommended" (Table 1) have been used throughout the world for 50 to 100 years, where they have been challenged by diverse phylloxera populations, with no reported cases of failure.

Phylloxera-resistant rootstocks vary in their other viticultural characteristics (vigor, drought tolerance, etc.) and deciding which ones are best suited for a particular vineyard is complex. Information on the performance of these rootstocks in Europe, Australia, and South Africa but extrapolating results of research or experience from other countries to California conditions can be problematic. Field experiences with rootstocks under California conditions are the most likely to provide useful guidance.

### **Phylloxera and fanleaf degeneration**

The specific case of fanleaf degeneration complex involves vineyard sites infested with grapevine fanleaf virus (GFLV) and its vector the dagger nematode *Xiphinema index*. The rootstock VR O39-16 is a special case where a rootstock with *V. vinifera* in its parentage is recommended these North Coast vineyards. VR O39-16 is a cross of *V. vinifera* and *Muscadinia rotundifolia*. The "VR hybrids" (a short-hand name from *vinifera* and *rotundifolia*) were developed at the University of California, Davis. In fanleaf sites, vines on VR O39-16 will eventually become infected with GFLV, but they maintain significantly higher yields than vines on other affected rootstocks.

There is currently no effective way to rid a vineyard of fanleaf degeneration complex once it is infested. In the North Coast, these sites tend to be infested with phylloxera as well. Despite the *V. vinifera* in its parentage, VR O39-16 is still recommended for these sites. This is a case of a known risk, i.e., damage from GFLV, outweighing an unknown risk, a future problem with phylloxera. To date, roots of VR O39-16 have not supported phylloxera in laboratory, greenhouse or field tests. However, VR O39-16 should only be used in sites which are infested with GFLV and its nematode vector *Xiphinema index*. It should not be considered as a rootstock for general use in phylloxera-infested regions. The related VR hybrid O43-43 has declining in the field and thus can no longer be recommended. O39-16 will continue monitored for any early signs of evidence that phylloxera tolerance is breaking down. In the meantime,

### **Phylloxera and nematodes**

Rootstock selection for vineyards in parts of the San Joaquin Valley and the Central Coast is made more difficult by the presence of damaging nematodes in addition to phylloxera. Most of the rootstocks listed in Table 1 have very little broad resistance to nematodes. In these areas, and where nematodes are a significantly greater threat than phylloxera, rootstocks with *V. vinifera* in their parentage could be considered. Rootstocks with nematode resistance are Dog Ridge, Ramsey, Freedom and Harmony.

Harmony and Freedom were produced by hybridizing an open-pollinated seedling of 1613C with an open-pollinated seedling of Dog Ridge. Both 1613C and Dog Ridge have female flowers and



will not produce fruit without pollen from another variety. Open pollination means that the male parent, the source of pollen, is not known. The male parents could have been other resistant *Vitis* rootstocks; however, they might have been *vinifera* varieties which are susceptible to phylloxera.

The phylloxera resistance of 1613C itself is not high. It is a cross of *V. solonis* x 'Othello'. 'Othello' is a cross of 'Clinton' (*riparia* x *labrusca*) x *vinifera* 'Muscat Hamburg.' Therefore, 1613C is one quarter *vinifera*, and an open pollinated seedling of 1613C has at least one-eighth *vinifera* if the pollen parent was not *vinifera* and five-eighths if the parent was pure *vinifera*.

Historically, worldwide, only rootstocks with *vinifera* parentage have succumbed to phylloxera. How much *vinifera* Freedom and Harmony possess is not known, and accordingly, no confidence can be placed in their long-term phylloxera resistance. In order to avoid a catastrophic loss of resistance, as happened with AXR#1, Harmony and Freedom cannot be recommended in sites where phylloxera is the sole soil pest threat.

### **Cultural considerations**

When developing any new vineyard on resistant rootstock, it is important to plant the new vines properly. Graft unions should be at least four inches above the soil line to prevent scion rooting. Fumigation prior to planting is not necessary if phylloxera is the only soil pest of concern.

Rootstock performance is greatly affected by site conditions, including pest pressure, soil type, rooting depth, fertility, water-holding capacity, and macro- and mesoclimatic conditions such as temperature and rainfall. In addition, it is important to know what soil pests are likely to be present (phylloxera, nematodes).

Managers influence the performance of grafted vines through the cultural practices they employ. Fertilization, irrigation, cover crops and the vine age at which covers are employed, vine spacing and trellising, and the desired wine variety will all influence vine performance. Within certain parameters, low vigor rootstocks can be invigorated or high vigor rootstocks devigorated, by careful attention to these practices.

Growers or wineries producing grapes for the premium wine market may want to use low or moderate vigor rootstocks in order to limit growth and crop. On the other hand, producers for the "popular premium" wine market may wish to encourage higher vigor and larger crops. In this regard, marketing decisions may influence the eventual selection of rootstock, in order to balance crop and vine growth.

## Materials and Methods

Trials are reported from the North Coast region, Central Coast, Sacramento Delta and foothills of the Sierra Nevada. Table 1 gives information on all sites, including the year planted, row and vine spacing, statistical design and number of replications, years that data were taken and years for which data are reported, soil type and depth, and other site conditions that may be pertinent to interpretation. Scion cultivar in each trial was a matter of preference by the grower-cooperator.

Sixteen rootstocks were reported (Table 2). Twelve of those were originally utilized in Europe and were either pure American species selections (St. George and Ramsey) or were their hybrids (5C, 5BB, 420A, 110R, 1103P, 140Ru, 101-14 Mgt, 3309C, 44-53M and 1616C). Four, originated in the United States, O39-16 and O43-43 bred by Olmo of UC Davis, and Harmony and Freedom released by Harmon and Snyder of the USDA. Taken together, these sixteen are the most widely employed rootstocks in California today. Not all rootstocks were present in all trials. Two rootstocks, Schwarzmann and 225Ru, used in two trials each, are less widely used.

Each trial was located within a much larger vineyard of the same scion cultivar. Cultural practices, including pruning level, irrigation and fertilization regimes, and canopy management was normal for the cultivar. Shoot thinning (“suckering”) was utilized to remove shoots from latent buds and double primary shoots (except for Lake County Sauvignon Blanc in which no shoot thinning was performed). No fruit thinning was employed.

A treatment-replicate was comprised of between five and ten vines as vineyard space permitted. Data were taken on a per-vine basis from the center three to six vines in each treatment-replicate and averaged for analysis. In three locations, guard rows of the same rootstock-cultivar combination were employed and in those cases data were taken on the center row of a three-row treatment-replicate. In general, however, guard rows were not utilized.

Clusters were counted if they had ten berries or more. Shoots were counted in the dormant season prior to pruning. Shoots longer than 25 cm of mature wood were counted. Juice composition was measured on a 100-berry composite sample just prior to harvest, one sample per treatment-replicate. Juice composition measurements included Brix, titratable acidity and pH, performed as previously outlined.

Leaf petioles were collected in selected trials and analyzed to determine the influence of rootstock on vine nutrition. In some trials and in some years, leaf blades were collected and both petioles and blades were collected at veraison and pre-harvest. Nutritional information will be presented in a separate paper.

All data are presented as multiple-year averages. Stable vine size measurements (pruning weight) were used as an indicator of full vine maturity. Early years' data were not included in the average if there was a trend for increasing pruning weight. Data for individual years are available from the senior author by specific request.

## Rootstock Recommendations

The summary of rootstock attributes below is compiled from a combination of vineyard experiments and grower experience.

### **Vitis berlandieri x V. riparia hybrids**

**Teleki 5C** was one of the most widely used rootstocks in the early transitions to alternative rootstocks because it was available in large supply from nurseries. 5C has since declined in favor because its performance varies so greatly with site. It grows well in moist fertile sites where scions can become quite vigorous; however, in sites where water supply is limited, even temporarily, scion growth suffers. Drought in young plantings can delay training and vine development, while drought in mature vineyards can result in substantial leaf loss and even fruit shriveling. In some heavy soils (clays and clay loams) it appears to be a good choice. Until about 1990, some selections of Teleki 5C were erroneously labeled "SO4." European comparisons have shown little difference in performance between 5C and SO4. UC nematologist Mike McKenry reports that 5C has the broadest nematode tolerance of any phylloxera-resistant rootstock.

In Amador (Table 33), under non-irrigated conditions, 5C was visually one of the most severely affected by water stress, suffering leaf loss and berry shrivel. Only 420A showed symptoms as routinely as 5C. Low cluster weight, despite having average numbers of berries per cluster, may be a sign of berry shrivel. 5C performed well in the poorly drained vineyard in Lake County (Table 4) compared to other rootstocks but, of course, one would be better advised to properly drain a site rather than choose a rootstock for that condition.

**Kober 5BB** has a relatively limited history of use in California. It seems to be more drought tolerant than either 5C or 420A but less so than 110R and St. George. Further experience will be required to show where it fits in the rootstock picture. Like 5C, it seems to perform well on heavy soils. However, several cases have arisen where vines on 5BB have died from what was diagnosed as *Phytophthora* crown and root rot. Growers having sites prone to standing water or with a history of *Phytophthora* should avoid using 5BB. California selections of 5A have been shown by genetic analysis to be identical to 5BB.

**420A Mgt** is a low to moderate vigor rootstock. Despite being of similar parentage as 5C and 5BB, it is by far the least vigorous. It can be more difficult to root and graft, so vines may cost more as a result. It may prove to be most useful in high density plantings or on rich soils where reduced growth is desired. In conditions where growth reduction was more than predicted or desired, vineyard managers report that 420A requires more water and fertilization to achieve growth similar to other rootstocks and it is susceptible to potassium deficiency.

In the most fertile site and with a vigorous scion (Sacramento Delta Cabernet, Table 15), 420A performed better than in almost any other situation, producing 1.1 kg/m prunings, but still about 10% less than other rootstocks. In virtually all other sites, 420A was among the weakest rootstocks. The yield of 420A can be maintained by retaining a number of buds similar to other rootstocks but the growth that year suffers and the yield:prunings ratio to values high enough to cause concern.

**SO4** (Selection Oppenheim 4) received its name as a selection of the Oppenheim research station in Germany. It is the least well known of this parentage in California. International sources report that it responds similar to Teleki 5C but there is no experience with it in our trials.

### *Vitis riparia* x *V. rupestris* hybrids

**3309 Couderc** is a moderately vigorous rootstock. It appears to be a good candidate for closer spacing where no particular site limitation can be seen. It has virtually no resistance to nematodes. Its reputation has suffered because of its sensitivity to latent viruses (or virus-like diseases) when grafted to non-certified field selections of scion wood, although this sensitivity is found to some degree in almost all rootstocks. In non-irrigated sites it has performed better than its reputation would suggest, however, supplementary irrigation is recommended, particularly in locations prone to hot weather spells after veraison in order to prevent leaf loss and fruit sunburning prior to harvest.

**101-14Mgt** has moderate vigor, similar to or slightly greater than 3309C. Experience in Australia found 101-14 to have substantial nematode resistance and, from that point of view alone, it merits further testing in California. It is now one of the most widely used rootstocks, generally in valley floor sites where deep soils would encourage too much growth in other rootstocks.

It performed relatively poorly in the Napa (Rutherford) site may be an indicator that it does not tolerate drought well, and this should be further investigated. 101-14 was not in any other trial that was designed to be deficit-irrigated. Not considering the phylloxera-afflicted AXR, 101-14 had the fewest and lightest clusters and despite the low crop was the slowest to ripen. While there is no current usage pattern to suggest that the rootstock is being used in deficit irrigated conditions, care should be taken until this particular concern can be better understood.

### *V. berlandieri* x *V. rupestris* hybrids

**110 Richter** can be recommended for hillsides or non-irrigated sites where water stress is likely. In these sites, 110R generally outyields St. George and has a better yield:prunings ratio. In deep, fertile sites it can be overly vigorous. This has resulted in a reputation for vegetative wines, an outcome which is more likely due to an indirect effect of large canopy size rather than a direct rootstock effect. On very heavy soils, some growers report that 110R has shown apparent potassium deficiency, although this needs to be further investigated for confirmation.

**1103 Paulsen** and **140 Ruggeri** were both selected in Sicily and are both prized worldwide for their drought resistance. Experience and data show that both are highly vigorous, more so than 110R. In the Sacramento Delta Chardonnay trial (Table 10) it has among the highest yield and highest pruning wt (1.0 kg/m) and in the final year of the trial (Table 14) was the only rootstock with yield:prunings ratio under 8. Although planted two years later in the non-irrigated Amador trial (Table 33), 1103P became the highest yielding and largest vine in the trial, slightly ahead of 110R. Experience from another AVF/V/C/CRC-sponsored trial (Rootstock Interaction), showed that 140Ru is as vigorous and drought-resistant as 1103P, if not slightly more.

### Species selections

**St. George** (also known as Rupestris du Lot) is a rootstock with a long history of use in California, traditionally used in non-irrigated vineyards. Although it is not drought-resistant *per se*, it is reported to avoid water stress by developing a deep root system. Therefore, it should not be used in soils where restrictions prevent deep rooting. St. George typically has a low yield:prunings ratio, usually because of increased growth and lower yield due to reduced fruitset. St. George is generally avoided for small clustered varieties, such as Pinot noir or Chardonnay, or in varieties with a tendency for bloomtime shatter, such as Merlot. Australian researchers rate St. George's phylloxera resistance as insufficient because of the high populations it supports. However, worldwide there are no reports of its failure, Australia included.

**Riparia Gloire** has recently been re-introduced into the California certification program. What was previously listed as Riparia Gloire was found to be 1616C (see below). Riparia Gloire has a reputation for low vigor even in fertile sites but little is known about the performance of this rootstock under conditions of heat spikes and high evaporative demand, as occurs occasionally in California, even in cool regions such as Carneros.

#### **Other rootstocks**

**1616C** is reputed to be a low vigor rootstock, reflecting its *riparia* parentage. However, in one particularly fertile site with ample water and with Cabernet Sauvignon as the scion, it has shown above-average growth and yield. Confusion surrounds the correct identity of 1616C in California and apparently in France as well where multiple phenotypes exist. The second author (A.W.) found that 1616C is resistant to nematodes, increasing interest in it for a wider range of sites.

**VR O39-16** is recommended only for sites in which the fanleaf degeneration complex is found (i.e., grapevine fanleaf virus and its nematode vector, *Xiphinema index*). Although it is one-half *vinifera*, O39-16 has thus far not supported phylloxera in laboratory and greenhouse tests. For fanleaf sites, there is no alternative recommendation. VR O43-43, also originally released for fanleaf sites, is now known to be less tolerant of fanleaf than O39-16 and O43-43 has failed to phylloxera in the field. Growth and yield of O39-16 was highest in the Napa Rutherford trial (Table 28) and second highest in Mendocino (Table 40)

**Dog Ridge and Ramsey (Salt Creek)** are rootstocks prized for their resistance to rootknot nematode in warm interior valleys. These two rootstocks can be highly vigorous. In coastal locations growers who wish to control growth and crop for the premium wine market should consider other rootstocks.

**Freedom** was promoted in the 1990's for coastal and northern San Joaquin Valley vineyards primarily because it was widely available. As indicated previously, the parents are not fully known. One declining Freedom vineyard has been discovered, with high populations of phylloxera present and is still being investigated. The resistance is not durable enough to support a recommendation when phylloxera is the target soil pest. Freedom has been singled out for criticism because of a reputed problem with high juice K. In our trials it was generally no higher than other widely used rootstocks such as 110R, 11103P and St George (in Cabernet Sauvignon, Tables 15 and 18), although in one case it was the highest (Chardonnay, Table 10) and in another the lowest (Zinfandel, Table 21).

**Harmony** has failed to phylloxera at one location in the North Coast and must therefore be avoided, except for sandy soils rootknot nematodes are a problem.

#### **Rootstocks not recommended**

**AXR#1, 1202 Couderc, 41B Mgt, Fercal and 1045 Paulsen** all have significant *vinifera* in their parentage. Their phylloxera resistance is either known to be inadequate or is suspect. Rootstocks in this group, especially AXR#1, cannot be recommended for use **anywhere** in California, even in locations where phylloxera has not yet been discovered. The rootstock 1202C is still recommended in several countries, even those where use of AXR#1 has been discontinued. This implies that the phylloxera resistance is higher than AXR#1, however, 1202C has no attributes which compel us to use it. Recommendations in France for the use of 41B and Fercal are entirely driven by the requirement for limestone tolerance. In the absence of that condition, there is no compelling reason to use them in California.

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<b>Table 1. List of rootstocks, parentage and breeder and their suitability for phylloxera resistance. Compiled by M.A. Walker.</b>		
Rootstock	Parentage	Breeder
<b>Recommended for phylloxera resistance</b>		
Riparia Gloire	riparia	Viala, Portalis/Montpellier, ca 1860's
St. George	rupestris	Sijas of Montpellier, ca 1860's
3309 C	riparia x rupestris	Couderc 1881
101-14 Mgt	riparia x rupestris	Millardet 1882
Schwarzmann	riparia x rupestris	Schwarzmann, 1891
44-53 Malegue	riparia x (cordifolia x rupestris)	Malegue
99R	berlandieri x rupestris	Richter 1889
110R	berlandieri x rupestris	Richter 1889
140 Ruggeri	berlandieri x rupestris	Ruggeri, 1897
775 Paulsen	berlandieri x rupestris	Paulsen, 1894
779 Paulsen	berlandieri x rupestris	Paulsen, 1894
1103 Paulsen	berlandieri x rupestris	Paulsen, 1895
1447 Paulsen	berlandieri x rupestris	Paulsen, 1896
SO4	berlandieri x riparia	Teleki group 4A, 1896
8B	berlandieri x riparia	Teleki, 1896
5A	berlandieri x riparia	Teleki, 1896
5BB	berlandieri x riparia	Kober from Teleki 5A
5C	berlandieri x riparia	A. Teleki, from 5A, 1922
125AA	berlandieri x riparia	Kober from Teleki 5A?
420 A Mgt	berlandieri x riparia	Millardet, 1887
225 Ru	berlandieri x riparia	Ruggeri, 1897
Cosmo 2	berlandieri x riparia	Cosmo from 8B, 1931
Cosmo 10	berlandieri x riparia	Cosmo from 8B, 1931
Boerner	riparia x cinerea	Boerner (released by Becker 1988)
1616 C	solonis x riparia	Couderc 1881
<b>Probably resistant to phylloxera (but little information is available on performance)</b>		
187G	rupestris	Geiseheim
3306 C	riparia x rupestris	Couderc 1881
106-8 Mgt	riparia x (cordifolia x rupestris)	Millardet 1882
44R	berlandieri x rupestris	Richter
57R	berlandieri x rupestris	Richter
Vivet 15	rupestris x berlandieri	? from Neustadt
161-49 C	berlandieri x riparia	Couderc 1888
157-11 C	berlandieri x riparia	Couderc 1889

Gravesac	161-49C x 3309 C	Pouget/Ottenwaelter, 1985
33 EM	berlandieri x riparia	Foex 1899
34 EM	berlandieri x riparia	Foex 1899
216-3 Castel	solonis x rup (1616 x St. Geo)	Castel, 1880's
<b>Questionable Phylloxera Resistance</b> (rootstocks show some resistance to phylloxera but long term durability of this resistance is unknown)		
Ramsey (Salt Creek)	champinii	Species selection (Munson?) 1900
Dog Ridge	champinii	Munson selection 1900
Freedom	op 1613 C x op champinii	Weinberger/Harmon, 1967
VR O39-16	vinifera x rotundifolia	Olmo, 1948, patent 1988
<b>Not Recommended for Phylloxera Resistance</b>		
41 B	vinifera x berlandieri	Millardet 1882
333 EM	vinifera x berlandieri	Foex 1883
Vidal 1	vinifera x berlandieri?	Vidal
Evex 13-5	probable vin x berlandieri	Fernandez de Bobadilla, 1943
AXR#1	vinifera x rupestris	Ganzin, 1879
AXR#2	vinifera x rupestris	Ganzin, 1879
AXR#9	vinifera x rupestris	Ganzin, 1879
1202 C	vinifera x rupestris	Couderc, 1883
93-5 C	vinifera x rupestris	Couderc, 1889
1045 P	berlandieri x AXR#1	Paulsen, 1895
Fercal	(berl x vin) x 333 EM	Pouget/Ottenwaelter, 1983
196-17 Castel	1202 x Riparia Gloire	Castel, late 1800's
1613 C	solonis x Othello (lab x rip x vin)	Couderc 1881
Lenoir (Jacquez)	Bourquiniana (aest x cin x vin)	?
Harmony	op 1613 C x op champinii	Weinberger/Harmon, 1966
VR O43-43	vinifera x rotundifolia	Olmo, 1948, patent 1988
171-6	rufotomentosa x vinifera	Lider, 1966

**Table 2. DETAILED DESCRIPTION OF AVF ROOTSTOCK TRIAL SITES**

Site Location Variety	Plot				Data Collection			Soil		Site Condition
	Year Plant -ed	Spacing r x v in ft (m)	Design	Repli- cations	Years Collect- ed	Stable Years	Status	Type	Depth (in)	
Sacramento Delta Chardonnay	1990	10 x 9 (3.0 x 2.7)	Randomized Complete Block	5	1992 - 97	1994 - 97	concluded 1997	Egbert clay (sandy loam variant)	48	
Sacramento Delta Cab. Sauv.	1990	10 x 10 (3.0 x 3.0)	"	5	1992 - 98	1994 - 98	concluded 1998	Tinnin loam sand	>66	
Amador Zinfandel (1)	1987	10 x 6 (3.0 x 1.8)	"	5	1990 - 2000	1995 - 2000	concluded 1998	Sierra coarse sandy loam		no irrigation
Amador Zinfandel (2)	1990	10 x 6 (3.0 x 1.8)	"	5	1992 - 99	1994 - 99	concluded 1999	Sierra coarse sandy loam	>72	
Mendocino Cab. Sauv.	1990	12 x 8 (3.7 x 2.4)	"	5	1993 - 98	1995 - 98	concluded 1998	Russian loam, gravelly substratum	32	various nematodes
Lake Sauv. Blanc	1987	10 x 6 (3.0 x 1.8)	"	5	1990 - 94	1990 - 94	concluded 1994	Clear Lake clay		poor drainage

Site Location Variety	Plot			Data Collection			Soil			
	Year Plant ed	Spacing (r x v)	Design	Repli- cations	Years Collecte d	Stable Years	Status	Type	Depth (in)	Site Condition
Monterey (1) Chenin blanc	1986	12 x 7 (3.7 x 2.1)	Randomize d complete block		1988-94	1988- 94	Concluded 1994	Danville gravelly loam		Phylloxera
Monterey (2) Chardonnay	1988	9 x 5 (2.7 x 1.5)	"		1992-96	1992- 96	Concluded 1996	Metz loamy sand		Rootknot, Ring nematodes
Monterey (3) Chardonnay	1988	9.6 x 7 (2.9 x 2.1)	"		1993-98	1993- 98	Ongoing	Arroyo Seco gravelly sandy loam		Phylloxera, Rootknot nematodes
Monterey (4) Chardonnay	1990	12 x 7 (3.7 x 2.1)	"		1993-98	1993- 98	Ongoing	Arroyo Seco gravelly sandy loam	20	Rootknot nematodes
Monterey (5) Cab. Sauv.	1990	9.6 x 6 (2.9 x 1.8)	"		1994-98	1994- 98	Ongoing	Garey sandy Loam		Rootknot nematodes
Monterey (6) Cab. Sauv.	1990	11 x 7 (3.4 x 2.1)	"		1994-98	1994- 98	Ongoing	Chualar loam		None apparent

Site Location	Plot				Data Collection			Soil		Site Condition
Variety	Year Planted	Spacing (r x v)	Design	Repliations	Years Collected	Stable Years	Status	Type	Depth (in)	Site Condition
Napa, Rutherford Cab. Sauv.	1990	10 x 6 (3.0 x 1.8)	"	8	1994 - 97	1994 - 97	Concluded 1997	Cortina very gravelly loam	60	type "B" phylloxera
Napa, Oakville  Cab. Sauv.	1991	11 x 7 (3.4 x 2.1)		3	1995-98		Concluded			
Sonoma Chalk Hill Merlot	1992	12 x 6 (3.7 x 1.8)	"	5	1996 - 98	1998	Concluded In 1998	Clear Lake / Haire clay	30 - 45	potassium deficient
Sonoma, Sonoma Chardonnay	1989	12 x 8 (3.7 x 2.4)	Random- ized complete block	4	1993 - 98	1993 - 98	Concluded in 1998	Cortina very gravelly sandy loam / Yolo gravelly loam	>72	Phylloxera
San Joaquin, Lodi Cab. Sauv.	1985	12 x 7 (3.7 x 2.1)	Completely random	4 to 6	1989-94	1990- 94	Concluded in 1994			X. index GFLV

**Table 3 Rootstock List by trial.**

Site Location Variety	latitude	longitude	5C	5BB	420A	110R	1103P	140 Ru	101-14	3309	St George	44-53	1616	O39-16	O43-43	Harmony	Freedom	Ramsey	Other
Sacramento Delta Chardonnay	38.33	121.51	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Sacramento Delta Cab. Sauv.	38.34	121.52	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Amador Zinfandel (2)	38.51	120.80	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Amador Zinfandel (1)			"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Mendocino Cab. Sauv.	39.08	123.16	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
Lake Sauv. Blanc			"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"

Site Location Variety	latitude	longitude	5C	5BB	420A	110R	1103P	140 Ru	101-14	3309	St George	44-53	1616	O39-16	O43-43	Harmony	Freedom	Ramsey	Other
Monterey (1) Chenin blanc			"	"		"				"	"					"	"		5A
Monterey (2) Chardonnay			"	"		"								"	"	"	"		Schwarz- mann
Monterey (3) Chardonnay			"	"		"				"						"	"		
Monterey (4) Chardonnay			"	"										"	"	"	"		Schwarz- mann
Monterey (5) Cab. Sauv.	36.15	121.10	"	"		"				"				"		"	"		
Monterey (6) Cab. Sauv.	36.06	121.01	"	"		"				"				"		"	"	"	
Sonoma Merlot			"	"	"	"	"	"	"	"		"							
Sonoma Chardonnay	38.49	122.79	"	"	"	"	"		"	"	"			"					1045P, 779P, 225Ru
San Joaquin Cab. Sauv.			"								"			"	"	"		"	



Site Location Variety	latitude	longitude	5C	5BB	420A	110R	1103P	140 Ru	101-14	3309	St George	44-53	1616	O39-16	O43-43	Harmony	Freedom	Ramsey	Other
Napa Rutherford Cab. Sauv.	38.46	122.38	"		"	"	"		"	"			"	"		"	"		
Napa Oakville Cab. Sauv.			"	"	"	"	"	"	"	"	"		"	"	"	"	"		

## Lake County Rootstock Trial

Scion: Sauvignon blanc

Years conducted: 1990-1994

Years reported: 1990-1994

Rootstocks:

5C  
420A  
110 R  
101-14  
3309 C  
St George  
AxR#1

Site conditions: This site was characterized by a very heavy clay soil with poor water infiltration. In years with significant late spring rains, standing water was present at budburst. Budburst was erratic and growth was irregular but the effect was highly variable by rootstock. The site was established prior to Type B phylloxera and therefore included AXR#1.

