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Rootstocks for Planting or Replanting New York Vineyards

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Introduction. Many New York grape growers are thinking about vineyard planting. There are two primary reasons. First, our markets are changing. The demand for traditional native varieties is contracting. There are several reasons for this, including: changes in the juice market that reduce the reliance on labrusca grapes and which have a downward pressure on grape value, decreased demand for “low acid” labruscas for wine, and decreased demand for Catawba. The markets have not disappeared, but native grape production has become a specialized craft that emphasizes low labor inputs and high yields. These changes encourage consolidation and encourage some growers to move out of production or to shift production to hybrid or vinifera wine varieties.

The second reason is the impact of two very cold winters. Surveys indicate that as much as ¼ of Finger Lakes vinifera were killed in January 2004. Demand for these varieties is high, so most growers will replant the damaged vines and consider expanding their acreage. However, the extent of damage to vinifera illustrates their sensitivity to winter cold, and should prompt many growers to hedge their bets by planting more cold-hardy hybrid wine varieties.

A vineyard is a large capital project, so the decision about what variety to plant in which location is critical. However, once made, the grower is immediately faced with two other decisions. These are: 1) Should I plant an own rooted vine or a grafted plant? And 2) If I decide to plant a grafted vine, which rootstock should I select?For the last 15 years we have been investigating how different rootstocks have affected Chardonnay vine growth and yield. The soil at our Geneva site is “typical” of the Finger Lakes in that it is an imperfectly drained clay/loam. The data from this experiment will be presented to help you understand what you might expect from the different choices you might have.

Why consider a resistant rootstock? The term resistant is critical. Rootstock varieties have been bred or selected to provide resistance and/or tolerance to an insect, a soil condition, a disease or an environmental problem. If hazards to vine health are not present, or if the roots of the scion variety itself have sufficient tolerance to the problem, then using grafted stocks will only increase expense and complicate subsequent vine management. On the other hand, using the wrong rootstock can be a disaster, as the growers in the Napa valley found when they selected a rootstock with inadequate resistance to phylloxera, A x R #1 (Ganzin 1).

In New York we can expect rootstocks to do one of the following:

1. Provide increased resistance to soil borne pests such as phylloxera or nematodes.
2. Combat replant effects (primarily high initial phylloxera population, but perhaps also impact of nematodes and crown gall bacteria).
3. Provide increased lime (calcium) tolerance.
4. Provide a larger root system to improve vine drought tolerance.
5. Provide cold tolerant roots and trunk.
6. Reduce chance of virus transmission by nematodes.
7. Confer tolerance to low soil pH.

If we read European, especially French literature, attributes are listed which, if true, would certainly benefit Finger Lakes grape growers. To explore the possibilities, we established a rootstock trial at Geneva, comparing vine growth and yield of Chardonnay grafted to more than 20 rootstocks. A separate table lists the reported attributes of different rootstocks (Appendix A). Aspects that would benefit a Finger Lakes grape grower are indicated in bold. We included rootstocks with a range of vigor in our test to explore how vigor itself might determine suitability in a typical Finger Lakes soil. We were particularly interested in rootstocks that would shorten the vegetative growth period, hasten fruit maturity or tolerate less well-drained soils. A formal part of the experiment was to evaluate cold acclimation of the rootstock plants themselves and of Chardonnay grafted to the vines to see if rootstocks could increase cold hardiness. A second objective was to evaluate the impact of rootstock on vine vigor and to determine suitable vigor levels for the Finger Lakes.

Vine vigor. Strictly speaking, there is a difference between vine vigor and vine size. In practice today, the two terms are used interchangeably. We usually express vine size in terms of cane pruning weight per vine, but because there is little standardization about in-row spacing of vinifera vineyards in New York, we will talk about prunings per foot of canopy. We have suggested that the typical VSP trained vinifera vine will have desirable canopy characteristics when the vine size ranges from 0.2 to 0.3 lbs of cane prunings per foot of canopy (this is equivalent to 1.6 to 2.4 lbs pruning for vines spaced 8 feet apart in the row).

Note that in this planting on a soil with, at most, moderate internal drainage, the vine vigor associated with different stocks does not always conform to descriptions found in nursery catalogues (Table 1). The two highest-vigor stocks, C1202 and Harmony, were selected for high lime and nematode tolerance respectively. C 3309 and 101-14 are usually thought of as low-vigor stocks, certainly lower vigor than AxR1 or 5BB. SO4 is usually thought of as a higher vigor stock than C 3309. In this case, because of the confusion between 5C and SO4, the SO4 vines were planted 2 years later than most of the vines. However, 5BB grafted vines were planted in the same year and attained greater vine size.

Table 1. Average vine size (cane prunings/foot of row) for Chardonnay vines grafted to different rootstocks for the period, 1994 – 2000*

Large Vines	Cane Prunings/ Ft. of Row	**Medium Vines**	Cane Prunings/ Ft. of Row	**Small Vines**	Cane Prunings/ Ft. of Row
C 1202	0.32 a	MgT 18-815	0.24 cd	1616E	0.16 ghij
Harmony	0.31 a	**R. Gloire**	0.22 de	Own	0.16 ghij
C 3309	0.31 a	44-53	0.22 def	41B	0.15 ghijk
MgT 101-14	0.29 ab	420A	0.19 efg	110R	0.14 hijk
125AA	0.29 ab	333EM	0.18 efgh	Sonona	0.14 hijk
AxR 1	0.26 bc	5A	0.17 fghi	99R	0.13 jk
5BB	0.26 bc	**SO4**	0.17 ghi	R. Montreal	0.11 k
				Shakoka	0.06 l

* Values followed by the same letter do not differ at the 5% probability level. Stock names in bold are commonly available from U.S. grape nurseries.

Rate of vine growth varied according to vigor level (Figure 1