Figure 1.

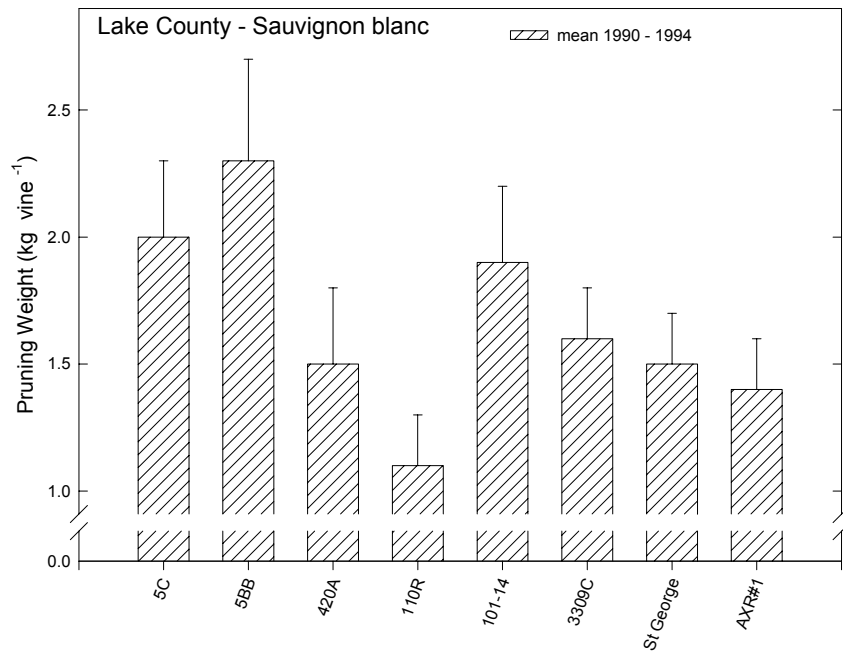
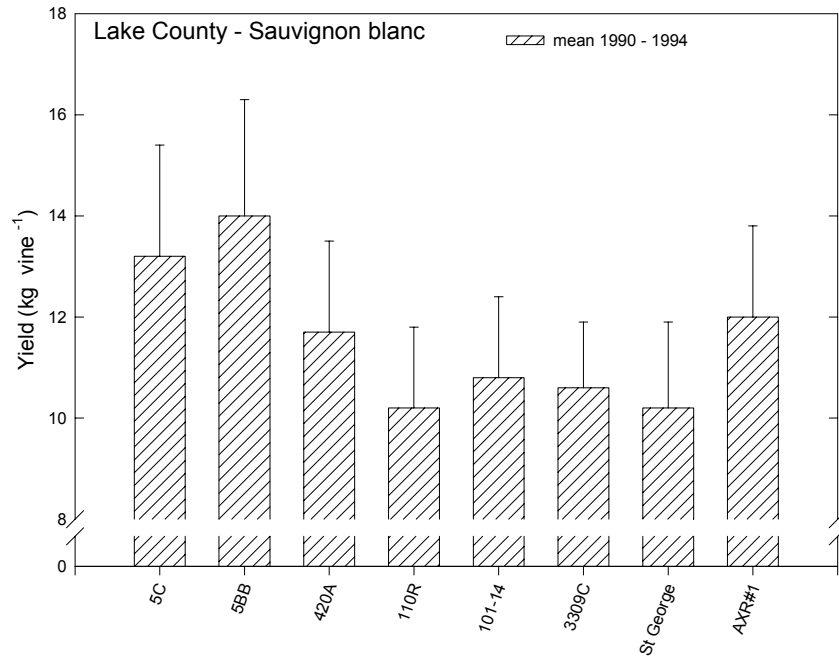


Table 4 - Lake County – Sauvignon blanc/ Rootstock Trial, 1990 - 1994

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number (1991 – 1994)	Shoot Weight (1991 – 1994) (g)	Yield : Pruning Weight
5C	13.2 ± 2.2	2.0 ± 0.3	51 ± 1	43 ± 3	6.3 ± 1.1
5BB	14.0 ± 2.3	2.3 ± 0.4	54 ± 1	47 ± 4	5.8 ± 1.0
420A	11.7 ± 1.8	1.5 ± 0.3	45 ± 1	33 ± 3	7.6 ± 1.0
110 R	10.2 ± 1.6	1.1 ± 0.2	40 ± 1	29 ± 3	9.2 ± 1.5
101-14	10.8 ± 1.6	1.9 ± 0.3	46 ± 1	43 ± 3	5.4 ± 1.0
3309 C	10.6 ± 1.3	1.6 ± 0.2	45 ± 1	35 ± 2	6.7 ± 0.8
St. Geo	10.2 ± 1.7	1.5 ± 0.2	46 ± 1	34 ± 3	6.5 ± 1.0
AxR#1	12.0 ± 1.8	1.4 ± 0.2	47 ± 1	32 ± 3	8.2 ± 1.2

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	118 ± 12	109 ± 10	82 ± 12	1.4 ± 0.1
5BB	125 ± 12	110 ± 10	84 ± 11	1.4 ± 0.1
420A	109 ± 10	106 ± 10	86 ± 12	1.3 ± 0.1
110 R	103 ± 10	100 ± 10	81 ± 11	1.3 ± 0.0
101-14	102 ± 9	105 ± 9	82 ± 10	1.3 ± 0.1
3309 C	103 ± 8	104 ± 9	82 ± 9	1.3 ± 0.0
St. Geo	103 ± 13	99 ± 9	84 ± 12	1.3 ± 0.1
AxR#1	114 ± 10	103 ± 9	91 ± 13	1.2 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	22.5 ± 0.7	5.4 ± 1.1	3.41 ± 0.06
5BB	22.6 ± 0.6	5.3 ± 1.1	3.42 ± 0.06
420A	22.1 ± 0.6	5.2 ± 1.0	3.37 ± 0.04
110 R	22.8 ± 0.7	5.0 ± 1.0	3.39 ± 0.04
101-14	23.8 ± 0.4	5.3 ± 1.1	3.44 ± 0.06
3309 C	23.5 ± 0.6	5.2 ± 1.1	3.45 ± 0.07
St. Geo	22.4 ± 0.9	5.0 ± 1.0	3.45 ± 0.05
AxR#1	21.8 ± 0.6	5.0 ± 1.0	3.34 ± 0.04

Table 5 - 1990  
 Lake County – Sauvignon blanc/ Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	7.5 ± 0.8	2.3 ± 0.2	3.4 ± 0.6
5BB	8.3 ± 0.6	2.4 ± 0.3	3.7 ± 0.5
420A	10.7 ± 0.9	2.1 ± 0.2	5.4 ± 0.7
110 R	9.0 ± 0.6	1.4 ± 0.1	6.5 ± 0.7
101-14	7.3 ± 0.5	2.1 ± 0.2	3.5 ± 0.3
3309 C	7.6 ± 0.4	2.1 ± 0.2	3.8 ± 0.4
St. Geo	6.9 ± 0.7	1.9 ± 0.1	3.9 ± 0.7
AxR#1	10.0 ± 0.6	1.5 ± 0.1	6.9 ± 0.7

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	88 ± 6	84 ± 4	71 ± 6	1.2 ± 0.0
5BB	91 ± 7	91 ± 3	75 ± 5	1.2 ± 0.0
420A	107 ± 4	100 ± 6	86 ± 6	1.2 ± 0.0
110 R	97 ± 4	92 ± 3	78 ± 4	1.2 ± 0.0
101-14	86 ± 3	85 ± 4	71 ± 5	1.2 ± 0.0
3309 C	86 ± 1	88 ± 4	73 ± 4	1.2 ± 0.0
St. Geo	83 ± 7	83 ± 2	73 ± 3	1.2 ± 0.0
AxR#1	99 ± 4	100 ± 3	94 ± 7	1.1 ± 0.0

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	24.6 ± 0.4	6.3 ± 0.2	3.59 ± 0.04
5BB	24.7 ± 0.3	6.8 ± 0.3	3.54 ± 0.02
420A	23.5 ± 0.4	6.5 ± 0.2	3.47 ± 0.04
110 R	24.7 ± 0.3	5.8 ± 0.2	3.49 ± 0.01
101-14	25.0 ± 0.2	6.3 ± 0.2	3.53 ± 0.02
3309 C	25.2 ± 0.1	6.5 ± 0.3	3.56 ± 0.03
St. Geo	24.7 ± 0.0	5.9 ± 0.2	3.58 ± 0.03
AxR#1	23.4 ± 0.4	5.6 ± 0.1	3.48 ± 0.03

Table 6 - 1991  
Lake County – Sauvignon blanc/ Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	18.9 ± 1.5	2.2 ± 0.2	50 ± 1	43 ± 3	8.8 ± 0.3
5BB	19.8 ± 1.4	2.4 ± 0.3	52 ± 3	46 ± 3	8.4 ± 0.4
420A	18.4 ± 1.7	1.8 ± 0.2	47 ± 2	38 ± 3	10.3 ± 0.3
110 R	16.8 ± 1.0	1.3 ± 0.1	41 ± 1	31 ± 3	13.8 ± 1.0
101-14	17.1 ± 1.8	2.2 ± 0.3	49 ± 1	44 ± 4	8.1 ± 0.3
3309 C	15.5 ± 0.9	1.8 ± 0.2	47 ± 1	40 ± 5	8.8 ± 0.8
St. Geo	15.9 ± 1.1	1.7 ± 0.2	49 ± 2	34 ± 3	9.5 ± 0.6
AxR#1	17.6 ± 1.4	1.4 ± 0.1	47 ± 2	30 ± 3	12.4 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	145 ± 8	130 ± 6	125 ± 5	1.2 ± 0.0
5BB	145 ± 9	138 ± 4	120 ± 8	1.2 ± 0.0
420A	140 ± 10	133 ± 4	125 ± 7	1.1 ± 0.0
110 R	135 ± 6	126 ± 4	117 ± 5	1.2 ± 0.0
101-14	135 ± 8	127 ± 10	113 ± 8	1.2 ± 0.1
3309 C	126 ± 3	130 ± 5	102 ± 5	1.2 ± 0.0
St. Geo	139 ± 9	116 ± 5	125 ± 7	1.1 ± 0.0
AxR#1	138 ± 8	123 ± 5	135 ± 8	1.0 ± 0.0

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	20.8 ± 0.3	5.1 ± 0.1	3.53 ± 0.03
5BB	21.5 ± 0.6	4.6 ± 0.1	3.63 ± 0.04
420A	20.4 ± 0.2	5.3 ± 0.1	3.49 ± 0.03
110 R	21.1 ± 0.2	4.7 ± 0.2	3.50 ± 0.02
101-14	23.7 ± 0.9	5.0 ± 0.2	3.65 ± 0.04
3309 C	24.2 ± 0.5	4.8 ± 0.1	3.70 ± 0.04
St. Geo	21.6 ± 0.4	4.7 ± 0.2	3.60 ± 0.02
AxR#1	20.5 ± 0.3	5.4 ± 0.1	3.42 ± 0.02

Table 7 - 1992  
Lake County – Sauvignon blanc/ Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	19.6 ± 1.4	2.1 ± 0.2	55 ± 2	39 ± 3	9.4 ± 0.6
5BB	20.3 ± 0.5	2.6 ± 0.2	56 ± 2	46 ± 4	8.2 ± 0.6
420A	13.7 ± 1.8	1.5 ± 0.2	47 ± 2	31 ± 3	9.5 ± 1.1
110 R	10.7 ± 1.4	0.9 ± 0.1	40 ± 1	23 ± 3	11.9 ± 1.4
101-14	12.1 ± 1.9	1.8 ± 0.4	43 ± 1	42 ± 8	7.0 ± 0.4
3309 C	12.2 ± 1.8	1.7 ± 0.2	46 ± 1	36 ± 3	7.6 ± 1.4
St. Geo	13.5 ± 0.7	1.8 ± 0.1	45 ± 2	39 ± 2	7.6 ± 0.4
AxR#1	16.1 ± 1.4	1.7 ± 0.2	50 ± 1	35 ± 3	9.2 ± 0.2

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	148 ± 8	133 ± 5	89 ± 5	1.5 ± 0.1
5BB	158 ± 4	129 ± 2	93 ± 5	1.4 ± 0.1
420A	116 ± 12	116 ± 5	92 ± 4	1.3 ± 0.1
110 R	98 ± 11	108 ± 6	84 ± 5	1.3 ± 0.0
101-14	99 ± 11	123 ± 5	94 ± 4	1.3 ± 0.1
3309 C	105 ± 13	114 ± 4	100 ± 7	1.2 ± 0.1
St. Geo	120 ± 5	112 ± 3	88 ± 5	1.3 ± 0.1
AxR#1	132 ± 8	121 ± 5	99 ± 6	1.2 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	20.9 ± 0.3	7.1 ± 0.2	3.36 ± 0.01
5BB	20.8 ± 0.3	7.1 ± 0.2	3.35 ± 0.01
420A	22.6 ± 0.8	7.0 ± 0.2	3.37 ± 0.03
110 R	23.3 ± 0.6	7.0 ± 0.2	3.35 ± 0.02
101-14	24.4 ± 0.5	7.8 ± 0.2	3.42 ± 0.04
3309 C	23.7 ± 0.7	7.4 ± 0.2	3.38 ± 0.04
St. Geo	22.2 ± 0.4	6.8 ± 0.1	3.42 ± 0.01
AxR#1	21.4 ± 0.2	7.1 ± 0.1	3.27 ± 0.02

Table 8 - 1993  
Lake County – Sauvignon blanc/ Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	9.9 ± 0.8	0.9 ± 0.2	52 ± 3	36 ± 5	6.0 ± 1.0
5BB	10.3 ± 0.4	0.9 ± 0.1	53 ± 2	36 ± 2	5.5 ± 0.5
420A	7.6 ± 0.7	0.5 ± 0.1	42 ± 3	24 ± 3	8.6 ± 1.3
110 R	7.0 ± 0.5	0.4 ± 0.1	36 ± 2	22 ± 2	9.3 ± 1.2
101-14	8.1 ± 0.8	0.7 ± 0.2	44 ± 4	34 ± 8	6.3 ± 1.1
3309 C	8.7 ± 0.7	0.6 ± 0.1	45 ± 3	26 ± 3	7.9 ± 1.0
St. Geo	8.0 ± 0.6	0.5 ± 0.1	45 ± 3	24 ± 3	7.6 ± 0.7
AxR#1	8.0 ± 0.7	0.5 ± 0.1	46 ± 4	23 ± 3	8.1 ± 0.8

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	123 ± 2	82 ± 7	47 ± 3	1.7 ± 0.1
5BB	136 ± 3	76 ± 2	47 ± 1	1.6 ± 0.0
420A	116 ± 6	65 ± 3	43 ± 2	1.5 ± 0.1
110 R	116 ± 5	60 ± 3	42 ± 1	1.4 ± 0.1
101-14	109 ± 7	75 ± 4	47 ± 4	1.6 ± 0.1
3309 C	118 ± 6	72 ± 3	49 ± 1	1.5 ± 0.0
St. Geo	116 ± 5	68 ± 3	45 ± 1	1.5 ± 0.1
AxR#1	121 ± 5	66 ± 4	45 ± 2	1.4 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	22.5 ± 0.5	7.8 ± 0.4	3.29 ± 0.02
5BB	22.4 ± 0.3	7.2 ± 0.2	3.31 ± 0.01
420A	20.6 ± 0.8	6.5 ± 0.4	3.29 ± 0.02
110 R	20.9 ± 0.6	6.5 ± 0.3	3.32 ± 0.04
101-14	22.4 ± 0.5	6.8 ± 0.5	3.35 ± 0.04
3309 C	20.9 ± 0.4	6.5 ± 0.3	3.35 ± 0.02
St. Geo	19.3 ± 0.7	6.8 ± 0.3	3.35 ± 0.04
AxR#1	20.4 ± 0.5	5.9 ± 0.3	3.28 ± 0.02



Table 9 - 1994  
 Lake County – Sauvignon blanc/ Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	10.3 ± 0.7	2.7 ± 0.4	49 ± 1	54 ± 7	4.1 ± 0.4
5BB	11.1 ± 0.6	3.5 ± 0.3	57 ± 3	61 ± 4	3.3 ± 0.2
420A	8.0 ± 1.2	1.9 ± 0.4	46 ± 1	40 ± 8	4.4 ± 0.3
110 R	7.6 ± 0.8	1.7 ± 0.2	44 ± 0	39 ± 5	4.5 ± 0.2
101-14	9.5 ± 0.8	2.5 ± 0.6	46 ± 2	51 ± 11	2.0 ± 0.3
3309 C	9.1 ± 0.9	1.7 ± 0.2	44 ± 1	40 ± 6	5.5 ± 0.6
St. Geo	6.8 ± 0.9	1.8 ± 0.3	44 ± 1	39 ± 7	4.0 ± 0.3
AxR#1	8.2 ± 0.7	1.8 ± 0.3	47 ± 2	39 ± 6	4.6 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	88 ± 4	116 ± 4	78 ± 2	1.5 ± 0.0
5BB	95 ± 3	116 ± 3	83 ± 3	1.4 ± 0.0
420A	69 ± 6	114 ± 14	84 ± 7	1.3 ± 0.1
110 R	69 ± 7	113 ± 4	84 ± 5	1.4 ± 0.0
101-14	81 ± 4	117 ± 11	86 ± 4	1.4 ± 0.1
3309 C	81 ± 8	115 ± 3	84 ± 2	1.4 ± 0.0
St. Geo	57 ± 7	118 ± 7	91 ± 3	1.3 ± 0.1
AxR#1	78 ± 4	106 ± 3	81 ± 2	1.3 ± 0.0

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	23.6 ± 0.1	0.9 ± 0.0	3.29 ± 0.02
5BB	23.6 ± 0.2	0.9 ± 0.0	3.28 ± 0.01
420A	23.4 ± 0.2	0.8 ± 0.0	3.23 ± 0.01
110 R	24.2 ± 0.1	0.8 ± 0.0	3.28 ± 0.01
101-14	23.6 ± 0.1	0.7 ± 0.2	3.25 ± 0.01
3309 C	23.8 ± 0.2	0.8 ± 0.0	3.27 ± 0.01
St. Geo	24.1 ± 0.2	0.8 ± 0.0	3.30 ± 0.02
AxR#1	23.1 ± 0.1	0.8 ± 0.0	3.24 ± 0.01

## Sacramento Delta Rootstock Trial

Scion: Chardonnay

Years conducted: 1992-1997

Years reported: 1994-1997

### Rootstocks:

5C  
5BB  
420A  
110 R  
1103 P  
101-14 Mgt  
3309 C  
St. George  
44-53 Mgt  
1616 C  
O39-16  
Harmony  
Freedom  
Ramsey

Site conditions: This soil type is characterized by an undulating hardpan at about 24 to 30 inches, therefore rootstock growth was not as strong as the companion Delta Cabernet Sauvignon trial (below). Yields were kept reasonably high by retaining about 12 shoots/m even though growth of the weakest rootstocks was relatively low at 0.3 to 0.5 kg/m. This resulted in more than half of the rootstocks having unusually high Y:P ratios, between 10 and 15 for the four year average, and increasing dramatically over the life of the trial.

Figure 2.

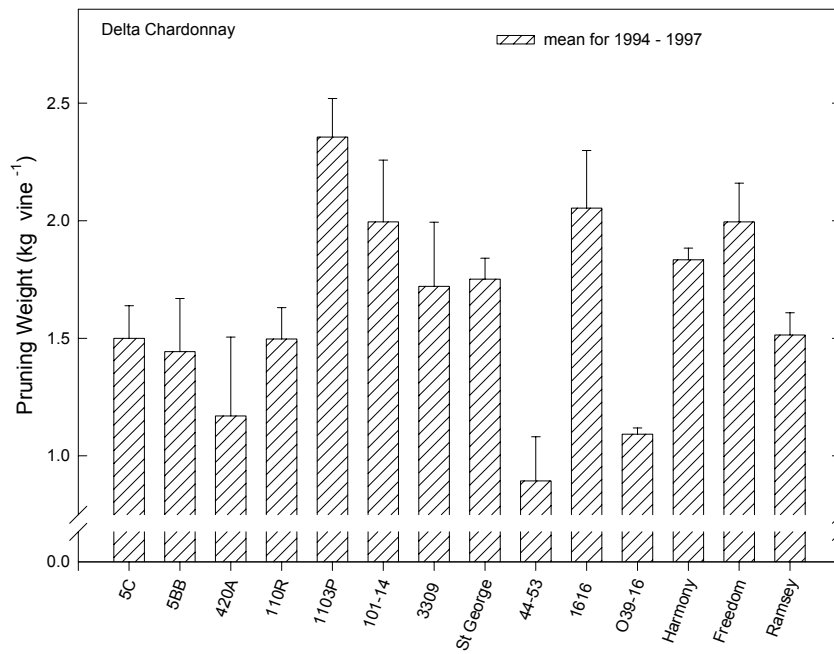
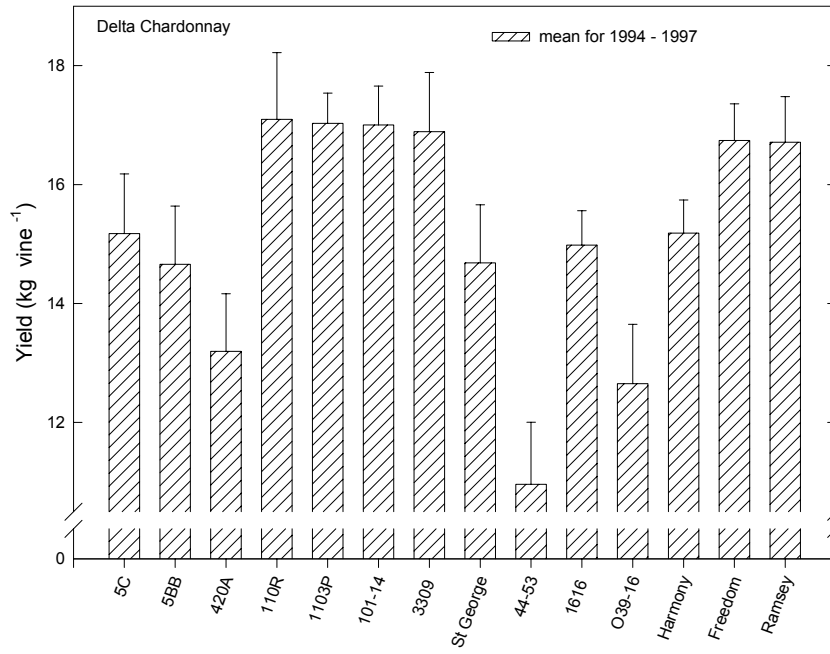


Table 10 - 1994 - 1997  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	15.2 ± 1.0	1.5 ± 0.1	33 ± 2	48 ± 8	11.0 ± 1.8
5BB	14.7 ± 1.0	1.4 ± 0.2	31 ± 1	48 ± 4	11.5 ± 2.1
420A	13.2 ± 1.0	1.2 ± 0.3	32 ± 1	37 ± 5	16.1 ± 4.5
110R	17.1 ± 1.1	1.5 ± 0.1	33 ± 2	47 ± 3	12.9 ± 2.1
1103P	17.0 ± 0.5	2.4 ± 0.2	37 ± 3	64 ± 2	7.5 ± 0.7
101-14	17.0 ± 0.7	2.0 ± 0.3	34 ± 2	61 ± 5	9.5 ± 1.3
3309	16.9 ± 1.0	1.7 ± 0.3	33 ± 2	54 ± 5	10.9 ± 1.8
St. Geo	14.7 ± 1.0	1.8 ± 0.1	32 ± 3	57 ± 4	9.0 ± 0.8
44-53	11.0 ± 1.0	0.9 ± 0.2	26 ± 2	35 ± 4	15.9 ± 3.7
1616	15.0 ± 0.6	2.1 ± 0.2	34 ± 2	63 ± 5	7.8 ± 0.9
O39-16	12.7 ± 1.0	1.1 ± 0.0	28 ± 4	43 ± 4	12.6 ± 1.3
Harmony	15.2 ± 0.6	1.8 ± 0.0	34 ± 2	55 ± 2	8.5 ± 0.5
Freedom	16.7 ± 0.6	2.0 ± 0.2	35 ± 4	58 ± 2	8.9 ± 1.1
Ramsey	16.7 ± 0.8	1.5 ± 0.1	32 ± 3	48 ± 2	11.7 ± 1.0

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	57 ± 6	271 ± 10	159 ± 6	1.7 ± 0.1
5BB	59 ± 2	254 ± 6	153 ± 4	1.7 ± 0.0
420A	57 ± 2	231 ± 6	152 ± 2	1.5 ± 0.1
110R	63 ± 3	276 ± 7	169 ± 4	1.6 ± 0.0
1103P	62 ± 2	282 ± 9	159 ± 5	1.8 ± 0.1
101-14	60 ± 2	290 ± 6	170 ± 4	1.7 ± 0.0
3309	62 ± 3	277 ± 7	166 ± 4	1.7 ± 0.1
St. Geo	58 ± 3	259 ± 7	156 ± 6	1.7 ± 0.1
44-53	49 ± 2	229 ± 2	153 ± 2	1.5 ± 0.1
1616	57 ± 2	266 ± 6	157 ± 5	1.7 ± 0.1
O39-16	51 ± 2	244 ± 4	148 ± 4	1.7 ± 0.1
Harmony	57 ± 2	270 ± 7	155 ± 4	1.8 ± 0.1
Freedom	61 ± 2	281 ± 8	158 ± 4	1.8 ± 0.1
Ramsey	60 ± 2	284 ± 8	165 ± 5	1.7 ± 0.1

Table 10 (cont) - 1994 - 1997  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (1995 – 1997) (ppm)
5C	22.8 ± 0.1	8.82 ± 0.29	3.37 ± 0.07	2560 ± 395
5BB	22.8 ± 0.1	8.80 ± 0.26	3.40 ± 0.06	2716 ± 451
420A	21.7 ± 0.3	8.49 ± 0.26	3.34 ± 0.07	2217 ± 268
110R	22.2 ± 0.4	9.21 ± 0.20	3.37 ± 0.06	2089 ± 175
1103P	22.8 ± 0.2	10.29 ± 0.27	3.40 ± 0.05	2327 ± 181
101-14	22.3 ± 0.1	9.06 ± 0.19	3.37 ± 0.06	2453 ± 359
3309	22.1 ± 0.2	9.22 ± 0.08	3.36 ± 0.06	2425 ± 292
St. Geo	22.7 ± 0.3	9.17 ± 0.13	3.40 ± 0.05	2351 ± 247
44-53	22.6 ± 0.3	8.45 ± 0.21	3.37 ± 0.06	2415 ± 227
1616	22.6 ± 0.3	9.15 ± 0.06	3.36 ± 0.04	2367 ± 207
O39-16	22.5 ± 0.2	8.50 ± 0.21	3.38 ± 0.05	2530 ± 331
Harmony	22.6 ± 0.2	8.96 ± 0.24	3.40 ± 0.06	2307 ± 193
Freedom	22.7 ± 0.2	10.04 ± 0.21	3.44 ± 0.06	3023 ± 579
Ramsey	22.2 ± 0.1	9.36 ± 0.26	3.36 ± 0.06	2311 ± 311

Table 11 - 1994  
Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	14.7 ± 0.6	1.8 ± 0.1	26 ± 0	70 ± 4	8.4 ± 0.9
5BB	15.1 ± 0.8	2.2 ± 0.0	29 ± 1	77 ± 2	6.9 ± 0.3
420A	10.8 ± 1.1	2.3 ± 0.0	32 ± 0	72 ± 1	4.7 ± 0.5
110R	16.8 ± 0.8	1.5 ± 0.2	26 ± 2	58 ± 3	11.5 ± 1.1
1103P	17.7 ± 0.9	1.8 ± 0.0	30 ± 1	61 ± 0	9.8 ± 0.5
101-14	17.1 ± 0.9	2.9 ± 0.1	29 ± 0	98 ± 4	6.0 ± 0.3
3309	16.3 ± 0.6	2.6 ± 0.0	29 ± 1	90 ± 2	6.2 ± 0.3
St. Geo	13.3 ± 0.9	2.1 ± 0.1	25 ± 0	82 ± 3	6.6 ± 0.6
44-53	9.4 ± 1.7	1.5 ± 0.1	24 ± 0	64 ± 2	6.1 ± 1.1
1616	14.6 ± 1.6	2.9 ± 0.1	29 ± 0	100 ± 3	5.0 ± 0.5
O39-16	13.4 ± 2.2	1.2 ± 0.0	16 ± 0	73 ± 3	11.3 ± 1.6
Harmony	15.3 ± 0.8	1.9 ± 0.1	29 ± 1	66 ± 2	8.2 ± 0.6
Freedom	17.6 ± 0.5	1.5 ± 0.1	24 ± 1	61 ± 3	12.5 ± 1.1
Ramsey	18.2 ± 1.3	1.3 ± 0.1	23 ± 1	54 ± 1	14.5 ± 0.8

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	55 ± 1	266 ± 9	165 ± 5	1.6 ± 0.1
5BB	57 ± 3	264 ± 12	169 ± 8	1.6 ± 0.0
420A	53 ± 2	197 ± 13	145 ± 8	1.4 ± 0.0
110R	58 ± 1	291 ± 10	184 ± 8	1.6 ± 0.1
1103P	61 ± 3	294 ± 11	176 ± 8	1.7 ± 0.0
101-14	57 ± 3	304 ± 10	185 ± 7	1.6 ± 0.0
3309	57 ± 1	286 ± 14	183 ± 9	1.6 ± 0.0
St. Geo	47 ± 4	284 ± 9	188 ± 5	1.5 ± 0.0
44-53	44 ± 5	214 ± 20	156 ± 14	1.4 ± 0.0
1616	52 ± 3	279 ± 15	183 ± 6	1.5 ± 0.1
O39-16	50 ± 7	262 ± 18	176 ± 8	1.5 ± 0.0
Harmony	54 ± 2	283 ± 7	169 ± 4	1.7 ± 0.1
Freedom	61 ± 1	289 ± 7	170 ± 5	1.7 ± 0.0
Ramsey	57 ± 3	316 ± 9	194 ± 4	1.6 ± 0.1

Table 11 (cont) - 1994  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	23.2 ± 0.2	9.3 ± 0.3	3.22 ± 0.02
5BB	22.9 ± 0.3	9.3 ± 0.2	3.27 ± 0.01
420A	22.5 ± 0.4	8.9 ± 0.0	3.22 ± 0.02
110R	23.3 ± 0.3	9.3 ± 0.1	3.27 ± 0.03
1103P	22.8 ± 0.3	10.7 ± 0.2	3.32 ± 0.01
101-14	22.4 ± 0.2	9.5 ± 0.1	3.27 ± 0.03
3309	22.6 ± 0.2	9.4 ± 0.1	3.24 ± 0.01
St. Geo	23.4 ± 0.1	9.0 ± 0.1	3.36 ± 0.01
44-53	23.0 ± 0.3	8.4 ± 0.3	3.28 ± 0.02
1616	23.1 ± 0.2	9.4 ± 0.2	3.28 ± 0.01
O39-16	21.9 ± 0.3	8.6 ± 0.4	3.26 ± 0.01
Harmony	22.8 ± 0.3	9.4 ± 0.3	3.28 ± 0.02
Freedom	23.0 ± 0.1	10.5 ± 0.1	3.33 ± 0.02
Ramsey	22.5 ± 0.3	9.8 ± 0.3	3.26 ± 0.02

Table 12 - 1995  
Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	12.2 ± 1.7	1.7 ± 0.2	30 ± 1	56 ± 5	7.1 ± 0
5BB	12.2 ± 1.0	1.4 ± 0.1	30 ± 1	46 ± 2	8.7 ± 0
420A	12.3 ± 0.4	0.9 ± 0.0	28 ± 1	34 ± 1	13.1 ± 1
110R	14.1 ± 1.2	1.9 ± 0.2	31 ± 2	60 ± 4	7.9 ± 1
1103P	16.5 ± 0.3	2.7 ± 0.1	35 ± 1	78 ± 2	6.1 ± 0
101-14	15.6 ± 0.7	1.8 ± 0.2	31 ± 0	59 ± 6	9.0 ± 1
3309	14.5 ± 0.8	1.6 ± 0.1	29 ± 1	54 ± 2	9.2 ± 0
St. Geo	13.5 ± 0.8	1.6 ± 0.3	28 ± 2	57 ± 7	9.3 ± 1
44-53	9.1 ± 1.1	0.7 ± 0.1	21 ± 1	32 ± 4	13.9 ± 1
1616	14.2 ± 1.2	1.8 ± 0.2	32 ± 1	56 ± 4	8.0 ± 0
O39-16	9.6 ± 2.1	1.1 ± 0.2	27 ± 3	39 ± 5	8.9 ± 1
Harmony	13.9 ± 1.5	2.0 ± 0.3	31 ± 1	62 ± 6	7.2 ± 0
Freedom	16.2 ± 0.5	2.3 ± 0.1	34 ± 0	70 ± 4	7.0 ± 0
Ramsey	15.2 ± 1.9	1.8 ± 0.3	30 ± 2	57 ± 5	8.7 ± 1

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	39 ± 3	305 ± 22	174 ± 12	1.8 ± 0.0
5BB	42 ± 2	286 ± 16	168 ± 9	1.7 ± 0.0
420A	47 ± 3	263 ± 9	165 ± 5	1.6 ± 0.0
110R	45 ± 3	316 ± 8	187 ± 6	1.7 ± 0.0
1103P	49 ± 1	338 ± 4	185 ± 2	1.8 ± 0.0
101-14	48 ± 1	323 ± 13	186 ± 9	1.7 ± 0.0
3309	45 ± 1	319 ± 14	186 ± 6	1.7 ± 0.0
St. Geo	47 ± 2	289 ± 8	172 ± 5	1.7 ± 0.0
44-53	37 ± 2	244 ± 18	161 ± 8	1.5 ± 0.0
1616	47 ± 2	297 ± 14	172 ± 7	1.7 ± 0.0
O39-16	35 ± 5	257 ± 27	149 ± 14	1.7 ± 0.1
Harmony	45 ± 4	307 ± 14	179 ± 9	1.7 ± 0.1
Freedom	49 ± 2	332 ± 10	184 ± 7	1.8 ± 0.0
Ramsey	47 ± 4	321 ± 19	181 ± 10	1.8 ± 0.0



Table 12 (cont) - 1995  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.0 ± 0.4	9.4 ± 0.3	3.26 ± 0.01	1851 ± 22
5BB	23.0 ± 0.4	9.3 ± 0.2	3.27 ± 0.01	1939 ± 16
420A	21.2 ± 0.3	8.9 ± 0.4	3.21 ± 0.02	1700 ± 72
110R	22.4 ± 0.2	9.5 ± 0.3	3.22 ± 0.02	1687 ± 53
1103P	22.5 ± 0.1	10.8 ± 0.1	3.27 ± 0.01	1904 ± 21
101-14	22.0 ± 0.1	9.2 ± 0.1	3.22 ± 0.01	1771 ± 49
3309	21.9 ± 0.1	9.3 ± 0.2	3.26 ± 0.02	1856 ± 70
St. Geo	22.0 ± 0.2	9.2 ± 0.4	3.28 ± 0.01	1866 ± 37
44-53	22.0 ± 0.2	8.3 ± 0.3	3.27 ± 0.01	2001 ± 13
1616	21.7 ± 0.2	9.1 ± 0.2	3.28 ± 0.00	1975 ± 40
O39-16	22.3 ± 0.4	8.4 ± 0.3	3.30 ± 0.01	1999 ± 64
Harmony	21.8 ± 0.2	9.4 ± 0.4	3.28 ± 0.02	1894 ± 69
Freedom	22.0 ± 0.1	10.4 ± 0.2	3.30 ± 0.02	1929 ± 27
Ramsey	21.8 ± 0.2	9.2 ± 0.3	3.24 ± 0.02	1731 ± 68

Table 13 - 1996  
Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	16.5 ± 1.0	1.4 ± 0.2	37 ± 3	37 ± 3	12.5 ± 1
5BB	13.9 ± 0.6	1.2 ± 0.1	32 ± 1	36 ± 3	12.5 ± 1
420A	13.7 ± 0.9	0.8 ± 0.1	34 ± 1	24 ± 1	17.0 ± 1
110R	17.1 ± 0.4	1.5 ± 0.2	36 ± 1	40 ± 5	13.0 ± 2
1103P	15.6 ± 0.8	2.5 ± 0.1	40 ± 1	63 ± 3	6.3 ± 0
101-14	16.2 ± 0.8	1.8 ± 0.2	37 ± 2	48 ± 4	9.8 ± 1
3309	16.7 ± 0.4	1.4 ± 0.1	35 ± 1	40 ± 3	12.4 ± 1
St. Geo	13.9 ± 0.9	1.6 ± 0.2	36 ± 2	44 ± 4	9.1 ± 1
44-53	11.0 ± 1.0	0.7 ± 0.1	27 ± 2	26 ± 3	16.8 ± 2
1616	14.2 ± 0.8	1.7 ± 0.2	36 ± 2	45 ± 3	8.8 ± 1
O39-16	12.5 ± 0.6	1.0 ± 0.2	32 ± 3	31 ± 4	15.5 ± 4
Harmony	14.6 ± 1.1	1.7 ± 0.3	37 ± 1	46 ± 5	9.1 ± 1
Freedom	15.0 ± 0.6	2.1 ± 0.2	41 ± 1	52 ± 3	7.2 ± 1
Ramsey	15.1 ± 1.3	1.5 ± 0.2	36 ± 3	40 ± 4	11.2 ± 1

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	69 ± 3	249 ± 12	157 ± 9	1.6 ± 0.0
5BB	64 ± 2	217 ± 12	134 ± 3	1.6 ± 0.1
420A	62 ± 4	223 ± 8	149 ± 5	1.5 ± 0.0
110R	74 ± 1	231 ± 3	148 ± 3	1.6 ± 0.0
1103P	66 ± 3	240 ± 3	144 ± 2	1.7 ± 0.0
101-14	67 ± 2	246 ± 10	148 ± 8	1.7 ± 0.1
3309	72 ± 3	234 ± 8	149 ± 5	1.6 ± 0.0
St. Geo	66 ± 4	212 ± 9	132 ± 4	1.6 ± 0.0
44-53	51 ± 4	228 ± 21	157 ± 20	1.5 ± 0.1
1616	65 ± 5	224 ± 7	138 ± 6	1.6 ± 0.0
O39-16	57 ± 2	219 ± 9	140 ± 3	1.6 ± 0.1
Harmony	65 ± 3	225 ± 8	137 ± 5	1.6 ± 0.0
Freedom	66 ± 2	229 ± 5	140 ± 4	1.6 ± 0.0
Ramsey	66 ± 3	229 ± 11	142 ± 5	1.6 ± 0.0

Table 13 (cont) - 1996  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.4 ± 0.2	8.6 ± 0.5	3.46 ± 0.02	2167 ± 101
5BB	22.4 ± 0.2	8.3 ± 0.3	3.48 ± 0.01	2229 ± 42
420A	22.2 ± 0.5	8.5 ± 0.1	3.44 ± 0.01	1996 ± 19
110R	21.8 ± 0.2	9.5 ± 0.4	3.51 ± 0.02	2038 ± 52
1103P	22.6 ± 0.1	10.3 ± 0.1	3.52 ± 0.01	2288 ± 78
101-14	22.6 ± 0.2	9.0 ± 0.3	3.45 ± 0.01	2142 ± 56
3309	22.1 ± 0.3	9.0 ± 0.1	3.38 ± 0.00	2192 ± 27
St. Geo	22.6 ± 0.2	9.0 ± 0.3	3.41 ± 0.01	2159 ± 23
44-53	23.3 ± 0.1	7.9 ± 0.3	3.39 ± 0.00	2198 ± 35
1616	22.6 ± 0.3	9.0 ± 0.3	3.38 ± 0.01	2187 ± 34
O39-16	22.7 ± 0.2	7.9 ± 0.3	3.40 ± 0.00	2129 ± 29
Harmony	22.7 ± 0.3	8.9 ± 0.5	3.51 ± 0.01	2203 ± 23
Freedom	22.8 ± 0.2	9.9 ± 0.1	3.54 ± 0.01	2514 ± 68
Ramsey	22.3 ± 0.3	8.6 ± 0.5	3.41 ± 0.01	2028 ± 29

Table 14 - 1997  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	17.4 ± 1.6	1.1 ± 0.1	37 ± 2	30 ± 1	16.0 ± 2
5BB	17.5 ± 1.3	1.0 ± 0.1	33 ± 2	31 ± 3	17.7 ± 2
420A	16.0 ± 0.7	0.6 ± 0.1	34 ± 1	18 ± 3	29.5 ± 4
110R	20.4 ± 1.2	1.1 ± 0.1	39 ± 1	29 ± 3	19.3 ± 2
1103P	18.2 ± 0.7	2.4 ± 0.1	44 ± 2	55 ± 1	7.7 ± 0
101-14	19.1 ± 0.9	1.5 ± 0.1	38 ± 1	39 ± 2	13.1 ± 1
3309	20.0 ± 0.9	1.3 ± 0.0	37 ± 1	34 ± 2	15.8 ± 0
St. Geo	18.0 ± 0.4	1.7 ± 0.2	39 ± 2	44 ± 3	11.1 ± 1
44-53	14.4 ± 0.9	0.6 ± 0.1	31 ± 2	19 ± 3	26.9 ± 4
1616	17.0 ± 0.8	1.8 ± 0.2	38 ± 1	48 ± 3	9.5 ± 1
O39-16	15.1 ± 1.8	1.1 ± 0.2	37 ± 0	30 ± 5	14.7 ± 1
Harmony	16.9 ± 1.3	1.8 ± 0.1	39 ± 1	45 ± 3	9.7 ± 1
Freedom	18.2 ± 0.7	2.1 ± 0.2	43 ± 1	48 ± 2	8.9 ± 0
Ramsey	18.3 ± 1.7	1.5 ± 0.2	39 ± 2	39 ± 4	12.3 ± 1

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	66 ± 7	266 ± 6	141 ± 3	1.9 ± 0.0
5BB	71 ± 4	248 ± 12	140 ± 8	1.8 ± 0.1
420A	67 ± 3	242 ± 14	150 ± 5	1.6 ± 0.1
110R	77 ± 2	266 ± 10	156 ± 4	1.7 ± 0.0
1103P	72 ± 4	255 ± 4	129 ± 4	2.0 ± 0.0
101-14	67 ± 3	286 ± 10	158 ± 5	1.8 ± 0.1
3309	75 ± 3	268 ± 5	146 ± 4	1.8 ± 0.0
St. Geo	74 ± 3	249 ± 11	131 ± 4	1.9 ± 0.0
44-53	63 ± 3	231 ± 13	138 ± 5	1.7 ± 0.0
1616	65 ± 2	262 ± 8	134 ± 5	2.0 ± 0.0
O39-16	62 ± 4	238 ± 20	127 ± 7	1.9 ± 0.1
Harmony	64 ± 4	263 ± 9	135 ± 5	2.0 ± 0.0
Freedom	67 ± 3	272 ± 5	137 ± 4	2.0 ± 0.0
Ramsey	68 ± 4	270 ± 11	142 ± 3	1.9 ± 0.0

Table 14 (cont) - 1997  
 Sacramento Delta - Chardonnay / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.8 ± 0.5	8.0 ± 0.2	3.56 ± 0.01	3663 ± 220
5BB	22.7 ± 0.3	8.2 ± 0.2	3.56 ± 0.01	3981 ± 129
420A	20.9 ± 0.4	7.7 ± 0.1	3.50 ± 0.01	2954 ± 153
110R	21.3 ± 0.3	8.5 ± 0.1	3.48 ± 0.01	2542 ± 118
1103P	23.4 ± 0.2	9.4 ± 0.1	3.47 ± 0.00	2788 ± 85
101-14	22.4 ± 0.3	8.5 ± 0.1	3.53 ± 0.01	3447 ± 133
3309	21.8 ± 0.3	9.2 ± 0.2	3.55 ± 0.00	3227 ± 53
St. Geo	23.0 ± 0.2	9.6 ± 0.5	3.54 ± 0.01	3027 ± 68
44-53	22.0 ± 0.1	9.1 ± 0.1	3.55 ± 0.01	3046 ± 68
1616	23.1 ± 0.3	9.1 ± 0.3	3.50 ± 0.01	2940 ± 79
O39-16	22.9 ± 0.2	9.1 ± 0.4	3.54 ± 0.01	3462 ± 240
Harmony	22.9 ± 0.3	8.2 ± 0.1	3.53 ± 0.01	2824 ± 193
Freedom	23.2 ± 0.1	9.4 ± 0.3	3.58 ± 0.01	4626 ± 154
Ramsey	22.1 ± 0.6	9.8 ± 0.4	3.54 ± 0.01	3175 ± 67

## Sacramento Delta Rootstock Trial

Scion: Cabernet Sauvignon

Years conducted: 1992-1998

Years reported: 1994-1998

Rootstocks:

5C  
5BB  
420A  
110 R  
1103 P  
101-14 Mgt  
3309 C  
St. George  
44-53 Mgt  
1616 C  
O39-16  
Harmony  
Freedom  
Ramsey

Site Conditions: This site is characterized by a deep and well drained soil, and a water table that fluctuated between 4 and 7 ft. The relatively wide vine spacing (10 ft) did not reduce vine size (1.3 to 1.6 kg/m). That in concert with relatively high shoot numbers (17 to 20/m) resulted in the extraordinarily large vine yields (20 to 25 kg/vine).

Figure 3.

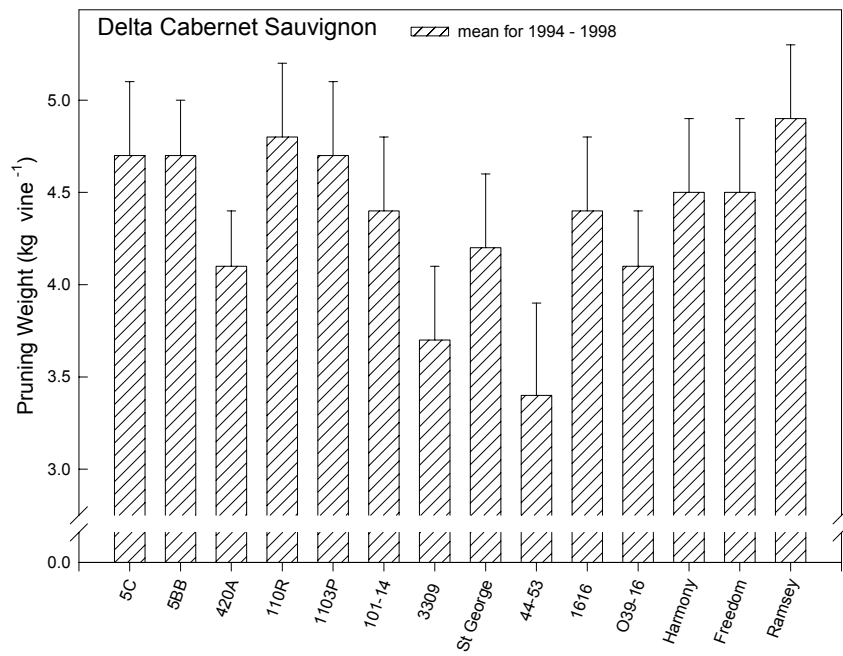
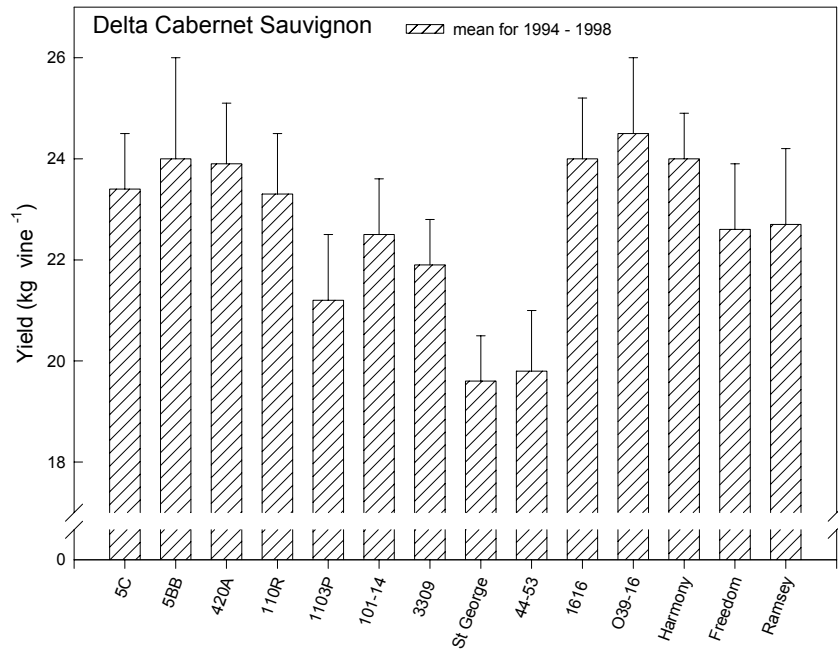


Table 15 - 1994 - 1998  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	23.4 ± 1.0	4.7 ± 0.4	58 ± 5	83 ± 6	5.1 ± 0.4
5BB	24.0 ± 1.8	4.7 ± 0.3	54 ± 6	91 ± 10	5.2 ± 0.5
420A	23.9 ± 1.1	4.1 ± 0.3	58 ± 5	73 ± 5	6.0 ± 0.5
110R	23.3 ± 1.1	4.8 ± 0.4	59 ± 5	83 ± 5	5.2 ± 0.5
1103P	21.2 ± 1.1	4.7 ± 0.4	60 ± 5	81 ± 6	4.7 ± 0.4
101-14	22.5 ± 1.0	4.4 ± 0.4	57 ± 5	81 ± 8	5.5 ± 0.7
3309	21.9 ± 0.8	3.7 ± 0.3	56 ± 5	68 ± 6	6.4 ± 0.7
St. Geo	19.6 ± 0.8	4.2 ± 0.4	57 ± 5	77 ± 8	4.9 ± 0.5
44-53	19.8 ± 1.1	3.4 ± 0.4	51 ± 6	71 ± 7	6.2 ± 0.7
1616	24.0 ± 1.1	4.4 ± 0.4	60 ± 5	75 ± 6	5.7 ± 0.7
O39-16	24.5 ± 1.4	4.1 ± 0.3	60 ± 5	71 ± 7	6.3 ± 0.6
Harmony	24.0 ± 0.8	4.5 ± 0.4	59 ± 5	78 ± 7	5.7 ± 0.7
Freedom	22.6 ± 1.2	4.5 ± 0.4	56 ± 4	82 ± 8	5.3 ± 0.5
Ramsey	22.7 ± 1.4	4.9 ± 0.3	62 ± 5	81 ± 6	4.8 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	108 ± 6	219 ± 9	152 ± 7	1.5 ± 0.0
5BB	104 ± 8	232 ± 5	156 ± 4	1.5 ± 0.0
420A	109 ± 7	221 ± 8	160 ± 6	1.4 ± 0.0
110R	106 ± 6	221 ± 7	158 ± 5	1.4 ± 0.0
1103P	100 ± 5	213 ± 9	153 ± 6	1.4 ± 0.0
101-14	106 ± 5	214 ± 9	153 ± 5	1.4 ± 0.0
3309	104 ± 5	212 ± 6	155 ± 4	1.4 ± 0.0
St. Geo	97 ± 5	205 ± 9	155 ± 7	1.3 ± 0.0
44-53	96 ± 8	210 ± 6	152 ± 6	1.4 ± 0.0
1616	110 ± 6	219 ± 8	157 ± 6	1.4 ± 0.0
O39-16	109 ± 6	228 ± 9	152 ± 5	1.5 ± 0.0
Harmony	113 ± 5	215 ± 9	155 ± 6	1.4 ± 0.0
Freedom	106 ± 5	215 ± 7	148 ± 6	1.5 ± 0.0
Ramsey	104 ± 6	219 ± 7	151 ± 5	1.5 ± 0.0



Table 15 (cont) - 1994 - 1998  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (1995 – 1997) (ppm)
5C	23.5 ± 0.2	7.4 ± 0.2	3.36 ± 0.03	1732 ± 148
5BB	22.6 ± 0.4	8.0 ± 0.2	3.35 ± 0.04	1802 ± 192
420A	22.8 ± 0.3	7.7 ± 0.2	3.34 ± 0.04	1793 ± 124
110R	23.0 ± 0.3	7.6 ± 0.2	3.31 ± 0.03	1750 ± 135
1103P	23.7 ± 0.3	7.3 ± 0.1	3.35 ± 0.03	1854 ± 149
101-14	23.7 ± 0.3	7.1 ± 0.2	3.38 ± 0.03	1827 ± 118
3309	23.1 ± 0.2	7.4 ± 0.3	3.36 ± 0.03	1771 ± 100
St. Geo	23.8 ± 0.3	6.7 ± 0.2	3.43 ± 0.03	1861 ± 120
44-53	23.6 ± 0.4	7.4 ± 0.3	3.36 ± 0.04	1848 ± 119
1616	23.0 ± 0.3	7.6 ± 0.2	3.40 ± 0.04	1841 ± 92
O39-16	22.6 ± 0.2	7.6 ± 0.2	3.37 ± 0.04	1780 ± 130
Harmony	22.9 ± 0.3	7.6 ± 0.2	3.35 ± 0.04	1750 ± 144
Freedom	23.4 ± 0.2	7.3 ± 0.2	3.38 ± 0.03	1852 ± 167
Ramsey	23.0 ± 0.2	7.2 ± 0.2	3.35 ± 0.03	1652 ± 94

Table 16 - 1994  
Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	25.5 ± 0.7	4.4 ± 0.2	47 ± 1	93 ± 4	5.9 ± 0.2
5BB	18.1 ± 0.9	4.1 ± 0.1	33 ± 1	127 ± 5	4.4 ± 0.3
420A	23.2 ± 1.7	3.8 ± 0.3	43 ± 2	89 ± 9	6.4 ± 0.8
110R	23.4 ± 0.6	4.2 ± 0.3	45 ± 1	93 ± 6	5.8 ± 0.5
1103P	24.6 ± 0.9	4.4 ± 0.3	47 ± 1	94 ± 6	5.7 ± 0.2
101-14	23.0 ± 0.9	4.5 ± 0.3	44 ± 2	103 ± 8	5.2 ± 0.2
3309	21.5 ± 1.4	3.3 ± 0.3	41 ± 3	80 ± 8	6.8 ± 0.5
St. Geo	22.2 ± 0.9	4.3 ± 0.2	43 ± 1	99 ± 5	5.2 ± 0.2
44-53	16.2 ± 0.6	2.6 ± 0.2	28 ± 1	91 ± 6	6.4 ± 0.4
1616	23.4 ± 1.2	3.9 ± 0.1	46 ± 1	84 ± 2	6.0 ± 0.1
O39-16	26.2 ± 0.7	4.2 ± 0.3	46 ± 2	93 ± 4	6.3 ± 0.5
Harmony	24.9 ± 0.7	4.1 ± 0.2	46 ± 0	90 ± 5	6.1 ± 0.4
Freedom	24.0 ± 0.7	4.6 ± 0.3	44 ± 1	104 ± 8	5.3 ± 0.3
Ramsey	25.7 ± 1.1	4.9 ± 0.3	50 ± 1	97 ± 5	5.3 ± 0.2

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	102 ± 2	250 ± 4	169 ± 1	1.5 ± 0.0
5BB	74 ± 3	245 ± 5	164 ± 5	1.5 ± 0.0
420A	92 ± 7	251 ± 6	177 ± 4	1.4 ± 0.0
110R	93 ± 3	251 ± 4	174 ± 3	1.4 ± 0.0
1103P	98 ± 3	254 ± 6	177 ± 7	1.4 ± 0.0
101-14	98 ± 3	235 ± 6	161 ± 7	1.5 ± 0.0
3309	93 ± 5	233 ± 7	164 ± 3	1.4 ± 0.0
St. Geo	93 ± 3	239 ± 4	170 ± 4	1.4 ± 0.0
44-53	72 ± 2	224 ± 7	162 ± 5	1.4 ± 0.0
1616	98 ± 2	240 ± 9	171 ± 3	1.4 ± 0.0
O39-16	99 ± 2	267 ± 4	172 ± 2	1.6 ± 0.0
Harmony	102 ± 3	248 ± 8	170 ± 5	1.5 ± 0.0
Freedom	98 ± 2	245 ± 5	167 ± 3	1.5 ± 0.0
Ramsey	105 ± 3	247 ± 7	167 ± 6	1.5 ± 0.0

Table 16 (cont) - 1994  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	24.0 ± 0.3	7.7 ± 0.1	3.39 ± 0.01
5BB	23.7 ± 0.2	8.3 ± 0.3	3.46 ± 0.02
420A	23.5 ± 0.4	8.2 ± 0.3	3.42 ± 0.01
110R	23.4 ± 0.1	8.0 ± 0.1	3.37 ± 0.01
1103P	23.9 ± 0.4	7.6 ± 0.1	3.41 ± 0.01
101-14	24.4 ± 0.3	7.4 ± 0.1	3.44 ± 0.02
3309	23.9 ± 0.3	7.6 ± 0.1	3.41 ± 0.02
St. Geo	24.2 ± 0.3	7.1 ± 0.1	3.46 ± 0.01
44-53	24.9 ± 0.3	8.3 ± 0.6	3.45 ± 0.02
1616	24.2 ± 0.5	8.0 ± 0.1	3.50 ± 0.02
O39-16	22.5 ± 0.2	8.2 ± 0.1	3.41 ± 0.01
Harmony	23.7 ± 0.5	7.6 ± 0.1	3.44 ± 0.01
Freedom	23.9 ± 0.5	7.7 ± 0.1	3.45 ± 0.01
Ramsey	23.7 ± 0.3	7.7 ± 0.1	3.38 ± 0.01

Table 17 - 1995  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	23.2 ± 0.6	4.9 ± 0.3	52 ± 1	94 ± 4	4.8 ± 0.2
5BB	26.7 ± 1.1	5.2 ± 0.2	50 ± 2	102 ± 2	5.2 ± 0.3
420A	23.9 ± 1.3	4.5 ± 0.3	55 ± 1	81 ± 5	5.4 ± 0.1
110R	22.4 ± 0.1	5.0 ± 0.3	54 ± 1	92 ± 6	4.6 ± 0.4
1103P	21.3 ± 0.8	5.1 ± 0.2	55 ± 1	92 ± 4	4.2 ± 0.1
101-14	22.3 ± 0.6	4.8 ± 0.2	51 ± 1	94 ± 4	4.7 ± 0.1
3309	21.9 ± 0.9	3.9 ± 0.3	51 ± 1	78 ± 6	5.7 ± 0.4
St. Geo	19.8 ± 0.4	4.4 ± 0.1	51 ± 0	87 ± 2	4.5 ± 0.1
44-53	22.3 ± 0.5	3.8 ± 0.2	47 ± 2	82 ± 7	6.0 ± 0.3
1616	23.8 ± 1.2	4.6 ± 0.2	55 ± 0	84 ± 4	5.2 ± 0.1
O39-16	25.6 ± 1.1	4.1 ± 0.3	52 ± 1	79 ± 5	6.3 ± 0.4
Harmony	24.2 ± 0.2	4.7 ± 0.3	55 ± 1	86 ± 5	5.2 ± 0.3
Freedom	23.9 ± 0.3	4.9 ± 0.2	51 ± 1	96 ± 5	4.9 ± 0.2
Ramsey	23.1 ± 0.5	4.9 ± 0.2	55 ± 1	90 ± 5	4.7 ± 0.2

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	113 ± 4	207 ± 4	149 ± 2	1.4 ± 0.0
5BB	115 ± 4	235 ± 8	166 ± 5	1.4 ± 0.0
420A	115 ± 5	209 ± 8	163 ± 8	1.3 ± 0.1
110R	108 ± 4	210 ± 8	155 ± 6	1.4 ± 0.0
1103P	107 ± 5	200 ± 4	148 ± 5	1.4 ± 0.1
101-14	109 ± 3	206 ± 5	152 ± 5	1.4 ± 0.0
3309	109 ± 5	203 ± 7	156 ± 7	1.3 ± 0.0
St. Geo	103 ± 3	193 ± 3	158 ± 6	1.2 ± 0.0
44-53	106 ± 4	211 ± 7	153 ± 7	1.4 ± 0.0
1616	114 ± 4	209 ± 8	157 ± 4	1.3 ± 0.0
O39-16	116 ± 4	223 ± 5	156 ± 5	1.4 ± 0.0
Harmony	119 ± 4	206 ± 8	156 ± 7	1.3 ± 0.0
Freedom	110 ± 6	221 ± 11	155 ± 9	1.4 ± 0.0
Ramsey	109 ± 3	214 ± 5	155 ± 3	1.4 ± 0.0

Table 17 (cont) - 1995  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.2 ± 0.1	7.9 ± 0.1	3.33 ± 0.02	1706 ± 36
5BB	21.8 ± 0.3	8.8 ± 0.2	3.31 ± 0.02	1709 ± 20
420A	22.2 ± 0.5	8.3 ± 0.3	3.31 ± 0.01	1705 ± 23
110R	22.8 ± 0.3	8.3 ± 0.3	3.29 ± 0.01	1799 ± 39
1103P	23.6 ± 0.2	7.8 ± 0.2	3.35 ± 0.01	1876 ± 44
101-14	23.4 ± 0.1	7.7 ± 0.2	3.34 ± 0.01	1763 ± 26
3309	22.3 ± 0.3	8.3 ± 0.3	3.31 ± 0.02	1693 ± 36
St. Geo	23.5 ± 0.3	7.5 ± 0.2	3.37 ± 0.01	1766 ± 38
44-53	22.3 ± 0.3	8.2 ± 0.2	3.28 ± 0.02	1788 ± 28
1616	22.5 ± 0.2	8.4 ± 0.1	3.35 ± 0.01	1778 ± 27
O39-16	21.7 ± 0.5	8.0 ± 0.3	3.30 ± 0.03	1647 ± 42
Harmony	22.4 ± 0.3	8.3 ± 0.4	3.35 ± 0.01	1773 ± 24
Freedom	22.9 ± 0.2	7.7 ± 0.2	3.36 ± 0.01	1751 ± 34
Ramsey	22.5 ± 0.3	7.5 ± 0.2	3.29 ± 0.02	1541 ± 36

Table 18 - 1996  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	20.0 ± 1.2	4.2 ± 0.4	50 ± 1	84 ± 9	4.9 ± 0.3
5BB	21.0 ± 0.4	4.3 ± 0.3	50 ± 2	86 ± 3	4.9 ± 0.3
420A	20.8 ± 0.9	3.6 ± 0.2	51 ± 1	71 ± 5	5.9 ± 0.4
110R	19.5 ± 1.0	4.6 ± 0.6	51 ± 2	92 ± 13	4.5 ± 0.5
1103P	17.3 ± 0.9	3.9 ± 0.4	50 ± 1	77 ± 8	4.7 ± 0.4
101-14	20.0 ± 0.2	4.1 ± 0.4	50 ± 2	81 ± 10	5.2 ± 0.4
3309	19.4 ± 1.3	3.4 ± 0.5	50 ± 2	68 ± 10	6.1 ± 0.7
St. Geo	16.6 ± 0.9	3.6 ± 0.4	48 ± 1	75 ± 8	4.9 ± 0.5
44-53	19.0 ± 0.7	2.9 ± 0.3	48 ± 1	61 ± 7	6.7 ± 0.5
1616	21.7 ± 0.9	4.2 ± 0.2	52 ± 1	81 ± 4	5.2 ± 0.2
O39-16	19.4 ± 1.2	3.6 ± 0.4	53 ± 1	69 ± 7	5.6 ± 0.6
Harmony	21.6 ± 0.7	4.5 ± 0.5	50 ± 2	91 ± 8	5.0 ± 0.4
Freedom	18.2 ± 0.5	3.8 ± 0.4	50 ± 1	76 ± 9	5.1 ± 0.6
Ramsey	17.2 ± 0.4	4.2 ± 0.4	52 ± 0	81 ± 8	4.3 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	88 ± 3	232 ± 14	171 ± 8	1.4 ± 0.1
5BB	91 ± 2	230 ± 1	161 ± 6	1.4 ± 0.1
420A	90 ± 3	231 ± 3	171 ± 5	1.4 ± 0.0
110R	90 ± 4	216 ± 7	166 ± 4	1.3 ± 0.0
1103P	82 ± 2	213 ± 7	158 ± 6	1.3 ± 0.0
101-14	89 ± 1	226 ± 4	167 ± 6	1.4 ± 0.0
3309	89 ± 4	220 ± 7	166 ± 6	1.3 ± 0.0
St. Geo	78 ± 3	213 ± 8	168 ± 4	1.3 ± 0.0
44-53	84 ± 1	226 ± 7	170 ± 5	1.3 ± 0.0
1616	94 ± 2	232 ± 4	173 ± 6	1.3 ± 0.0
O39-16	87 ± 4	223 ± 6	151 ± 4	1.5 ± 0.0
Harmony	96 ± 2	223 ± 7	171 ± 7	1.3 ± 0.0
Freedom	88 ± 2	208 ± 7	151 ± 6	1.4 ± 0.0
Ramsey	79 ± 3	221 ± 5	157 ± 6	1.4 ± 0.0

Table 18 (cont) - 1996  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.7 ± 0.3	6.9 ± 0.2	3.47 ± 0.00	1473 ± 90
5BB	21.6 ± 0.3	7.5 ± 0.0	3.44 ± 0.01	1543 ± 50
420A	21.9 ± 0.4	7.0 ± 0.3	3.44 ± 0.01	1664 ± 95
110R	22.1 ± 0.3	6.9 ± 0.3	3.39 ± 0.03	1451 ± 84
1103P	22.5 ± 0.2	6.9 ± 0.1	3.45 ± 0.02	1662 ± 133
101-14	22.8 ± 0.3	6.5 ± 0.2	3.48 ± 0.01	1711 ± 80
3309	22.7 ± 0.2	6.6 ± 0.2	3.47 ± 0.01	1762 ± 70
St. Geo	23.0 ± 0.2	6.0 ± 0.1	3.55 ± 0.01	1881 ± 84
44-53	23.0 ± 0.2	6.8 ± 0.1	3.48 ± 0.01	1746 ± 137
1616	22.3 ± 0.1	6.9 ± 0.1	3.51 ± 0.02	1844 ± 59
O39-16	22.5 ± 0.2	6.7 ± 0.2	3.52 ± 0.03	1616 ± 86
Harmony	21.7 ± 0.4	7.3 ± 0.4	3.44 ± 0.01	1502 ± 34
Freedom	22.7 ± 0.3	6.8 ± 0.3	3.47 ± 0.02	1859 ± 136
Ramsey	22.4 ± 0.2	6.4 ± 0.2	3.48 ± 0.02	1557 ± 29

Table 19 - 1997  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	25.8 ± 1.8	4.0 ± 0.3	67 ± 2	60 ± 3	6.5 ± 0.2
5BB	29.1 ± 0.4	4.0 ± 0.1	64 ± 1	62 ± 1	7.3 ± 0.2
420A	28.1 ± 1.3	3.5 ± 0.2	66 ± 2	53 ± 4	8.0 ± 0.2
110R	27.0 ± 1.4	4.0 ± 0.3	67 ± 2	61 ± 6	6.9 ± 0.5
1103P	23.0 ± 1.9	4.1 ± 0.3	72 ± 2	57 ± 5	5.6 ± 0.1
101-14	26.3 ± 1.2	3.1 ± 0.2	65 ± 1	49 ± 4	8.6 ± 0.5
3309	25.3 ± 2.0	2.8 ± 0.3	65 ± 1	43 ± 4	9.1 ± 0.4
St. Geo	20.7 ± 1.6	3.2 ± 0.4	67 ± 1	48 ± 5	6.6 ± 0.3
44-53	22.7 ± 1.2	2.8 ± 0.3	61 ± 2	46 ± 4	8.3 ± 0.4
1616	28.6 ± 1.9	3.5 ± 0.3	68 ± 2	51 ± 4	8.5 ± 0.8
O39-16	28.1 ± 0.5	3.3 ± 0.2	70 ± 2	48 ± 5	8.7 ± 0.5
Harmony	26.6 ± 2.3	3.2 ± 0.3	65 ± 2	49 ± 3	8.4 ± 0.4
Freedom	25.9 ± 1.9	3.5 ± 0.2	66 ± 2	53 ± 3	7.4 ± 0.4
Ramsey	25.4 ± 1.6	4.3 ± 0.3	72 ± 1	60 ± 5	6.0 ± 0.1

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	124 ± 4	207 ± 9	131 ± 4	1.6 ± 0.1
5BB	122 ± 2	239 ± 4	147 ± 3	1.6 ± 0.0
420A	130 ± 4	217 ± 5	142 ± 2	1.5 ± 0.0
110R	122 ± 3	223 ± 10	146 ± 8	1.5 ± 0.1
1103P	116 ± 4	200 ± 11	137 ± 6	1.5 ± 0.0
101-14	118 ± 3	223 ± 9	151 ± 9	1.5 ± 0.1
3309	120 ± 4	211 ± 11	141 ± 3	1.5 ± 0.1
St. Geo	110 ± 4	188 ± 8	129 ± 6	1.5 ± 0.1
44-53	121 ± 4	189 ± 8	130 ± 2	1.5 ± 0.1
1616	127 ± 5	225 ± 8	144 ± 6	1.6 ± 0.0
O39-16	129 ± 4	221 ± 9	135 ± 5	1.6 ± 0.1
Harmony	125 ± 3	213 ± 17	140 ± 8	1.5 ± 0.1
Freedom	124 ± 3	208 ± 11	130 ± 6	1.6 ± 0.0
Ramsey	120 ± 3	213 ± 9	135 ± 4	1.6 ± 0.1



Table 19 (cont) - 1997  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	24.0 ± 0.3	7.5 ± 0.1	3.29 ± 0.01	2224 ± 39
5BB	23.6 ± 0.2	8.0 ± 0.1	3.28 ± 0.01	2452 ± 174
420A	23.4 ± 0.2	7.5 ± 0.1	3.26 ± 0.01	2215 ± 100
110R	24.1 ± 0.2	7.4 ± 0.0	3.22 ± 0.01	2163 ± 30
1103P	24.8 ± 0.3	7.2 ± 0.2	3.25 ± 0.03	2328 ± 46
101-14	23.8 ± 0.2	7.4 ± 0.2	3.31 ± 0.01	2225 ± 59
3309	23.4 ± 0.3	7.4 ± 0.1	3.30 ± 0.02	2089 ± 49
St. Geo	24.8 ± 0.2	6.7 ± 0.2	3.41 ± 0.02	2227 ± 44
44-53	24.4 ± 0.1	7.1 ± 0.1	3.28 ± 0.02	2246 ± 59
1616	23.0 ± 0.2	7.6 ± 0.2	3.36 ± 0.02	2127 ± 74
O39-16	23.3 ± 0.4	7.5 ± 0.2	3.34 ± 0.01	2230 ± 123
Harmony	23.5 ± 0.4	7.6 ± 0.1	3.26 ± 0.03	2211 ± 47
Freedom	24.0 ± 0.4	7.4 ± 0.1	3.28 ± 0.02	2364 ± 77
Ramsey	23.5 ± 0.1	7.3 ± 0.1	3.30 ± 0.01	1977 ± 73

Table 20 - 1998  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	22.3 ± 1.0	6.2 ± 0.4	73 ± 3	85 ± 3	3.6 ± 0.2
5BB	25.1 ± 0.9	5.8 ± 0.2	74 ± 2	78 ± 3	4.3 ± 0.1
420A	23.3 ± 1.1	5.4 ± 0.3	76 ± 2	71 ± 4	4.4 ± 0.1
110R	24.0 ± 0.8	6.2 ± 0.3	78 ± 1	80 ± 4	3.9 ± 0.2
1103P	19.6 ± 1.8	6.3 ± 0.4	74 ± 4	85 ± 2	3.1 ± 0.1
101-14	20.9 ± 1.0	5.7 ± 0.1	73 ± 1	79 ± 2	3.7 ± 0.2
3309	21.6 ± 1.9	5.0 ± 0.5	72 ± 2	69 ± 6	4.4 ± 0.2
St. Geo	19.0 ± 1.3	5.6 ± 0.4	73 ± 2	76 ± 4	3.4 ± 0.1
44-53	19.0 ± 0.9	5.1 ± 0.3	71 ± 2	73 ± 3	3.7 ± 0.2
1616	22.5 ± 1.1	5.9 ± 0.2	77 ± 2	77 ± 3	3.8 ± 0.2
O39-16	23.1 ± 0.8	5.2 ± 0.2	78 ± 1	67 ± 3	4.5 ± 0.1
Harmony	22.9 ± 1.4	6.0 ± 0.3	79 ± 3	76 ± 3	3.8 ± 0.1
Freedom	21.1 ± 0.8	5.8 ± 0.2	70 ± 2	83 ± 2	3.6 ± 0.1
Ramsey	21.9 ± 1.3	6.2 ± 0.2	79 ± 2	79 ± 4	3.6 ± 0.1

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	113 ± 7	198 ± 4	138 ± 5	1.4 ± 0.1
5BB	120 ± 5	210 ± 3	142 ± 2	1.5 ± 0.0
420A	117 ± 4	200 ± 4	146 ± 3	1.4 ± 0.0
110R	118 ± 6	206 ± 9	149 ± 10	1.4 ± 0.0
1103P	98 ± 7	199 ± 6	145 ± 5	1.4 ± 0.0
101-14	116 ± 2	181 ± 8	134 ± 5	1.3 ± 0.0
3309	111 ± 7	193 ± 7	148 ± 6	1.3 ± 0.0
St. Geo	100 ± 6	189 ± 6	148 ± 4	1.3 ± 0.0
44-53	95 ± 5	201 ± 5	146 ± 4	1.4 ± 0.0
1616	119 ± 4	189 ± 4	141 ± 4	1.3 ± 0.0
O39-16	113 ± 3	205 ± 4	147 ± 2	1.4 ± 0.0
Harmony	124 ± 6	185 ± 8	138 ± 5	1.3 ± 0.0
Freedom	108 ± 2	196 ± 5	136 ± 6	1.5 ± 0.0
Ramsey	110 ± 4	200 ± 9	141 ± 8	1.4 ± 0.0

Table 20 (cont) - 1998  
 Sacramento Delta – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.4 ± 0.5	6.9 ± 0.4	3.32 ± 0.02	1526 ± 43
5BB	22.4 ± 0.4	7.6 ± 0.2	3.26 ± 0.01	1503 ± 43
420A	23.0 ± 0.2	7.5 ± 0.2	3.25 ± 0.01	1588 ± 20
110R	22.7 ± 0.4	7.6 ± 0.2	3.27 ± 0.01	1586 ± 45
1103P	23.5 ± 0.3	7.1 ± 0.2	3.31 ± 0.02	1551 ± 19
101-14	24.2 ± 0.2	6.5 ± 0.1	3.32 ± 0.01	1609 ± 22
3309	23.2 ± 0.2	7.1 ± 0.4	3.28 ± 0.01	1541 ± 35
St. Geo	23.5 ± 0.2	6.4 ± 0.1	3.37 ± 0.01	1569 ± 14
44-53	23.5 ± 0.2	6.8 ± 0.1	3.31 ± 0.01	1613 ± 31
1616	23.1 ± 0.4	7.4 ± 0.2	3.28 ± 0.01	1616 ± 16
O39-16	23.0 ± 0.3	7.4 ± 0.1	3.29 ± 0.02	1628 ± 31
Harmony	22.9 ± 0.2	7.1 ± 0.2	3.26 ± 0.02	1513 ± 39
Freedom	23.5 ± 0.3	6.9 ± 0.2	3.32 ± 0.02	1434 ± 26
Ramsey	23.1 ± 0.5	7.3 ± 0.4	3.31 ± 0.01	1535 ± 23

## Sierra Foothills, Amador County, Rootstock Trial

Scion: Zinfandel

Years conducted: 1992-1999

Years reported: 1994-1999

Rootstocks:

110 R  
1103 P  
Harmony  
Freedom  
5C  
5BB  
420A  
101-14 Mgt  
1616 C  
3309 C  
St George  
44-53 Mgt  
Ramsey  
O39-16

Site Conditions: Although this site is characterized by a deep (>2 m), well drained soil, growth and yields were moderate, averaging 5 to 8 kg/vine in crop and 0.5 to 0.7 kg/m of growth. However, shoot numbers were very low at about 7/m, resulting in very heavy individual shoots (80 to 100 g). Nevertheless, the yield:pruning ratios are in a reasonable range of 5 to 7.

Figure 4.

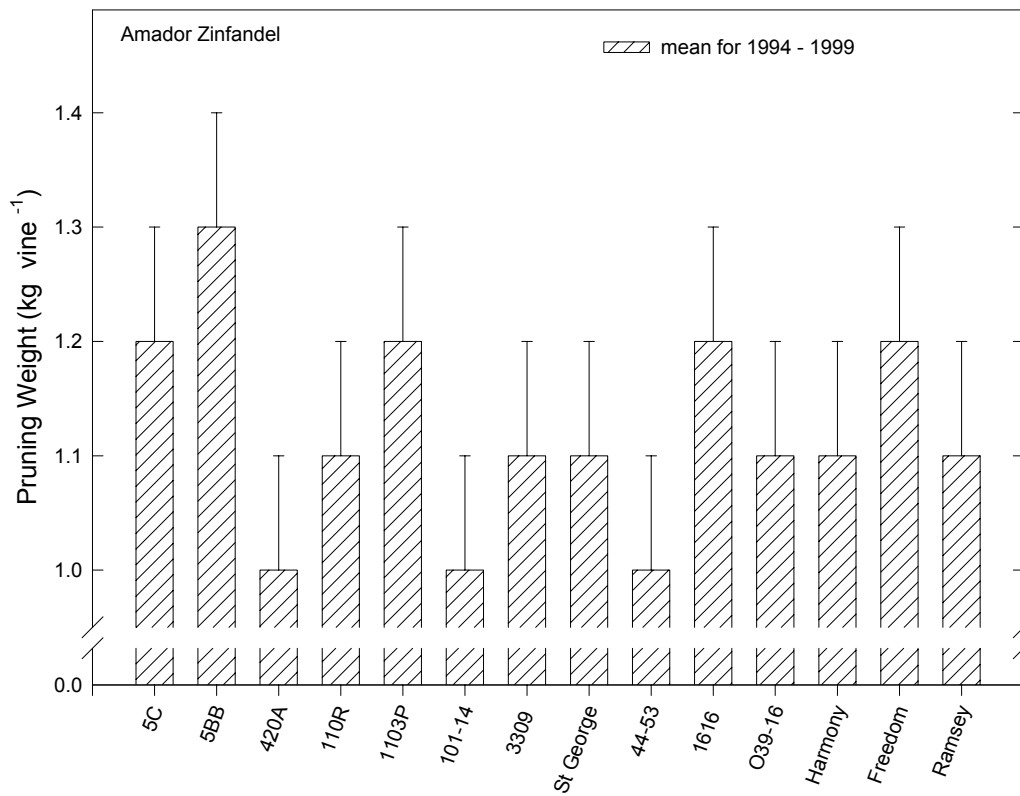
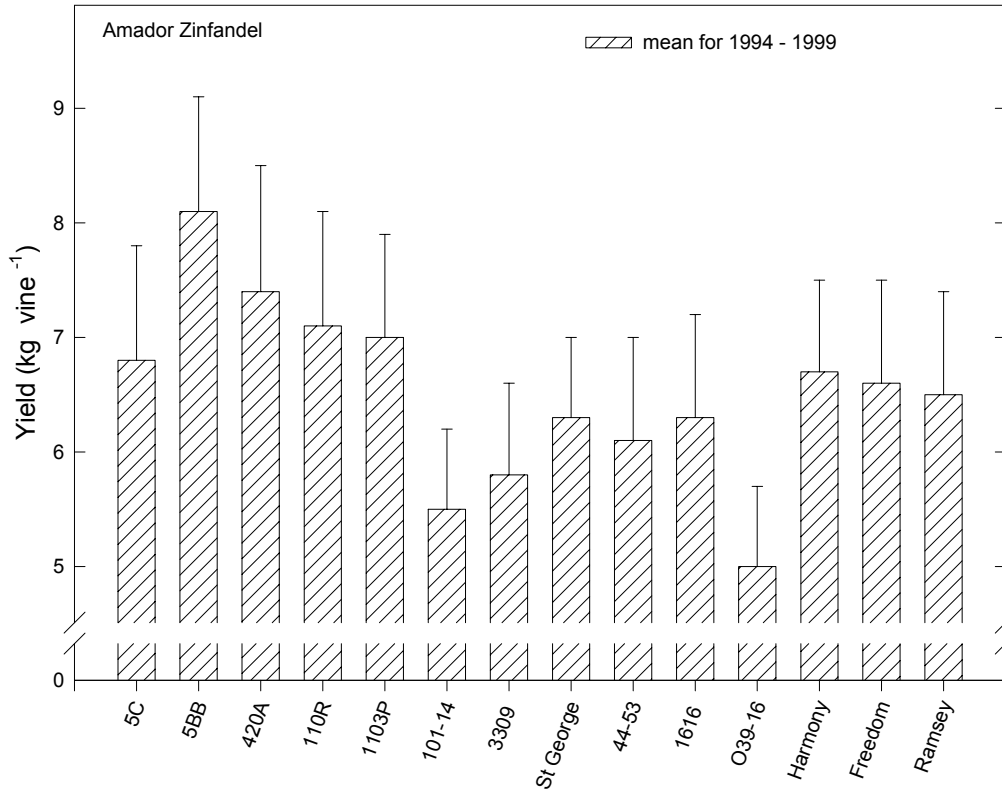


Table 21 - 1994 - 1999  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	6.8 ± 1.0	1.2 ± 0.1	13 ± 1	91 ± 5	6.3 ± 1.1
5BB	8.1 ± 1.0	1.3 ± 0.1	13 ± 1	101 ± 7	6.9 ± 0.9
420A	7.4 ± 1.1	1.0 ± 0.1	13 ± 1	81 ± 5	8.0 ± 1.4
110R	7.1 ± 1.0	1.1 ± 0.1	13 ± 1	84 ± 5	7.1 ± 1.1
1103P	7.0 ± 0.9	1.2 ± 0.1	13 ± 1	93 ± 4	6.2 ± 0.9
101-14	5.5 ± 0.7	1.0 ± 0.1	13 ± 1	81 ± 6	6.1 ± 0.9
3309	5.8 ± 0.8	1.1 ± 0.1	13 ± 1	87 ± 8	6.1 ± 0.9
St. Geo	6.3 ± 0.7	1.1 ± 0.1	13 ± 1	91 ± 5	5.8 ± 0.6
44-53	6.1 ± 0.9	1.0 ± 0.1	12 ± 1	93 ± 7	6.4 ± 1.0
1616	6.3 ± 0.9	1.2 ± 0.1	13 ± 1	95 ± 7	5.7 ± 0.8
O39-16	5.0 ± 0.7	1.1 ± 0.1	13 ± 1	87 ± 5	4.8 ± 0.7
Harmony	6.7 ± 0.8	1.1 ± 0.1	12 ± 1	88 ± 7	6.6 ± 0.8
Freedom	6.6 ± 0.9	1.2 ± 0.1	13 ± 1	93 ± 7	5.9 ± 0.8
Ramsey	6.5 ± 0.9	1.1 ± 0.1	13 ± 1	83 ± 6	6.6 ± 0.9

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	23 ± 1	292 ± 40	143 ± 18	2.0 ± 0.1
5BB	25 ± 1	327 ± 38	154 ± 18	2.1 ± 0.1
420A	22 ± 1	329 ± 41	158 ± 20	2.1 ± 0.1
110R	24 ± 1	296 ± 36	146 ± 17	2.0 ± 0.1
1103P	24 ± 1	297 ± 35	144 ± 15	2.0 ± 0.1
101-14	21 ± 1	266 ± 32	147 ± 18	1.8 ± 0.1
3309	22 ± 1	273 ± 37	140 ± 18	1.9 ± 0.1
St. Geo	23 ± 0	279 ± 33	140 ± 15	2.0 ± 0.1
44-53	21 ± 1	285 ± 34	142 ± 15	2.0 ± 0.1
1616	22 ± 1	283 ± 37	141 ± 16	1.9 ± 0.1
O39-16	20 ± 1	248 ± 32	122 ± 15	2.0 ± 0.1
Harmony	22 ± 1	296 ± 34	150 ± 18	2.0 ± 0.1
Freedom	24 ± 1	267 ± 32	131 ± 13	2.0 ± 0.1
Ramsey	22 ± 1	288 ± 32	137 ± 14	2.1 ± 0.1

Table 21 (cont) - 1994 - 1999  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	24.2 ± 0.4	6.5 ± 0.3	3.58 ± 0.06	1677 ± 68
5BB	23.7 ± 0.4	7.0 ± 0.4	3.57 ± 0.05	1640 ± 100
420A	23.7 ± 0.6	6.6 ± 0.4	3.55 ± 0.06	1634 ± 118
110R	24.4 ± 0.4	6.5 ± 0.4	3.54 ± 0.05	1683 ± 78
1103P	23.7 ± 0.3	6.7 ± 0.3	3.52 ± 0.05	1596 ± 71
101-14	25.2 ± 0.4	6.1 ± 0.3	3.67 ± 0.08	1658 ± 130
3309	25.0 ± 0.4	6.3 ± 0.3	3.63 ± 0.06	1801 ± 115
St. Geo	24.8 ± 0.3	6.0 ± 0.2	3.70 ± 0.04	1828 ± 118
44-53	25.0 ± 0.3	6.6 ± 0.4	3.68 ± 0.06	1879 ± 101
1616	24.3 ± 0.3	6.4 ± 0.4	3.64 ± 0.06	1785 ± 82
O39-16	24.6 ± 0.3	6.1 ± 0.3	3.72 ± 0.06	1940 ± 129
Harmony	24.1 ± 0.3	6.1 ± 0.4	3.63 ± 0.05	1650 ± 94
Freedom	24.8 ± 0.3	6.3 ± 0.4	3.64 ± 0.06	1595 ± 89
Ramsey	24.2 ± 0.4	6.6 ± 0.3	3.62 ± 0.04	1696 ± 64

Table 22 - 1994  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	5.0 ± 0.6	1.2 ± 0.1	12 ± 0	103 ± 3	4.0 ± 0.4
5BB	7.5 ± 0.8	1.3 ± 0.1	13 ± 0	99 ± 5	5.8 ± 0.5
420A	6.5 ± 0.6	1.1 ± 0.0	12 ± 0	92 ± 4	6.1 ± 0.6
110R	6.0 ± 0.7	1.1 ± 0.1	12 ± 0	88 ± 4	5.4 ± 0.3
1103P	6.2 ± 0.2	1.2 ± 0.0	13 ± 0	99 ± 3	5.1 ± 0.1
101-14	4.3 ± 0.4	1.1 ± 0.1	11 ± 0	95 ± 9	4.0 ± 0.2
3309	4.9 ± 0.4	1.1 ± 0.1	12 ± 0	89 ± 5	4.6 ± 0.4
St. Geo	5.8 ± 0.4	1.2 ± 0.1	12 ± 0	99 ± 6	5.0 ± 0.4
44-53	4.4 ± 0.3	1.0 ± 0.1	9 ± 0	111 ± 10	4.6 ± 0.4
1616	4.9 ± 0.7	1.4 ± 0.1	12 ± 0	111 ± 10	3.6 ± 0.4
O39-16	3.5 ± 0.2	1.1 ± 0.1	12 ± 0	93 ± 6	3.2 ± 0.1
Harmony	5.8 ± 0.6	1.2 ± 0.0	12 ± 0	100 ± 6	5.0 ± 0.5
Freedom	4.9 ± 0.5	1.3 ± 0.1	12 ± 0	111 ± 10	3.7 ± 0.1
Ramsey	5.5 ± 0.4	1.2 ± 0.0	12 ± 0	101 ± 5	4.8 ± 0.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	21 ± 1	235 ± 19	117 ± 9	2.0 ± 0.0
5BB	24 ± 1	306 ± 20	144 ± 6	2.1 ± 0.1
420A	20 ± 1	314 ± 13	148 ± 7	2.1 ± 0.0
110R	22 ± 1	264 ± 21	123 ± 8	2.1 ± 0.0
1103P	22 ± 1	277 ± 6	136 ± 4	2.0 ± 0.0
101-14	18 ± 1	242 ± 15	127 ± 7	1.9 ± 0.0
3309	19 ± 1	254 ± 10	127 ± 5	2.0 ± 0.0
St. Geo	22 ± 1	270 ± 13	134 ± 5	2.0 ± 0.0
44-53	16 ± 1	266 ± 18	139 ± 10	1.9 ± 0.0
1616	19 ± 1	246 ± 24	123 ± 11	2.0 ± 0.1
O39-16	16 ± 1	213 ± 11	106 ± 6	2.0 ± 0.0
Harmony	20 ± 1	277 ± 13	143 ± 7	1.9 ± 0.0
Freedom	23 ± 2	216 ± 7	109 ± 2	2.0 ± 0.1
Ramsey	19 ± 1	279 ± 10	133 ± 5	2.1 ± 0.0



Table 22 (cont) - 1994  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	25.7 ± 0.4	7.4 ± 0.1	3.71 ± 0.02	
5BB	24.7 ± 0.4	7.7 ± 0.1	3.61 ± 0.02	
420A	24.8 ± 0.3	7.2 ± 0.1	3.67 ± 0.02	
110R	25.4 ± 0.2	7.5 ± 0.1	3.60 ± 0.02	
1103P	24.6 ± 0.3	7.7 ± 0.1	3.58 ± 0.02	
101-14	25.9 ± 0.3	6.0 ± 0.2	3.99 ± 0.02	
3309	25.7 ± 0.3	6.4 ± 0.1	3.84 ± 0.03	
St. Geo	25.2 ± 0.3	6.4 ± 0.1	3.77 ± 0.03	
44-53	26.3 ± 0.3	7.0 ± 0.3	3.89 ± 0.03	
1616	25.2 ± 0.4	7.5 ± 0.3	3.82 ± 0.03	
O39-16	25.9 ± 0.1	5.9 ± 0.1	3.92 ± 0.01	
Harmony	24.6 ± 0.6	6.8 ± 0.1	3.74 ± 0.02	
Freedom	26.0 ± 0.4	6.9 ± 0.2	3.80 ± 0.03	
Ramsey	24.9 ± 0.3	6.9 ± 0.2	3.72 ± 0.02	

Table 23 - 1995  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	±	1.5 ± 0.1	13 ± 0	113 ± 5	±
5BB	±	1.8 ± 0.1	13 ± 1	135 ± 9	±
420A	±	1.3 ± 0.1	13 ± 0	104 ± 7	±
110R	±	1.4 ± 0.1	12 ± 0	109 ± 4	±
1103P	±	1.5 ± 0.1	13 ± 0	109 ± 7	±
101-14	±	1.3 ± 0.1	12 ± 0	106 ± 10	±
3309	±	1.6 ± 0.2	12 ± 0	126 ± 14	±
St. Geo	±	1.4 ± 0.1	13 ± 0	110 ± 5	±
44-53	±	1.3 ± 0.1	11 ± 0	120 ± 5	±
1616	±	1.5 ± 0.0	13 ± 1	121 ± 4	±
O39-16	±	1.4 ± 0.1	13 ± 0	108 ± 4	±
Harmony	±	1.4 ± 0.1	12 ± 0	114 ± 6	±
Freedom	±	1.5 ± 0.1	13 ± 0	118 ± 6	±
Ramsey	±	1.4 ± 0.1	13 ± 0	101 ± 6	±

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	±	±	±	2.3 ± 0.1
5BB	±	±	±	2.3 ± 0.1
420A	±	±	±	2.3 ± 0.1
110R	±	±	±	2.3 ± 0.1
1103P	±	±	±	2.3 ± 0.1
101-14	±	±	±	2.0 ± 0.0
3309	±	±	±	2.3 ± 0.1
St. Geo	±	±	±	2.2 ± 0.0
44-53	±	±	±	2.4 ± 0.1
1616	±	±	±	2.2 ± 0.0
O39-16	±	±	±	2.4 ± 0.1
Harmony	±	±	±	2.2 ± 0.1
Freedom	±	±	±	2.2 ± 0.1
Ramsey	±	±	±	2.3 ± 0.1

Table 23 (cont) - 1995  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.3 ± 0.3	7.4 ± 0.2	3.39 ± 0.01	1596 ± 50
5BB	23.3 ± 0.2	8.0 ± 0.2	3.43 ± 0.02	1626 ± 42
420A	22.6 ± 0.2	7.6 ± 0.2	3.39 ± 0.03	1639 ± 41
110R	23.7 ± 0.3	7.5 ± 0.2	3.39 ± 0.01	1518 ± 35
1103P	23.5 ± 0.2	7.5 ± 0.2	3.43 ± 0.02	1597 ± 44
101-14	25.2 ± 0.3	7.4 ± 0.1	3.46 ± 0.04	1652 ± 49
3309	24.4 ± 0.4	6.9 ± 0.2	3.45 ± 0.02	1566 ± 37
St. Geo	24.9 ± 0.2	6.4 ± 0.1	3.53 ± 0.05	1563 ± 54
44-53	24.5 ± 0.2	7.7 ± 0.2	3.46 ± 0.03	1655 ± 30
1616	23.7 ± 0.4	6.9 ± 0.2	3.50 ± 0.02	1665 ± 25
O39-16	23.4 ± 0.2	6.8 ± 0.2	3.49 ± 0.02	1611 ± 29
Harmony	23.9 ± 0.2	7.3 ± 0.2	3.46 ± 0.03	1601 ± 29
Freedom	24.4 ± 0.3	7.3 ± 0.1	3.48 ± 0.03	1500 ± 37
Ramsey	23.7 ± 0.4	7.5 ± 0.3	3.44 ± 0.02	1538 ± 29

Table 24 - 1996  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	10.8 ± 0.5	1.0 ± 0.0	12 ± 0	89 ± 4	10.4 ± 0.6
5BB	12.0 ± 0.4	1.1 ± 0.1	12 ± 0	95 ± 8	10.8 ± 0.8
420A	12.1 ± 0.7	0.9 ± 0.0	12 ± 0	72 ± 4	13.7 ± 0.4
110R	11.2 ± 0.9	1.0 ± 0.0	12 ± 0	79 ± 2	11.7 ± 1.3
1103P	10.4 ± 0.3	1.1 ± 0.1	12 ± 0	91 ± 4	9.9 ± 0.7
101-14	8.1 ± 0.4	0.9 ± 0.1	12 ± 0	81 ± 10	9.0 ± 0.7
3309	8.8 ± 0.3	1.0 ± 0.1	12 ± 0	84 ± 5	9.2 ± 0.6
St. Geo	9.1 ± 0.4	1.1 ± 0.0	12 ± 0	96 ± 3	8.1 ± 0.4
44-53	9.4 ± 0.5	1.0 ± 0.1	11 ± 0	92 ± 6	9.5 ± 1.1
1616	9.7 ± 1.0	1.1 ± 0.1	12 ± 0	92 ± 5	8.8 ± 0.7
O39-16	6.9 ± 0.7	1.1 ± 0.1	12 ± 0	92 ± 6	6.1 ± 0.4
Harmony	9.6 ± 0.8	1.1 ± 0.1	12 ± 0	91 ± 5	9.1 ± 0.7
Freedom	9.8 ± 0.9	1.2 ± 0.1	13 ± 0	91 ± 8	8.7 ± 0.8
Ramsey	10.1 ± 0.7	1.0 ± 0.0	12 ± 0	84 ± 4	10.0 ± 0.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	25 ± 1	445 ± 13	207 ± 5	2.2 ± 0.1
5BB	26 ± 1	463 ± 9	217 ± 6	2.2 ± 0.1
420A	25 ± 1	493 ± 16	233 ± 6	2.2 ± 0.1
110R	26 ± 1	441 ± 19	210 ± 13	2.1 ± 0.1
1103P	25 ± 1	431 ± 11	194 ± 10	2.2 ± 0.1
101-14	21 ± 1	390 ± 20	212 ± 16	1.9 ± 0.1
3309	22 ± 1	409 ± 15	203 ± 7	2.0 ± 0.1
St. Geo	22 ± 1	409 ± 16	194 ± 10	2.1 ± 0.0
44-53	23 ± 1	411 ± 23	195 ± 10	2.1 ± 0.0
1616	23 ± 2	424 ± 27	199 ± 9	2.1 ± 0.1
O39-16	19 ± 1	366 ± 14	167 ± 6	2.2 ± 0.0
Harmony	23 ± 1	424 ± 16	214 ± 5	2.0 ± 0.0
Freedom	25 ± 1	390 ± 21	176 ± 9	2.2 ± 0.0
Ramsey	25 ± 1	403 ± 14	183 ± 6	2.2 ± 0.1

Table 24 (cont) - 1996  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.7 ± 0.4	5.4 ± 0.0	3.70 ± 0.03	1674 ± 131
5BB	22.1 ± 0.4	5.8 ± 0.1	3.73 ± 0.02	1413 ± 132
420A	21.3 ± 0.2	5.3 ± 0.1	3.68 ± 0.05	1379 ± 82
110R	22.9 ± 0.4	5.4 ± 0.1	3.68 ± 0.01	1708 ± 193
1103P	22.4 ± 0.2	5.7 ± 0.1	3.66 ± 0.02	1411 ± 131
101-14	23.4 ± 0.4	5.3 ± 0.1	3.76 ± 0.04	1305 ± 51
3309	23.5 ± 0.4	5.5 ± 0.1	3.76 ± 0.01	2126 ± 44
St. Geo	23.7 ± 0.2	5.3 ± 0.1	3.82 ± 0.04	1932 ± 125
44-53	24.0 ± 0.1	5.5 ± 0.1	3.84 ± 0.01	2175 ± 93
1616	23.7 ± 0.2	5.8 ± 0.3	3.79 ± 0.02	1903 ± 176
O39-16	24.1 ± 0.2	5.2 ± 0.1	3.88 ± 0.03	2335 ± 59
Harmony	23.0 ± 0.4	5.1 ± 0.1	3.78 ± 0.04	1572 ± 93
Freedom	23.8 ± 0.4	5.3 ± 0.1	3.77 ± 0.03	1497 ± 201
Ramsey	22.6 ± 0.2	5.5 ± 0.1	3.68 ± 0.01	1653 ± 112

Table 25 - 1997  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	7.5 ± 0.3	1.0 ± 0.0	13 ± 0	80 ± 3	7.5 ± 0.3
5BB	7.8 ± 0.3	1.2 ± 0.1	12 ± 0	102 ± 9	6.7 ± 0.4
420A	6.9 ± 0.3	0.8 ± 0.0	11 ± 0	70 ± 5	9.0 ± 0.7
110R	6.6 ± 0.4	0.9 ± 0.0	12 ± 0	79 ± 4	7.2 ± 0.4
1103P	7.1 ± 0.3	1.1 ± 0.0	12 ± 0	93 ± 5	6.6 ± 0.5
101-14	6.1 ± 0.4	0.8 ± 0.1	11 ± 0	69 ± 5	7.7 ± 0.2
3309	5.8 ± 0.3	0.8 ± 0.0	12 ± 0	72 ± 5	7.1 ± 0.4
St. Geo	6.4 ± 0.3	1.0 ± 0.0	12 ± 0	81 ± 3	6.6 ± 0.4
44-53	6.7 ± 0.3	0.8 ± 0.1	11 ± 0	74 ± 7	8.3 ± 0.7
1616	6.5 ± 0.5	1.0 ± 0.1	12 ± 0	83 ± 7	6.6 ± 0.6
O39-16	5.8 ± 0.2	0.9 ± 0.0	12 ± 0	75 ± 4	6.6 ± 0.3
Harmony	6.8 ± 0.2	0.9 ± 0.0	12 ± 0	76 ± 4	7.8 ± 0.4
Freedom	7.4 ± 0.5	1.1 ± 0.1	13 ± 0	83 ± 9	7.2 ± 0.6
Ramsey	6.6 ± 0.3	0.9 ± 0.0	12 ± 0	70 ± 3	7.7 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	23 ± 1	331 ± 16	161 ± 5	2.1 ± 0.0
5BB	21 ± 1	367 ± 8	173 ± 5	2.1 ± 0.1
420A	20 ± 1	336 ± 11	174 ± 4	1.9 ± 0.0
110R	22 ± 1	297 ± 13	154 ± 5	1.9 ± 0.1
1103P	22 ± 1	318 ± 12	149 ± 6	2.1 ± 0.0
101-14	22 ± 1	280 ± 15	158 ± 7	1.8 ± 0.1
3309	20 ± 0	292 ± 11	150 ± 6	2.0 ± 0.1
St. Geo	22 ± 0	285 ± 11	136 ± 7	2.1 ± 0.1
44-53	21 ± 1	318 ± 6	158 ± 7	2.0 ± 0.1
1616	22 ± 1	304 ± 11	148 ± 4	2.1 ± 0.0
O39-16	23 ± 1	259 ± 9	129 ± 8	2.0 ± 0.1
Harmony	22 ± 1	305 ± 8	153 ± 5	2.0 ± 0.0
Freedom	26 ± 3	289 ± 15	146 ± 6	2.0 ± 0.0
Ramsey	22 ± 1	305 ± 5	147 ± 3	2.1 ± 0.0

Table 25 (cont) - 1997  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	24.3 ± 0.2	6.0 ± 0.2	3.60 ± 0.02	1896 ± 21
5BB	24.8 ± 0.2	6.5 ± 0.3	3.65 ± 0.01	1960 ± 32
420A	24.9 ± 0.3	6.4 ± 0.2	3.61 ± 0.02	2010 ± 80
110R	25.3 ± 0.2	5.8 ± 0.2	3.62 ± 0.03	1927 ± 33
1103P	24.3 ± 0.4	6.3 ± 0.5	3.57 ± 0.04	1811 ± 27
101-14	26.2 ± 0.2	5.6 ± 0.1	3.70 ± 0.01	2038 ± 45
3309	25.8 ± 0.4	6.2 ± 0.2	3.56 ± 0.01	1907 ± 24
St. Geo	26.0 ± 0.2	5.4 ± 0.1	3.72 ± 0.03	2163 ± 71
44-53	24.5 ± 0.3	6.4 ± 0.2	3.59 ± 0.03	1954 ± 24
1616	25.3 ± 0.4	5.8 ± 0.1	3.62 ± 0.01	1986 ± 56
O39-16	25.0 ± 0.1	5.9 ± 0.2	3.62 ± 0.01	1897 ± 48
Harmony	25.5 ± 0.3	5.5 ± 0.1	3.69 ± 0.03	1962 ± 54
Freedom	25.3 ± 0.2	5.9 ± 0.1	3.67 ± 0.02	1904 ± 53
Ramsey	25.4 ± 0.1	6.5 ± 0.1	3.59 ± 0.01	1892 ± 45

Table 26 - 1998  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	4.4 ± 0.2	1.0 ± 0.0	11 ± 0	86 ± 4	4.6 ± 0.2
5BB	5.3 ± 0.5	1.1 ± 0.1	12 ± 0	97 ± 0	4.9 ± 0.6
420A	4.9 ± 0.4	0.9 ± 0.1	12 ± 0	77 ± 8	5.7 ± 1.0
110R	4.6 ± 0.3	0.9 ± 0.0	12 ± 0	75 ± 4	5.3 ± 0.2
1103P	4.5 ± 0.3	1.1 ± 0.1	12 ± 0	91 ± 3	4.1 ± 0.2
101-14	3.7 ± 0.1	0.9 ± 0.1	12 ± 0	73 ± 5	4.2 ± 0.3
3309	3.6 ± 0.3	1.0 ± 0.1	12 ± 0	83 ± 5	3.7 ± 0.4
St. Geo	3.9 ± 0.3	1.0 ± 0.1	12 ± 0	87 ± 6	4.0 ± 0.6
44-53	4.0 ± 0.3	1.0 ± 0.0	11 ± 0	91 ± 6	3.9 ± 0.2
1616	4.0 ± 0.4	1.0 ± 0.1	12 ± 0	89 ± 6	4.0 ± 0.4
O39-16	2.8 ± 0.3	0.9 ± 0.1	11 ± 0	84 ± 6	2.9 ± 0.1
Harmony	4.2 ± 0.3	1.0 ± 0.0	12 ± 0	83 ± 1	4.3 ± 0.3
Freedom	4.0 ± 0.4	1.0 ± 0.1	12 ± 0	84 ± 9	4.3 ± 0.7
Ramsey	4.4 ± 0.5	0.9 ± 0.0	12 ± 0	75 ± 5	4.9 ± 0.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	24 ± 1	188 ± 9	90 ± 6	2.1 ± 0.1
5BB	25 ± 1	209 ± 12	95 ± 5	2.2 ± 0.1
420A	22 ± 1	218 ± 15	99 ± 9	2.2 ± 0.1
110R	24 ± 1	196 ± 8	97 ± 4	2.0 ± 0.1
1103P	24 ± 1	190 ± 10	92 ± 3	2.1 ± 0.1
101-14	22 ± 1	173 ± 6	93 ± 3	1.9 ± 0.0
3309	23 ± 1	152 ± 8	79 ± 4	1.9 ± 0.0
St. Geo	22 ± 1	178 ± 16	91 ± 8	2.0 ± 0.0
44-53	22 ± 0	180 ± 13	89 ± 6	2.0 ± 0.0
1616	23 ± 1	175 ± 11	93 ± 6	1.9 ± 0.0
O39-16	19 ± 1	145 ± 15	68 ± 5	2.1 ± 0.1
Harmony	22 ± 1	188 ± 10	88 ± 7	2.2 ± 0.1
Freedom	22 ± 2	180 ± 9	90 ± 6	2.1 ± 0.2
Ramsey	24 ± 1	183 ± 12	86 ± 7	2.2 ± 0.1



Table 26 (cont) - 1998  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	24.2 ± 0.2	7.1 ± 0.1	3.38 ± 0.00	1541 ± 67
5BB	23.2 ± 0.1	8.2 ± 0.1	3.36 ± 0.03	1560 ± 53
420A	23.4 ± 0.3	7.4 ± 0.2	3.33 ± 0.03	1507 ± 55
110R	24.2 ± 0.2	7.3 ± 0.2	3.33 ± 0.01	1581 ± 25
1103P	23.3 ± 0.2	7.0 ± 0.1	3.27 ± 0.02	1563 ± 27
101-14	24.7 ± 0.1	6.9 ± 0.1	3.39 ± 0.01	1639 ± 35
3309	24.5 ± 0.2	7.3 ± 0.1	3.51 ± 0.01	1604 ± 29
St. Geo	24.2 ± 0.3	6.9 ± 0.2	3.61 ± 0.05	1654 ± 53
44-53	24.9 ± 0.3	7.4 ± 0.2	3.64 ± 0.02	1733 ± 42
1616	23.8 ± 0.3	7.2 ± 0.0	3.39 ± 0.02	1586 ± 39
O39-16	24.5 ± 0.4	7.4 ± 0.3	3.70 ± 0.02	1917 ± 56
Harmony	23.4 ± 0.2	6.9 ± 0.1	3.44 ± 0.02	1465 ± 26
Freedom	24.1 ± 0.2	7.3 ± 0.2	3.41 ± 0.02	1481 ± 75
Ramsey	23.9 ± 0.3	7.4 ± 0.1	3.63 ± 0.03	1701 ± 58

Table 27 - 1999  
Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	6.3 ± 0.3	1.2 ± 0.1	16 ± 0	76 ± 4	5.1 ± 0.1
5BB	8.0 ± 0.4	1.3 ± 0.1	16 ± 0	81 ± 4	6.3 ± 0.5
420A	6.6 ± 0.4	1.2 ± 0.1	17 ± 0	73 ± 5	5.6 ± 0.4
110R	7.2 ± 0.7	1.2 ± 0.1	16 ± 0	72 ± 3	6.1 ± 0.3
1103P	7.0 ± 0.3	1.2 ± 0.0	17 ± 1	73 ± 3	5.6 ± 0.2
101-14	5.5 ± 0.3	1.0 ± 0.0	17 ± 1	62 ± 4	5.4 ± 0.3
3309	6.1 ± 0.3	1.1 ± 0.1	16 ± 0	68 ± 5	5.7 ± 0.2
St. Geo	6.2 ± 0.4	1.2 ± 0.0	17 ± 0	70 ± 3	5.4 ± 0.3
44-53	6.1 ± 0.3	1.1 ± 0.1	16 ± 1	69 ± 4	5.6 ± 0.6
1616	6.4 ± 0.7	1.2 ± 0.1	16 ± 0	73 ± 7	5.6 ± 0.7
O39-16	5.8 ± 0.3	1.2 ± 0.0	16 ± 0	71 ± 2	5.0 ± 0.2
Harmony	7.1 ± 0.3	1.0 ± 0.0	16 ± 0	63 ± 2	7.0 ± 0.2
Freedom	6.7 ± 0.5	1.2 ± 0.1	17 ± 1	71 ± 8	5.6 ± 0.2
Ramsey	5.8 ± 0.6	1.1 ± 0.1	17 ± 0	64 ± 5	5.4 ± 0.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	24 ± 1	263 ± 11	138 ± 4	1.4 ± 0.0
5BB	27 ± 1	294 ± 6	143 ± 3	1.5 ± 0.0
420A	23 ± 1	285 ± 11	136 ± 6	1.6 ± 0.0
110R	26 ± 1	281 ± 19	144 ± 5	1.5 ± 0.1
1103P	26 ± 1	271 ± 4	146 ± 4	1.4 ± 0.0
101-14	22 ± 1	245 ± 14	145 ± 8	1.3 ± 0.0
3309	24 ± 1	256 ± 7	140 ± 5	1.4 ± 0.1
St. Geo	24 ± 1	255 ± 9	143 ± 7	1.4 ± 0.1
44-53	24 ± 1	253 ± 5	131 ± 7	1.5 ± 0.1
1616	24 ± 2	267 ± 15	143 ± 9	1.4 ± 0.1
O39-16	22 ± 1	259 ± 8	140 ± 7	1.4 ± 0.1
Harmony	25 ± 1	283 ± 8	154 ± 7	1.4 ± 0.0
Freedom	26 ± 1	260 ± 9	133 ± 3	1.5 ± 0.1
Ramsey	21 ± 1	270 ± 14	136 ± 7	1.5 ± 0.1

Table 27 (cont) - 1999  
 Sierra Foothills, Amador County, - Zinfandel / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	25.1 ± 0.1	5.6 ± 0.1	3.67 ± 0.01	±
5BB	24.0 ± 0.3	5.7 ± 0.1	3.63 ± 0.03	±
420A	25.1 ± 0.2	5.5 ± 0.1	3.63 ± 0.02	±
110R	25.0 ± 0.2	5.5 ± 0.1	3.63 ± 0.01	±
1103P	23.9 ± 0.1	6.0 ± 0.1	3.62 ± 0.02	±
101-14	25.7 ± 0.1	5.4 ± 0.0	3.72 ± 0.01	±
3309	25.8 ± 0.4	5.6 ± 0.1	3.68 ± 0.01	±
St. Geo	24.6 ± 0.2	5.6 ± 0.0	3.76 ± 0.02	±
44-53	25.5 ± 0.3	5.5 ± 0.1	3.69 ± 0.01	±
1616	24.4 ± 0.4	5.2 ± 0.1	3.70 ± 0.02	±
O39-16	24.6 ± 0.4	5.2 ± 0.1	3.73 ± 0.02	±
Harmony	24.1 ± 0.1	5.1 ± 0.1	3.67 ± 0.04	±
Freedom	24.9 ± 0.2	5.3 ± 0.1	3.69 ± 0.03	±
Ramsey	24.7 ± 0.3	5.6 ± 0.1	3.64 ± 0.02	±

## Napa Valley Rootstock Trial

Scion: Cabernet Sauvignon

Years conducted: 1994-1997

Years reported: 1994-1997

Rootstocks:

5C  
420A  
110 R  
1103 P  
101-14  
3309 C  
1616 C  
039-16  
Freedom  
Harmony  
AxR#1

Site Conditions: This site is characterized as a very gravelly loam. That, in concert with the winery's desire to deficit-irrigate the vineyard, resulted in moderate yield, most in the range of 4 to 7, with an extreme of 10 kg/vine, and a wide range of pruning wt from 0.5 to 1.7 kg/m. Because this was one of the early Biotype B phylloxera sites, AXR#1 was included with the anticipation that it would fail; it did so by about the 7<sup>th</sup> leaf.

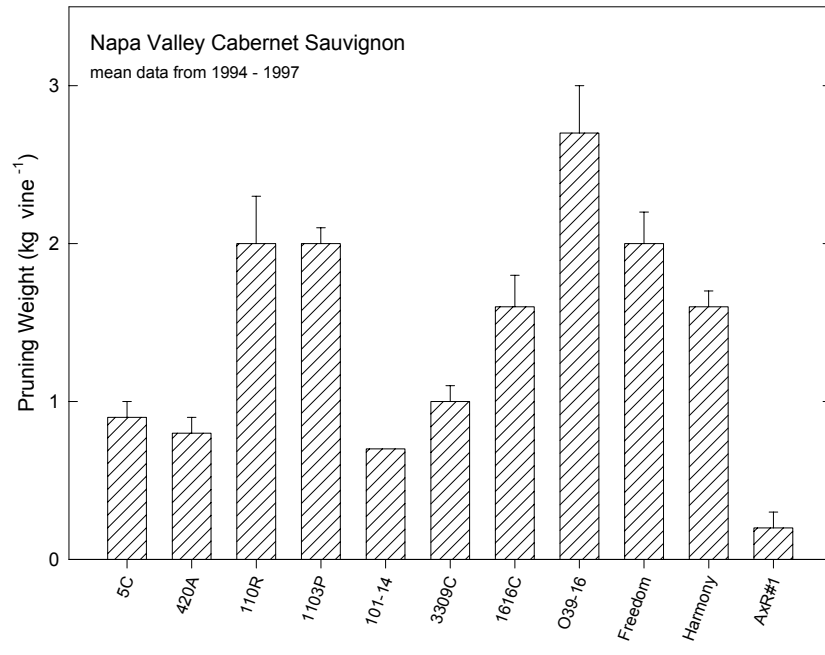
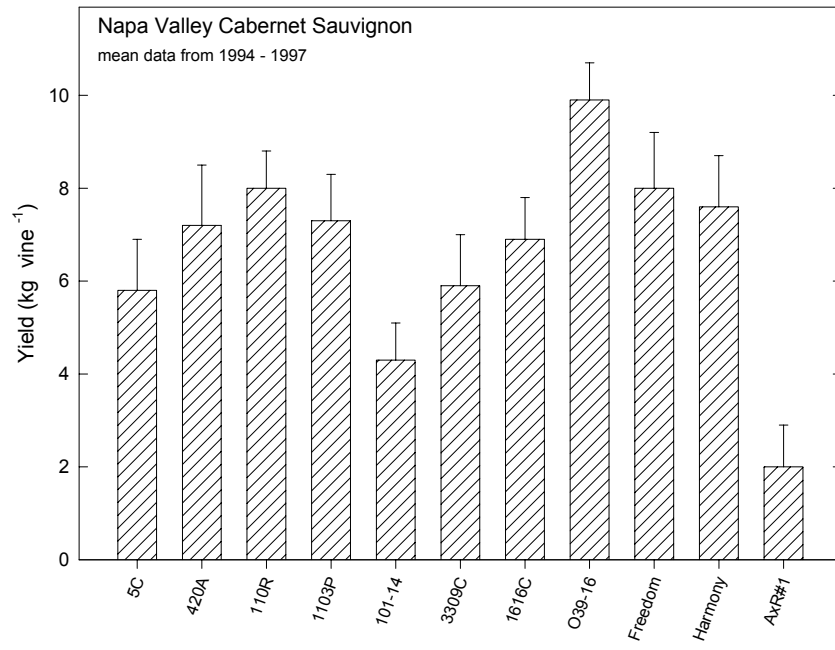


Table 28 - 1994 - 1997  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (1994 - 96) (kg vine <sup>-1</sup> )	Yield : Pruning Weight (1994 - 96)
5C	5.8 ± 1.1	0.9 ± 0.1	5.4 ± 0.2
420A	7.2 ± 1.3	0.8 ± 0.1	7.2 ± 0.6
110 R	8.0 ± 0.8	2.0 ± 0.3	3.7 ± 0.4
1103 P	7.3 ± 1.0	2.0 ± 0.1	3.1 ± 0.2
101-14	4.3 ± 0.8	0.7 ± 0.0	5.3 ± 0.5
3309 C	5.9 ± 1.1	1.0 ± 0.1	5.1 ± 0.9
1616 C	6.9 ± 0.9	1.6 ± 0.2	3.8 ± 0.4
039-16	9.9 ± 0.8	2.7 ± 0.3	3.4 ± 0.3
Freedom	8.0 ± 1.2	2.0 ± 0.2	3.4 ± 0.4
Harmony	7.6 ± 1.1	1.6 ± 0.1	4.2 ± 0.3
AxR#1	2.0 ± 0.9	0.2 ± 0.1	5.2 ± 1.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	36 ± 2	154 ± 21	132 ± 12	1.2 ± 0.1
420A	40 ± 2	174 ± 21	145 ± 12	1.2 ± 0.1
110 R	44 ± 1	183 ± 15	145 ± 9	1.3 ± 0.0
1103 P	42 ± 2	173 ± 18	139 ± 11	1.2 ± 0.0
101-14	34 ± 3	123 ± 16	113 ± 12	1.1 ± 0.1
3309 C	39 ± 3	146 ± 16	128 ± 8	1.1 ± 0.0
1616 C	40 ± 1	169 ± 16	130 ± 11	1.3 ± 0.1
039-16	49 ± 2	204 ± 18	157 ± 15	1.3 ± 0.0
Freedom	44 ± 2	179 ± 19	146 ± 15	1.2 ± 0.1
Harmony	42 ± 2	180 ± 19	142 ± 13	1.3 ± 0.0
AxR#1	19 ± 5	88 ± 18	93 ± 12	0.9 ± 0.1

Table 28 (cont) - 1994 - 1998  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (1995 - 97) (ppm)
5C	23.4 ± 0.3	5.7 ± 0.1	3.56 ± 0.06	1982 ± 88
420A	22.8 ± 0.2	6.2 ± 0.1	3.45 ± 0.05	1886 ± 121
110 R	23.5 ± 0.2	6.4 ± 0.1	3.52 ± 0.05	2173 ± 142
1103 P	23.5 ± 0.3	6.0 ± 0.1	3.55 ± 0.06	2025 ± 107
101-14	22.9 ± 0.3	5.6 ± 0.1	3.54 ± 0.05	1977 ± 92
3309 C	23.3 ± 0.3	5.5 ± 0.1	3.59 ± 0.05	2137 ± 121
1616 C	23.4 ± 0.2	6.4 ± 0.1	3.51 ± 0.05	2034 ± 142
039-16	23.7 ± 0.2	6.5 ± 0.1	3.55 ± 0.05	2198 ± 124
Freedom	23.5 ± 0.3	6.0 ± 0.1	3.61 ± 0.06	2166 ± 136
Harmony	23.5 ± 0.2	6.3 ± 0.0	3.56 ± 0.06	2147 ± 179
AxR#1	23.4 ± 0.6	5.5 ± 0.1	3.55 ± 0.06	1997 ± 45

Table 29 - 1994  
Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	4.1 ± 0.6	0.7 ± 0.1	5.9 ± 0.6
420A	5.8 ± 0.5	0.7 ± 0.1	8.8 ± 1.1
110 R	7.2 ± 0.4	1.8 ± 0.2	4.1 ± 0.4
1103 P	6.3 ± 0.4	1.9 ± 0.2	3.6 ± 0.3
101-14	3.7 ± 0.6	0.7 ± 0.1	6.4 ± 0.7
3309 C	5.5 ± 0.6	0.9 ± 0.1	6.6 ± 0.5
1616 C	5.5 ± 0.6	1.6 ± 0.3	4.1 ± 0.4
039-16	8.7 ± 0.5	2.4 ± 0.2	3.7 ± 0.2
Freedom	7.4 ± 0.5	2.0 ± 0.2	3.9 ± 0.3
Harmony	6.9 ± 0.6	1.5 ± 0.2	4.9 ± 0.5
AxR#1	1.5 ± 0.2	0.2 ± 0.0	7.9 ± 0.6

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	120 ± 10	120 ± 10	106 ± 9	1.2 ± 0.0
420A	147 ± 8	147 ± 8	124 ± 5	1.2 ± 0.0
110 R	166 ± 7	166 ± 7	131 ± 6	1.3 ± 0.0
1103 P	150 ± 6	150 ± 6	122 ± 4	1.2 ± 0.0
101-14	98 ± 12	98 ± 12	93 ± 7	1.0 ± 0.1
3309 C	129 ± 9	129 ± 9	118 ± 6	1.1 ± 0.0
1616 C	146 ± 12	146 ± 12	111 ± 9	1.3 ± 0.0
039-16	176 ± 8	176 ± 8	129 ± 7	1.4 ± 0.0
Freedom	155 ± 7	155 ± 7	123 ± 5	1.3 ± 0.0
Harmony	159 ± 8	159 ± 8	127 ± 4	1.2 ± 0.0
AxR#1	71 ± 4	71 ± 4	79 ± 4	0.9 ± 0.0



Table 29 (cont) - 1994  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	23.6 ± 0.1	5.7 ± 0.1	3.66 ± 0.01
420A	22.7 ± 0.2	6.1 ± 0.1	3.53 ± 0.02
110 R	24.0 ± 0.1	6.1 ± 0.2	3.60 ± 0.01
1103 P	24.0 ± 0.1	5.9 ± 0.1	3.68 ± 0.01
101-14	23.3 ± 0.2	5.7 ± 0.1	3.66 ± 0.03
3309 C	23.3 ± 0.2	5.7 ± 0.1	3.69 ± 0.03
1616 C	23.7 ± 0.2	6.5 ± 0.1	3.59 ± 0.02
039-16	23.8 ± 0.2	6.3 ± 0.1	3.65 ± 0.01
Freedom	23.7 ± 0.2	6.0 ± 0.2	3.72 ± 0.02
Harmony	23.6 ± 0.2	6.3 ± 0.2	3.64 ± 0.02
AxR#1	22.9 ± 0.3	5.5 ± 0.1	3.56 ± 0.02

Table 30 - 1995  
Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	5.3 ± 0.5	0.9 ± 0.1	6.1 ± 0.5
420A	5.7 ± 0.5	0.8 ± 0.1	7.8 ± 0.3
110 R	6.9 ± 0.2	1.7 ± 0.1	4.4 ± 0.3
1103 P	6.4 ± 0.3	1.9 ± 0.2	3.7 ± 0.4
101-14	3.9 ± 0.6	0.7 ± 0.1	5.9 ± 0.3
3309 C	4.7 ± 0.3	0.9 ± 0.1	5.4 ± 0.3
1616 C	6.4 ± 0.4	1.4 ± 0.2	5.0 ± 0.4
039-16	9.2 ± 0.4	2.5 ± 0.2	3.8 ± 0.3
Freedom	6.9 ± 0.3	1.8 ± 0.2	4.1 ± 0.3
Harmony	6.7 ± 0.4	1.7 ± 0.2	4.2 ± 0.3
AxR#1	0.7 ± 0.2	0.2 ± 0.0	5.0 ± 0.6

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	37 ± 1	142 ± 11	135 ± 9	1.1 ± 0.0
420A	37 ± 1	153 ± 8	143 ± 5	1.1 ± 0.0
110 R	41 ± 1	172 ± 6	154 ± 8	1.1 ± 0.0
1103 P	37 ± 1	172 ± 7	148 ± 5	1.2 ± 0.0
101-14	32 ± 3	118 ± 11	122 ± 8	1.0 ± 0.0
3309 C	38 ± 1	124 ± 5	118 ± 5	1.1 ± 0.0
1616 C	39 ± 2	162 ± 6	140 ± 4	1.2 ± 0.0
039-16	42 ± 2	220 ± 10	183 ± 9	1.2 ± 0.0
Freedom	39 ± 1	178 ± 9	169 ± 8	1.1 ± 0.0
Harmony	38 ± 1	180 ± 19	153 ± 12	1.2 ± 0.0
AxR#1	10 ± 1	71 ± 6	88 ± 12	0.8 ± 0.0

Table 30 (cont) - 1995  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.8 ± 0.2	6.2 ± 0.2	3.59 ± 0.01	1819 ± 23
420A	22.5 ± 0.3	6.5 ± 0.1	3.39 ± 0.02	1654 ± 51
110 R	23.4 ± 0.1	6.4 ± 0.1	3.57 ± 0.01	1891 ± 17
1103 P	23.3 ± 0.2	6.3 ± 0.1	3.54 ± 0.01	1945 ± 55
101-14	23.1 ± 0.5	5.7 ± 0.2	3.49 ± 0.03	1821 ± 38
3309 C	23.6 ± 0.2	5.5 ± 0.2	3.62 ± 0.01	1894 ± 25
1616 C	23.6 ± 0.2	6.2 ± 0.2	3.55 ± 0.01	1815 ± 31
039-16	23.8 ± 0.2	6.7 ± 0.1	3.51 ± 0.02	2002 ± 23
Freedom	23.8 ± 0.2	6.0 ± 0.1	3.67 ± 0.01	1906 ± 32
Harmony	23.7 ± 0.1	6.2 ± 0.1	3.58 ± 0.01	1841 ± 12
AxR#1	24.9 ± 0.4	5.7 ± 0.1	3.70 ± 0.02	1929 ± 15

Table 31 - 1996  
Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	4.9 ± 0.6	1.0 ± 0.1	5.1 ± 0.4
420A	6.1 ± 0.3	1.0 ± 0.1	6.3 ± 0.5
110 R	7.5 ± 0.4	2.5 ± 0.2	3.1 ± 0.2
1103 P	6.2 ± 0.5	2.3 ± 0.2	2.7 ± 0.2
101-14	3.0 ± 0.4	0.7 ± 0.1	4.4 ± 0.3
3309 C	4.3 ± 0.3	1.2 ± 0.2	3.9 ± 0.4
1616 C	6.1 ± 0.3	1.9 ± 0.3	3.5 ± 0.3
039-16	9.1 ± 0.3	3.3 ± 0.3	2.9 ± 0.3
Freedom	6.4 ± 0.4	2.3 ± 0.2	2.8 ± 0.2
Harmony	6.0 ± 0.4	2.5 ± 0.3	2.5 ± 0.2
AxR#1	1.1 ± 0.1	0.4 ± 0.1	3.2 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	34 ± 2	140 ± 9	124 ± 7	1.1 ± 0.0
420A	39 ± 2	157 ± 4	135 ± 3	1.2 ± 0.0
110 R	45 ± 2	167 ± 5	129 ± 4	1.3 ± 0.0
1103 P	42 ± 2	147 ± 6	120 ± 6	1.2 ± 0.0
101-14	27 ± 2	107 ± 9	96 ± 7	1.1 ± 0.0
3309 C	31 ± 2	138 ± 5	124 ± 5	1.1 ± 0.0
1616 C	40 ± 1	153 ± 5	113 ± 5	1.4 ± 0.0
039-16	53 ± 1	172 ± 5	134 ± 4	1.3 ± 0.0
Freedom	42 ± 2	151 ± 4	116 ± 4	1.3 ± 0.0
Harmony	41 ± 2	149 ± 5	115 ± 5	1.3 ± 0.0
AxR#1	16 ± 1	70 ± 5	76 ± 4	0.9 ± 0.0

Table 31 (cont) - 1996  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.4 ± 0.2	5.5 ± 0.0	3.60 ± 0.01	2008 ± 41
420A	22.7 ± 0.2	6.1 ± 0.1	3.53 ± 0.01	1944 ± 23
110 R	23.0 ± 0.2	6.5 ± 0.1	3.56 ± 0.01	2343 ± 77
1103 P	22.8 ± 0.2	6.0 ± 0.1	3.61 ± 0.01	1893 ± 38
101-14	22.1 ± 0.2	5.5 ± 0.1	3.59 ± 0.02	1973 ± 23
3309 C	22.5 ± 0.2	5.4 ± 0.1	3.61 ± 0.02	2265 ± 37
1616 C	22.7 ± 0.2	6.2 ± 0.2	3.55 ± 0.01	1985 ± 50
039-16	23.2 ± 0.2	6.4 ± 0.1	3.62 ± 0.01	2162 ± 57
Freedom	22.6 ± 0.3	6.2 ± 0.2	3.64 ± 0.01	2226 ± 41
Harmony	22.9 ± 0.3	6.3 ± 0.1	3.62 ± 0.01	2140 ± 36
AxR#1	22.1 ± 0.3	5.4 ± 0.1	3.54 ± 0.01	2081 ± 26

Table 32 - 1997  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )
5C	8.9 ± 0.6
420A	11.1 ± 0.6
110 R	10.3 ± 0.4
1103 P	10.3 ± 0.5
101-14	6.6 ± 0.7
3309 C	9.0 ± 0.6
1616 C	9.5 ± 0.3
039-16	12.4 ± 0.9
Freedom	11.5 ± 0.4
Harmony	10.7 ± 0.3
AxR#1	4.6 ± 0.6

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	41 ± 2	214 ± 8	164 ± 7	1.3 ± 0.0
420A	47 ± 1	238 ± 11	179 ± 6	1.3 ± 0.0
110 R	46 ± 2	226 ± 6	167 ± 4	1.4 ± 0.0
1103 P	46 ± 2	224 ± 6	167 ± 4	1.3 ± 0.0
101-14	39 ± 2	169 ± 8	142 ± 6	1.2 ± 0.0
3309 C	46 ± 2	195 ± 6	153 ± 4	1.3 ± 0.0
1616 C	44 ± 1	217 ± 3	155 ± 4	1.4 ± 0.0
039-16	50 ± 3	248 ± 7	182 ± 6	1.4 ± 0.0
Freedom	49 ± 2	233 ± 7	175 ± 6	1.3 ± 0.0
Harmony	46 ± 2	234 ± 5	175 ± 4	1.3 ± 0.0
AxR#1	32 ± 2	141 ± 11	129 ± 7	1.1 ± 0.0

Table 32 - 1997  
 Napa Valley – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.7 ± 0.1	5.6 ± 0.1	3.39 ± 0.01	2118 ± 41
420A	23.5 ± 0.2	6.2 ± 0.2	3.35 ± 0.02	2061 ± 81
110 R	23.7 ± 0.1	6.4 ± 0.2	3.37 ± 0.01	2285 ± 38
1103 P	24.0 ± 0.1	6.0 ± 0.2	3.40 ± 0.01	2236 ± 68
101-14	23.3 ± 0.2	5.6 ± 0.2	3.41 ± 0.01	2138 ± 42
3309 C	24.0 ± 0.1	5.5 ± 0.1	3.44 ± 0.01	2251 ± 44
1616 C	23.7 ± 0.2	6.5 ± 0.2	3.37 ± 0.01	2301 ± 50
039-16	23.9 ± 0.2	6.6 ± 0.1	3.41 ± 0.02	2429 ± 35
Freedom	24.1 ± 0.1	5.9 ± 0.1	3.42 ± 0.01	2364 ± 64
Harmony	23.9 ± 0.2	6.3 ± 0.1	3.39 ± 0.02	2461 ± 74
AxR#1	23.8 ± 0.1	5.3 ± 0.1	3.40 ± 0.01	1980 ± 45

## Amador County Dry Farmed Rootstock Trial

Scion: Zinfandel

Years conducted: 1990-2000

Years reported: 1995-2000

Rootstocks:

5C  
5BB  
420A  
110 R  
1103 P  
3309 C  
St George

Site Conditions: This site is characterized as a Sierra coarse sandy loam but, according to the grower, the specific site where the trial is located is also characterized by large amounts of decomposed granite. Thus the site has very low water-holding capacity and was chosen to test rootstocks for drought resistance/avoidance under extreme conditions. After establishment in the first four years, no irrigation was applied. The only exception was two sub-normal rainfall years in the early 1990's, the cooperator gave the vines one irrigation between veraison and harvest. All treatments showed leaf symptoms of water stress, especially after veraison. At harvest, fruit showed exhibited shriveling and occasional raisining. Both leaf and fruit symptoms were highly variable as a function of rootstock.



Figure 6

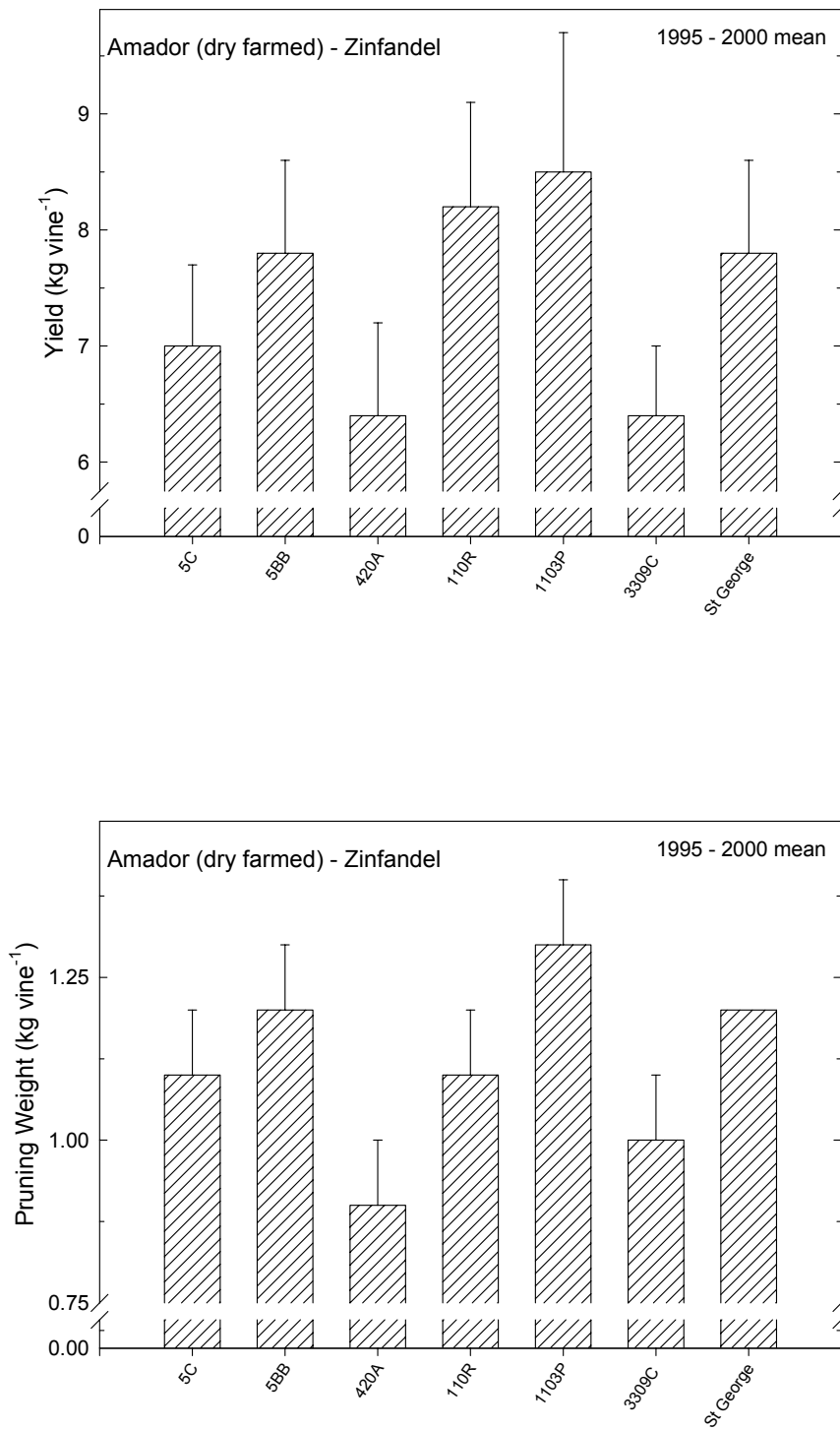


Table 33 - 1995 - 2000  
Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number (no 1998 data)	Shoot Weight (no 1998 data) (g)	Yield : Pruning Weight
5C	7.0 ± 0.7	1.1 ± 0.1	21 ± 1	49 ± 4	6.7 ± 0.9
5BB	7.8 ± 0.8	1.2 ± 0.1	21 ± 1	57 ± 3	6.6 ± 0.7
420A	6.4 ± 0.8	0.9 ± 0.1	21 ± 2	42 ± 4	7.5 ± 1.0
110 R	8.2 ± 0.9	1.1 ± 0.1	21 ± 1	53 ± 2	7.5 ± 0.9
1103 P	8.5 ± 1.2	1.3 ± 0.1	20 ± 2	64 ± 3	6.7 ± 1.0
3309 C	6.4 ± 0.6	1.0 ± 0.1	20 ± 1	51 ± 4	6.6 ± 0.8
St. Geo	7.8 ± 0.8	1.2 ± 0.0	20 ± 1	62 ± 3	6.3 ± 0.7

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	33 ± 3	207 ± 16	118 ± 13	1.8 ± 0.1
5BB	35 ± 3	224 ± 17	119 ± 14	1.9 ± 0.1
420A	31 ± 4	206 ± 18	122 ± 13	1.7 ± 0.1
110 R	36 ± 3	226 ± 17	113 ± 13	2.1 ± 0.1
1103 P	36 ± 4	235 ± 18	123 ± 11	1.9 ± 0.1
3309 C	32 ± 3	202 ± 18	110 ± 13	1.9 ± 0.1
St. Geo	35 ± 3	221 ± 15	114 ± 11	2.0 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (1995 – 1998) (ppm)
5C	23.9 ± 0.4	6.4 ± 0.3	3.58 ± 0.07	2136 ± 435
5BB	23.8 ± 0.4	6.4 ± 0.3	3.59 ± 0.06	2146 ± 362
420A	23.9 ± 0.5	6.0 ± 0.2	3.59 ± 0.07	2252 ± 403
110 R	24.4 ± 0.4	6.4 ± 0.3	3.55 ± 0.06	2149 ± 366
1103 P	23.8 ± 0.4	6.5 ± 0.3	3.59 ± 0.07	2261 ± 422
3309 C	25.0 ± 0.3	6.1 ± 0.3	3.58 ± 0.06	2197 ± 427
St. Geo	24.1 ± 0.3	6.2 ± 0.3	3.61 ± 0.06	2089 ± 420

Table 34 - 1995  
Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	6.9 ± 1.1	1.2 ± 0.1	21 ± 1	56 ± 4	5.7 ± 0.5
5BB	7.7 ± 0.7	1.4 ± 0.1	22 ± 1	64 ± 7	5.7 ± 0.3
420A	6.8 ± 0.9	1.1 ± 0.1	22 ± 2	51 ± 2	6.0 ± 0.2
110 R	9.0 ± 0.5	1.2 ± 0.1	22 ± 1	55 ± 4	7.3 ± 0.4
1103 P	7.2 ± 0.4	1.5 ± 0.1	20 ± 0	72 ± 3	4.9 ± 0.1
3309 C	6.5 ± 0.4	1.2 ± 0.1	20 ± 1	61 ± 2	5.3 ± 0.2
St. Geo	8.0 ± 0.6	1.4 ± 0.1	20 ± 1	72 ± 4	5.7 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	33 ± 2	201 ± 19	99 ± 4	2.0 ± 0.2
5BB	35 ± 1	219 ± 16	95 ± 2	2.3 ± 0.1
420A	32 ± 2	207 ± 19	101 ± 1	2.1 ± 0.2
110 R	40 ± 0	225 ± 14	94 ± 4	2.4 ± 0.1
1103 P	33 ± 0	218 ± 14	97 ± 1	2.3 ± 0.1
3309 C	33 ± 1	198 ± 8	90 ± 3	2.2 ± 0.1
St. Geo	37 ± 2	214 ± 13	100 ± 2	2.2 ± 0.2

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.2 ± 0.2	7.2 ± 0.3	3.46 ± 0.02	1805 ± 68
5BB	23.3 ± 0.3	7.2 ± 0.1	3.48 ± 0.02	2032 ± 61
420A	23.1 ± 0.1	6.5 ± 0.2	3.46 ± 0.02	1975 ± 72
110 R	23.5 ± 0.2	7.1 ± 0.1	3.41 ± 0.02	1978 ± 49
1103 P	24.3 ± 0.2	7.1 ± 0.3	3.54 ± 0.05	2056 ± 14
3309 C	24.6 ± 0.4	6.7 ± 0.1	3.52 ± 0.03	1901 ± 36
St. Geo	23.8 ± 0.2	6.9 ± 0.1	3.50 ± 0.02	1783 ± 37

Table 35 - 1996

## Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	7.1 ± 1.7	1.0 ± 0.1	20 ± 1	48 ± 7	7.0 ± 0.6
5BB	8.6 ± 1.4	1.1 ± 0.1	22 ± 1	51 ± 6	7.5 ± 0.7
420A	6.3 ± 1.3	0.7 ± 0.1	20 ± 2	36 ± 4	8.6 ± 1.2
110 R	8.9 ± 0.9	1.0 ± 0.1	21 ± 1	49 ± 4	8.6 ± 0.5
1103 P	7.5 ± 1.0	1.3 ± 0.1	19 ± 0	68 ± 4	5.9 ± 0.5
3309 C	7.2 ± 0.9	0.9 ± 0.0	19 ± 1	47 ± 2	8.0 ± 0.8
St. Geo	7.9 ± 1.2	1.2 ± 0.1	20 ± 1	62 ± 4	6.2 ± 0.6

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	28 ± 3	238 ± 37	142 ± 9	1.6 ± 0.2
5BB	32 ± 2	265 ± 31	164 ± 14	1.6 ± 0.2
420A	25 ± 1	246 ± 41	150 ± 11	1.6 ± 0.2
110 R	32 ± 2	272 ± 20	153 ± 13	1.8 ± 0.1
1103 P	32 ± 2	233 ± 18	129 ± 3	1.8 ± 0.1
3309 C	27 ± 1	260 ± 21	153 ± 9	1.7 ± 0.1
St. Geo	31 ± 2	247 ± 25	127 ± 8	1.9 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.4 ± 0.6	5.3 ± 0.1	3.76 ± 0.01	3421 ± 41
5BB	22.9 ± 0.3	5.1 ± 0.0	3.78 ± 0.01	3171 ± 173
420A	22.9 ± 0.4	5.1 ± 0.1	3.78 ± 0.03	3399 ± 91
110 R	24.0 ± 0.1	5.2 ± 0.1	3.73 ± 0.03	3190 ± 108
1103 P	22.4 ± 0.4	5.2 ± 0.0	3.77 ± 0.01	3478 ± 8
3309 C	24.2 ± 0.3	5.0 ± 0.1	3.74 ± 0.03	3431 ± 156
St. Geo	23.7 ± 0.2	4.8 ± 0.1	3.78 ± 0.03	3297 ± 115

Table 36 - 1997

## Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	7.3 ± 1.1	0.8 ± 0.1	18 ± 1	42 ± 3	9.2 ± 0.7
5BB	6.9 ± 0.7	1.0 ± 0.1	18 ± 1	54 ± 6	7.3 ± 0.7
420A	5.9 ± 1.0	0.6 ± 0.1	16 ± 2	38 ± 1	9.8 ± 2.0
110 R	7.8 ± 0.8	0.9 ± 0.0	17 ± 1	52 ± 3	8.7 ± 0.8
1103 P	8.9 ± 1.4	1.0 ± 0.0	16 ± 1	64 ± 2	8.8 ± 1.0
3309 C	6.1 ± 0.3	0.7 ± 0.0	17 ± 1	42 ± 4	8.6 ± 0.2
St. Geo	7.9 ± 0.9	1.1 ± 0.1	17 ± 1	64 ± 2	7.0 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	32 ± 1	225 ± 26	132 ± 5	1.7 ± 0.1
5BB	29 ± 1	237 ± 17	126 ± 5	1.9 ± 0.1
420A	27 ± 3	214 ± 25	141 ± 21	1.5 ± 0.1
110 R	33 ± 1	236 ± 19	113 ± 7	2.1 ± 0.1
1103 P	33 ± 3	271 ± 15	147 ± 6	1.8 ± 0.0
3309 C	29 ± 0	215 ± 12	119 ± 4	1.8 ± 0.1
St. Geo	33 ± 1	241 ± 25	128 ± 9	1.9 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	24.2 ± 0.3	6.3 ± 0.1	3.76 ± 0.01	1830 ± 38
5BB	24.6 ± 0.3	6.3 ± 0.1	3.78 ± 0.01	1912 ± 32
420A	24.7 ± 0.6	5.9 ± 0.1	3.78 ± 0.03	2113 ± 14 8
110 R	25.3 ± 0.3	6.2 ± 0.1	3.73 ± 0.03	1955 ± 21
1103 P	24.3 ± 0.3	6.5 ± 0.0	3.77 ± 0.01	1979 ± 52
3309 C	25.4 ± 0.2	5.9 ± 0.0	3.74 ± 0.03	1995 ± 65
St. Geo	24.6 ± 0.4	6.2 ± 0.1	3.78 ± 0.03	1917 ± 45

Table 37 - 1998

## Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	3.6 ± 0.7	1.2 ± 0.1	3.0 ± 0.3
5BB	4.4 ± 0.5	1.2 ± 0.1	3.5 ± 0.1
420A	2.9 ± 0.5	0.9 ± 0.1	3.3 ± 0.2
110 R	3.9 ± 0.1	1.2 ± 0.1	3.4 ± 0.2
1103 P	4.3 ± 0.2	1.4 ± 0.1	3.1 ± 0.1
3309 C	3.5 ± 0.2	1.1 ± 0.0	3.1 ± 0.2
St. Geo	4.3 ± 0.4	1.3 ± 0.1	3.4 ± 0.2

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	24 ± 2	146 ± 14	77 ± 7	1.9 ± 0.1
5BB	29 ± 2	152 ± 7	80 ± 3	1.9 ± 0.1
420A	22 ± 1	134 ± 12	92 ± 12	1.5 ± 0.1
110 R	24 ± 1	160 ± 5	77 ± 4	2.1 ± 0.1
1103 P	26 ± 1	168 ± 1	94 ± 9	1.8 ± 0.2
3309 C	26 ± 2	135 ± 3	80 ± 4	1.7 ± 0.1
St. Geo	26 ± 2	164 ± 6	84 ± 4	2.0 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.9 ± 0.2	6.1 ± 0.3	3.66 ± 0.03	1488 ± 48
5BB	24.1 ± 0.1	6.2 ± 0.2	3.62 ± 0.02	1469 ± 53
420A	24.3 ± 0.4	5.6 ± 0.2	3.69 ± 0.02	1521 ± 57
110 R	24.7 ± 0.3	6.0 ± 0.1	3.61 ± 0.02	1473 ± 44
1103 P	23.6 ± 0.2	6.2 ± 0.1	3.63 ± 0.01	1530 ± 27
3309 C	25.0 ± 0.2	5.6 ± 0.1	3.61 ± 0.02	1461 ± 57
St. Geo	23.9 ± 0.3	6.1 ± 0.2	3.60 ± 0.03	1359 ± 51

Table 38 - 1999

## Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	8.5 ± 1.3	1.2 ± 0.1	20 ± 1	60 ± 5	7.0 ± 0.5
5BB	9.6 ± 1.0	1.3 ± 0.1	21 ± 1	63 ± 4	7.3 ± 0.3
420A	7.8 ± 1.2	1.0 ± 0.0	20 ± 1	52 ± 2	7.5 ± 0.9
110 R	10.1 ± 0.8	1.2 ± 0.1	20 ± 1	60 ± 5	8.4 ± 0.5
1103 P	10.9 ± 1.4	1.2 ± 0.0	19 ± 1	64 ± 0	9.1 ± 1.4
3309 C	7.4 ± 0.8	1.1 ± 0.1	18 ± 1	58 ± 3	7.0 ± 0.6
St. Geo	9.6 ± 1.2	1.2 ± 0.1	20 ± 1	60 ± 4	7.8 ± 0.7

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	34 ± 2	249 ± 29	160 ± 2	1.6 ± 0.2
5BB	36 ± 1	265 ± 23	153 ± 5	1.7 ± 0.2
420A	31 ± 3	250 ± 27	159 ± 4	1.6 ± 0.2
110 R	38 ± 1	267 ± 20	153 ± 7	1.7 ± 0.1
1103 P	37 ± 0	294 ± 37	159 ± 7	1.9 ± 0.3
3309 C	32 ± 1	229 ± 16	137 ± 7	1.7 ± 0.1
St. Geo	36 ± 2	263 ± 24	154 ± 4	1.7 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	25.6 ± 0.4	7.0 ± 0.1	3.43 ± 0.01
5BB	25.3 ± 0.3	7.2 ± 0.1	3.44 ± 0.01
420A	25.7 ± 0.5	6.6 ± 0.1	3.48 ± 0.02
110 R	25.5 ± 0.3	7.0 ± 0.1	3.41 ± 0.02
1103 P	25.2 ± 0.5	6.9 ± 0.0	3.46 ± 0.03
3309 C	26.4 ± 0.3	6.9 ± 0.1	3.46 ± 0.01
St. Geo	25.5 ± 0.6	7.1 ± 0.1	3.49 ± 0.02

Table 39 - 2000

## Amador County Dry Farmed – Zinfandel / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	8.7 ± 0.9	1.0 ± 0.1	25 ± 1	41 ± 4	8.2 ± 0.3
5BB	9.8 ± 0.6	1.2 ± 0.1	24 ± 1	50 ± 5	8.2 ± 0.3
420A	8.5 ± 0.9	0.9 ± 0.1	26 ± 2	34 ± 2	9.5 ± 0.6
110 R	9.8 ± 0.9	1.1 ± 0.1	25 ± 1	46 ± 4	8.8 ± 0.8
1103 P	12.3 ± 1.3	1.4 ± 0.0	27 ± 1	53 ± 1	8.7 ± 1.2
3309 C	7.7 ± 0.6	1.0 ± 0.1	23 ± 1	45 ± 4	7.7 ± 0.5
St. Geo	9.3 ± 1.0	1.2 ± 0.1	23 ± 1	53 ± 3	7.5 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	47 ± 1	185 ± 15	100 ± 6	2.0 ± 0.2
5BB	47 ± 1	208 ± 12	95 ± 1	2.2 ± 0.1
420A	47 ± 3	183 ± 18	91 ± 5	2.0 ± 0.3
110 R	49 ± 3	198 ± 10	90 ± 4	2.2 ± 0.1
1103 P	54 ± 5	228 ± 2	112 ± 10	2.1 ± 0.2
3309 C	44 ± 1	175 ± 10	82 ± 2	2.1 ± 0.1
St. Geo	47 ± 2	196 ± 18	93 ± 5	2.1 ± 0.1

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	23.3 ± 0.3	6.5 ± 0.1	3.42 ± 0.01
5BB	22.7 ± 0.2	6.6 ± 0.1	3.45 ± 0.02
420A	22.4 ± 0.4	6.2 ± 0.1	3.38 ± 0.02
110 R	23.6 ± 0.4	6.7 ± 0.1	3.43 ± 0.02
1103 P	23.1 ± 0.1	7.0 ± 0.0	3.37 ± 0.01
3309 C	24.6 ± 0.3	6.2 ± 0.1	3.43 ± 0.02
St. Geo	23.4 ± 0.2	6.3 ± 0.1	3.49 ± 0.02



## Mendocino County Rootstock Trial

Scion: Cabernet Sauvignon

Years conducted: 1993 - 2001

Years reported: 1995 - 2001

Rootstocks:

5C  
420A  
110 R  
101-14  
3309 C  
O39-16  
O43-43  
Harmony  
Freedom  
AXR#1

Site Conditions: The site is considered moderate, loam underlain by gravel, even though the yields average 5 ton/acre because the growth was somewhat variable ranging from a week 0.3 kg/m to 1.1 kg/m, a more typical value for Cabernet. At both ends of the spectrum, however, yield prunings ratios were high for Cabernet, ranging from 5 to 7.5. The site was chosen primarily because it was known to be infested with several nematodes, including dagger, ring and lesion, as well as phylloxera. Nematodes were monitored by M. McKenry (nematologist) at several times during the data years. The trial will not be included in comments about rootstock characteristics because it is not clear whether the performance is due to the site or to the rootstock's reaction to local nematode populations.

Figure 7.

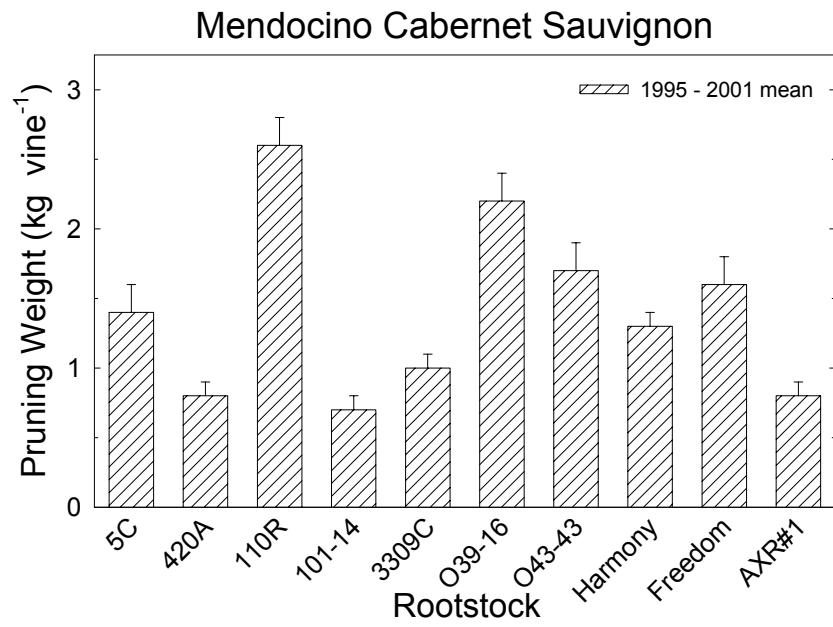
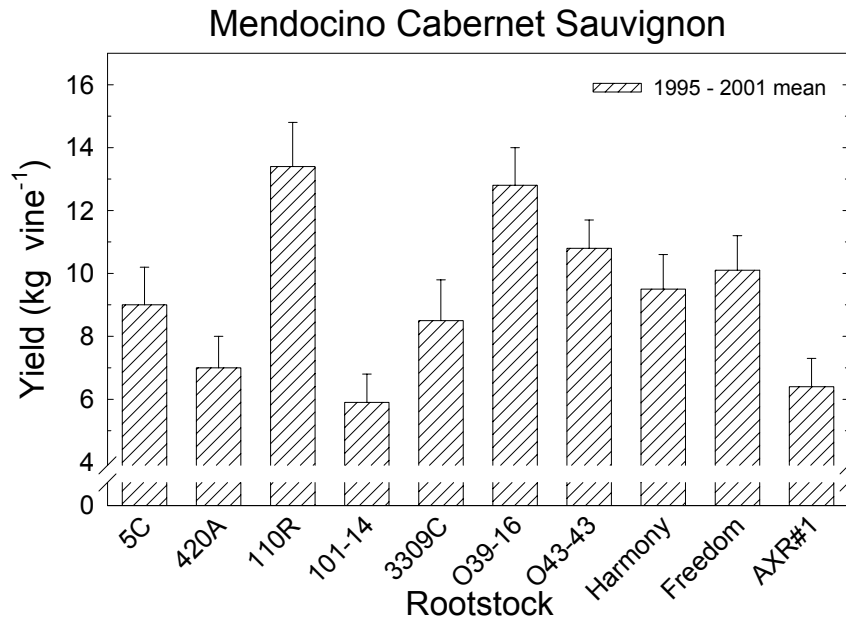


Table 40 - 1995 – 2001\*

\*no data collected in 1999

Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (no 2000 data) (kg vine <sup>-1</sup> )	Shoot Number (1996 and 1998 only)	Shoot Weight (1996 and 1998 only) (g)	Yield : Pruning Weight (no 2000 data)
5C	9.0 ± 1.2	1.4 ± 0.2	47 ± 7	40 ± 4	6.1 ± 1.1
420A	7.0 ± 1.0	0.8 ± 0.1	42 ± 6	23 ± 2	7.5 ± 1.0
110R	13.4 ± 1.4	2.6 ± 0.2	55 ± 7	54 ± 4	4.4 ± 0.4
101-14	5.9 ± 0.9	0.7 ± 0.1	40 ± 9	23 ± 4	6.8 ± 0.7
3309C	8.5 ± 1.3	1.0 ± 0.1	45 ± 9	28 ± 3	7.6 ± 0.9
O39-16	12.8 ± 1.2	2.2 ± 0.2	52 ± 7	49 ± 9	5.0 ± 0.6
O43-43	10.8 ± 0.9	1.7 ± 0.2	50 ± 7	44 ± 8	5.2 ± 0.9
Harmony	9.5 ± 1.1	1.3 ± 0.1	49 ± 7	32 ± 8	6.4 ± 0.8
Freedom	10.1 ± 1.1	1.6 ± 0.2	50 ± 7	40 ± 4	5.7 ± 1.0
AXR#1	6.4 ± 0.9	0.8 ± 0.1	41 ± 9	24 ± 3	7.3 ± 1.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	71 ± 5	123 ± 11	128 ± 11	1.0 ± 0.0
420A	58 ± 5	115 ± 9	128 ± 9	0.9 ± 0.0
110R	97 ± 6	138 ± 10	138 ± 10	1.0 ± 0.0
101-14	53 ± 6	104 ± 9	118 ± 9	0.9 ± 0.0
3309C	67 ± 6	122 ± 11	134 ± 11	0.9 ± 0.0
O39-16	90 ± 4	142 ± 11	137 ± 10	1.0 ± 0.0
O43-43	81 ± 4	133 ± 9	133 ± 8	1.0 ± 0.0
Harmony	76 ± 5	123 ± 10	131 ± 11	0.9 ± 0.0
Freedom	80 ± 4	125 ± 10	129 ± 11	1.0 ± 0.0
AXR#1	59 ± 6	104 ± 8	116 ± 9	0.9 ± 0.0

Table 40 (cont) - 1995 – 2001\*

\*no data collected in 1999

Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (1995 - 1998 only) (ppm)
5C	22.8 ± 0.5	5.6 ± 0.2	3.58 ± 0.05	1613 ± 19
420A	22.6 ± 0.4	5.8 ± 0.3	3.49 ± 0.05	1467 ± 26
110R	23.4 ± 0.3	6.0 ± 0.2	3.57 ± 0.04	1548 ± 59
101-14	22.8 ± 0.3	5.6 ± 0.3	3.54 ± 0.05	1561 ± 15
3309C	22.3 ± 0.5	5.7 ± 0.2	3.55 ± 0.06	1461 ± 25
O39-16	23.3 ± 0.4	6.2 ± 0.4	3.61 ± 0.05	1722 ± 23
O43-43	23.2 ± 0.3	6.1 ± 0.3	3.60 ± 0.03	1726 ± 20
Harmony	23.0 ± 0.5	5.7 ± 0.3	3.59 ± 0.05	1723 ± 45
Freedom	23.2 ± 0.4	5.8 ± 0.3	3.59 ± 0.04	1696 ± 48
AXR#1	22.2 ± 0.4	5.5 ± 0.1	3.47 ± 0.05	1478 ± 29

Table 41 - 1995  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	8.5 ± 0.7	1.3 ± 0.1	6.5 ± 0.4
420A	7.6 ± 1.2	0.9 ± 0.1	8.4 ± 0.2
110R	11.0 ± 0.6	2.6 ± 0.2	4.3 ± 0.2
101-14	5.8 ± 0.6	0.8 ± 0.0	7.0 ± 0.5
3309C	8.4 ± 0.7	1.0 ± 0.1	8.4 ± 0.5
O39-16	13.3 ± 0.9	2.2 ± 0.2	6.1 ± 0.3
O43-43	11.5 ± 0.5	1.6 ± 0.1	7.0 ± 0.1
Harmony	10.3 ± 0.4	1.4 ± 0.0	7.3 ± 0.3
Freedom	10.6 ± 0.3	1.6 ± 0.0	6.6 ± 0.1
AXR#1	5.3 ± 0.4	0.8 ± 0.1	6.6 ± 0.4

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	66 ± 5	128 ± 5	132 ± 4	1.0 ± 0.0
420A	61 ± 5	119 ± 12	132 ± 12	0.9 ± 0.0
110R	77 ± 4	143 ± 5	140 ± 6	1.0 ± 0.0
101-14	51 ± 4	110 ± 4	120 ± 4	0.9 ± 0.0
3309C	66 ± 4	128 ± 7	137 ± 8	0.9 ± 0.0
O39-16	83 ± 4	161 ± 4	155 ± 4	1.0 ± 0.0
O43-43	77 ± 2	149 ± 3	151 ± 3	1.0 ± 0.0
Harmony	74 ± 2	139 ± 2	158 ± 4	0.9 ± 0.0
Freedom	78 ± 1	134 ± 3	141 ± 3	1.0 ± 0.0
AXR#1	53 ± 2	100 ± 7	108 ± 4	0.9 ± 0.0

Table 41 (cont) - 1995  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	22.1 ± 0.2	4.7 ± 0.1	3.58 ± 0.01	1592 ± 19
420A	21.7 ± 0.2	5.0 ± 0.1	3.46 ± 0.01	1426 ± 26
110R	22.8 ± 0.2	5.1 ± 0.2	3.63 ± 0.02	1464 ± 24
101-14	22.2 ± 0.2	4.7 ± 0.1	3.53 ± 0.02	1584 ± 35
3309C	21.5 ± 0.3	5.1 ± 0.1	3.52 ± 0.03	1402 ± 28
O39-16	22.5 ± 0.2	5.3 ± 0.1	3.63 ± 0.03	1672 ± 47
O43-43	22.2 ± 0.2	5.3 ± 0.1	3.61 ± 0.01	1760 ± 48
Harmony	21.8 ± 0.1	4.8 ± 0.1	3.62 ± 0.02	1778 ± 21
Freedom	22.3 ± 0.3	4.9 ± 0.1	3.61 ± 0.02	1565 ± 27
AXR#1	21.8 ± 0.1	5.1 ± 0.1	3.48 ± 0.03	1565 ± 26

Table 42 - 1996  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	8.7 ± 0.8	1.6 ± 0.1	37 ± 2	45 ± 4	5.4 ± 0.3
420A	6.8 ± 1.0	0.9 ± 0.1	34 ± 2	26 ± 2	7.6 ± 0.3
110R	12.3 ± 0.2	2.6 ± 0.1	44 ± 1	59 ± 3	4.8 ± 0.3
101-14	5.0 ± 0.3	0.8 ± 0.0	28 ± 1	28 ± 2	6.5 ± 0.6
3309C	8.2 ± 0.6	1.1 ± 0.1	32 ± 2	33 ± 3	8.1 ± 0.5
O39-16	11.1 ± 0.8	2.6 ± 0.3	42 ± 1	62 ± 5	4.5 ± 0.5
O43-43	8.9 ± 0.6	2.2 ± 0.1	39 ± 1	56 ± 1	4.1 ± 0.3
Harmony	9.3 ± 0.2	1.7 ± 0.1	40 ± 1	43 ± 4	5.7 ± 0.5
Freedom	8.3 ± 0.1	1.8 ± 0.1	40 ± 1	45 ± 3	4.7 ± 0.2
AXR#1	5.6 ± 0.6	0.8 ± 0.1	28 ± 1	29 ± 3	7.0 ± 0.6

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	64 ± 5	137 ± 3	127 ± 4	1.1 ± 0.0
420A	55 ± 6	121 ± 7	127 ± 7	0.9 ± 0.0
110R	83 ± 1	148 ± 1	140 ± 4	1.1 ± 0.0
101-14	44 ± 2	112 ± 5	117 ± 4	1.0 ± 0.0
3309C	60 ± 4	136 ± 6	140 ± 3	1.0 ± 0.0
O39-16	72 ± 4	153 ± 4	137 ± 5	1.1 ± 0.0
O43-43	63 ± 4	140 ± 3	128 ± 2	1.1 ± 0.0
Harmony	70 ± 2	133 ± 2	130 ± 2	1.0 ± 0.0
Freedom	64 ± 2	132 ± 4	127 ± 7	1.0 ± 0.0
AXR#1	48 ± 4	113 ± 6	120 ± 9	0.9 ± 0.1

Table 42 (cont) - 1996  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.2 ± 0.2	5.3 ± 0.1	3.63 ± 0.01	1669 ± 84
420A	22.8 ± 0.2	5.0 ± 0.0	3.57 ± 0.01	1479 ± 81
110R	23.7 ± 0.3	5.4 ± 0.0	3.62 ± 0.02	1404 ± 21
101-14	23.4 ± 0.2	4.8 ± 0.1	3.65 ± 0.01	1543 ± 79
3309C	22.9 ± 0.3	5.1 ± 0.1	3.63 ± 0.03	1436 ± 40
O39-16	23.8 ± 0.2	5.0 ± 0.1	3.74 ± 0.03	1797 ± 63
O43-43	23.8 ± 0.1	5.3 ± 0.1	3.69 ± 0.01	1660 ± 52
Harmony	23.6 ± 0.2	5.1 ± 0.1	3.65 ± 0.02	1827 ± 76
Freedom	23.9 ± 0.2	5.1 ± 0.1	3.62 ± 0.01	1822 ± 90
AXR#1	23.1 ± 0.2	5.4 ± 0.2	3.51 ± 0.01	1441 ± 119



Table 43 - 1997

## Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	11.6 ± 0.4	0.7 ± 0.1	8.1 ± 1.2
420A	8.5 ± 1.2	0.5 ± 0.1	9.3 ± 1.5
110R	15.4 ± 0.3	1.5 ± 0.1	4.8 ± 0.5
101-14	7.3 ± 0.3	0.5 ± 0.0	7.2 ± 0.4
3309C	10.7 ± 0.9	0.6 ± 0.0	8.3 ± 0.7
O39-16	15.2 ± 0.6	1.4 ± 0.1	5.2 ± 0.4
O43-43	12.5 ± 0.4	1.0 ± 0.1	5.7 ± 0.2
Harmony	11.7 ± 0.2	0.7 ± 0.0	7.3 ± 0.3
Freedom	11.8 ± 0.3	0.9 ± 0.1	6.5 ± 0.7
AXR#1	8.1 ± 1.0	0.4 ± 0.1	10.3 ± 1.5

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	90 ± 1	129 ± 3	138 ± 2	0.9 ± 0.0
420A	68 ± 7	119 ± 7	132 ± 7	0.9 ± 0.0
110R	102 ± 1	151 ± 2	156 ± 9	1.0 ± 0.1
101-14	66 ± 1	109 ± 4	119 ± 6	0.9 ± 0.0
3309C	83 ± 5	128 ± 3	133 ± 8	1.0 ± 0.0
O39-16	100 ± 2	152 ± 5	149 ± 7	1.0 ± 0.0
O43-43	87 ± 2	145 ± 3	149 ± 5	1.0 ± 0.0
Harmony	89 ± 2	132 ± 4	140 ± 4	0.9 ± 0.0
Freedom	89 ± 1	133 ± 2	135 ± 2	1.0 ± 0.0
AXR#1	70 ± 7	110 ± 6	118 ± 8	0.9 ± 0.1

Table 43 (cont) - 1997  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	23.9 ± 0.1	6.4 ± 0.1	3.58 ± 0.01	1565 ± 54
420A	23.5 ± 0.1	7.2 ± 0.1	3.46 ± 0.01	1415 ± 26
110R	23.6 ± 0.1	6.6 ± 0.1	3.53 ± 0.02	1697 ± 81
101-14	23.4 ± 0.2	7.1 ± 0.1	3.51 ± 0.02	1522 ± 39
3309C	22.8 ± 0.2	6.6 ± 0.1	3.54 ± 0.02	1467 ± 41
O39-16	23.5 ± 0.2	7.4 ± 0.1	3.60 ± 0.02	1695 ± 57
O43-43	23.7 ± 0.1	7.0 ± 0.2	3.61 ± 0.02	1723 ± 46
Harmony	23.7 ± 0.0	7.1 ± 0.1	3.57 ± 0.01	1589 ± 15
Freedom	24.0 ± 0.1	7.0 ± 0.1	3.61 ± 0.02	1650 ± 19
AXR#1	22.4 ± 0.2	5.7 ± 0.1	3.40 ± 0.02	1413 ± 42

Table 44 - 1998  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Shoot Number	Shoot Weight (g)	Yield : Pruning Weight
5C	12.6 ± 0.7	1.9 ± 0.4	56 ± 1	34 ± 7	3.4 ± 0.4
420A	10.5 ± 0.9	1.0 ± 0.1	50 ± 4	20 ± 2	5.0 ± 0.4
110R	19.7 ± 0.2	3.2 ± 0.4	65 ± 1	49 ± 6	3.2 ± 0.6
101-14	9.1 ± 0.5	0.9 ± 0.1	53 ± 1	17 ± 3	5.1 ± 0.6
3309C	13.2 ± 0.8	1.3 ± 0.2	58 ± 2	23 ± 4	5.1 ± 0.9
O39-16	16.6 ± 0.9	2.3 ± 0.3	62 ± 2	36 ± 5	3.6 ± 0.4
O43-43	14.1 ± 0.5	2.0 ± 0.2	60 ± 1	32 ± 2	3.4 ± 0.3
Harmony	12.6 ± 0.3	1.3 ± 0.1	59 ± 1	22 ± 1	4.6 ± 0.4
Freedom	14.0 ± 0.4	2.1 ± 0.3	60 ± 2	35 ± 6	3.3 ± 0.4
AXR#1	10.3 ± 0.7	1.0 ± 0.1	54 ± 2	19 ± 2	4.6 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	84 ± 3	150 ± 4	156 ± 3	1.0 ± 0.0
420A	76 ± 5	138 ± 3	160 ± 3	0.9 ± 0.0
110R	118 ± 3	167 ± 4	163 ± 7	1.0 ± 0.0
101-14	75 ± 4	122 ± 7	145 ± 6	0.8 ± 0.0
3309C	86 ± 3	153 ± 6	178 ± 10	0.9 ± 0.0
O39-16	103 ± 5	161 ± 4	159 ± 6	1.0 ± 0.0
O43-43	94 ± 4	149 ± 2	151 ± 5	1.0 ± 0.0
Harmony	89 ± 2	142 ± 1	154 ± 3	0.9 ± 0.0
Freedom	93 ± 2	151 ± 1	163 ± 2	0.9 ± 0.0
AXR#1	84 ± 5	122 ± 3	142 ± 2	0.8 ± 0.0

Table 44 (cont) - 1998  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH	Juice Potassium (ppm)
5C	21.0 ± 0.1	5.8 ± 0.1	3.34 ± 0.01	1626 ± 23
420A	21.2 ± 0.3	6.0 ± 0.1	3.26 ± 0.01	1546 ± 37
110R	22.3 ± 0.1	6.4 ± 0.1	3.35 ± 0.01	1626 ± 43
101-14	21.7 ± 0.1	5.5 ± 0.1	3.31 ± 0.01	1595 ± 16
3309C	20.5 ± 0.2	6.0 ± 0.1	3.27 ± 0.01	1539 ± 28
O39-16	22.1 ± 0.4	6.9 ± 0.2	3.35 ± 0.02	1724 ± 29
O43-43	22.2 ± 0.2	5.9 ± 0.0	3.43 ± 0.01	1760 ± 39
Harmony	21.5 ± 0.2	6.0 ± 0.2	3.32 ± 0.02	1697 ± 38
Freedom	21.9 ± 0.0	5.7 ± 0.2	3.36 ± 0.01	1746 ± 78
AXR#1	20.6 ± 0.3	5.7 ± 0.1	3.29 ± 0.01	1493 ± 18

Table 45 - 2000  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )
5C	3.6 ± 0.5
420A	2.6 ± 0.2
110R	8.6 ± 0.8
101-14	1.8 ± 0.3
3309C	3.1 ± 0.4
O39-16	7.6 ± 0.8
O43-43	7.3 ± 0.2
Harmony	3.8 ± 0.2
Freedom	5.2 ± 0.1
AXR#1	2.9 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	55 ± 5	65 ± 3	73 ± 3	0.9 ± 0.0
420A	38 ± 3	70 ± 3	84 ± 4	0.8 ± 0.0
110R	97 ± 7	88 ± 3	87 ± 3	1.0 ± 0.0
101-14	30 ± 3	57 ± 4	74 ± 5	0.8 ± 0.0
3309C	44 ± 4	69 ± 4	87 ± 6	0.8 ± 0.0
O39-16	88 ± 8	86 ± 1	83 ± 3	1.1 ± 0.1
O43-43	82 ± 4	90 ± 4	95 ± 3	1.0 ± 0.0
Harmony	56 ± 5	70 ± 4	77 ± 3	0.9 ± 0.0
Freedom	69 ± 2	76 ± 2	76 ± 2	1.0 ± 0.0
AXR#1	48 ± 3	61 ± 5	75 ± 6	0.8 ± 0.0

Table 45(cont) - 2000  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	22.1 ± 0.2	6.1 ± 0.2	3.69 ± 0.02
420A	22.4 ± 0.1	6.2 ± 0.1	3.64 ± 0.02
110R	23.0 ± 0.2	6.5 ± 0.3	3.67 ± 0.01
101-14	22.2 ± 0.1	6.0 ± 0.2	3.63 ± 0.02
3309C	21.8 ± 0.1	6.1 ± 0.1	3.71 ± 0.02
O39-16	22.8 ± 0.2	6.9 ± 0.3	3.67 ± 0.02
O43-43	22.8 ± 0.1	6.8 ± 0.1	3.65 ± 0.03
Harmony	22.8 ± 0.2	5.9 ± 0.1	3.72 ± 0.02
Freedom	22.7 ± 0.1	6.4 ± 0.5	3.71 ± 0.02
AXR#1	22.0 ± 0.3	5.2 ± 0.2	3.65 ± 0.03

Table 46 - 2001  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Yield (kg vine <sup>-1</sup> )	Pruning Weight (kg vine <sup>-1</sup> )	Yield : Pruning Weight
5C	9.0 ± 0.9	1.3 ± 0.1	7.2 ± 0.3
420A	6.1 ± 0.6	0.9 ± 0.1	7.1 ± 0.6
110R	13.5 ± 0.7	2.9 ± 0.2	4.8 ± 0.4
101-14	6.3 ± 0.5	0.8 ± 0.1	8.2 ± 0.5
3309C	7.5 ± 1.0	0.9 ± 0.1	8.0 ± 0.8
O39-16	13.3 ± 0.6	2.4 ± 0.2	5.6 ± 0.5
O43-43	10.6 ± 0.7	1.8 ± 0.1	5.8 ± 0.3
Harmony	9.4 ± 0.9	1.3 ± 0.1	7.2 ± 0.8
Freedom	10.8 ± 0.3	1.5 ± 0.1	7.4 ± 0.5
AXR#1	5.9 ± 0.3	0.7 ± 0.0	7.9 ± 0.3

Rootstock	Cluster Number	Cluster Weight (g)	Berries per Cluster	Berry Weight (g berry <sup>-1</sup> )
5C	68 ± 5	131 ± 3	140 ± 2	0.9 ± 0.0
420A	50 ± 4	121 ± 4	130 ± 4	0.9 ± 0.0
110R	104 ± 3	130 ± 3	139 ± 2	0.9 ± 0.0
101-14	54 ± 2	115 ± 6	131 ± 7	0.9 ± 0.0
3309C	61 ± 7	121 ± 4	131 ± 5	0.9 ± 0.0
O39-16	94 ± 4	142 ± 2	139 ± 4	1.0 ± 0.0
O43-43	85 ± 4	125 ± 4	126 ± 1	1.0 ± 0.0
Harmony	77 ± 5	121 ± 4	126 ± 4	1.0 ± 0.0
Freedom	86 ± 2	126 ± 2	132 ± 4	1.0 ± 0.0
AXR#1	50 ± 1	118 ± 4	135 ± 6	0.9 ± 0.0

Table 46 (cont) - 2001  
Mendocino County – Cabernet Sauvignon / Rootstock Trial

Rootstock	Brix	TA (g l <sup>-1</sup> )	pH
5C	24.2 ± 0.3	5.5 ± 0.1	3.65 ± 0.03
420A	24.2 ± 0.2	5.7 ± 0.1	3.57 ± 0.01
110R	24.8 ± 0.2	5.8 ± 0.1	3.61 ± 0.02
101-14	24.0 ± 0.2	5.4 ± 0.0	3.61 ± 0.02
3309C	24.2 ± 0.1	5.5 ± 0.1	3.64 ± 0.02
O39-16	25.0 ± 0.3	5.9 ± 0.1	3.65 ± 0.03
O43-43	24.4 ± 0.2	6.2 ± 0.1	3.58 ± 0.00
Harmony	24.8 ± 0.2	5.7 ± 0.1	3.64 ± 0.03
Freedom	24.7 ± 0.2	5.9 ± 0.1	3.64 ± 0.01
AXR#1	23.4 ± 0.1	5.7 ± 0.1	3.51 ± 0.01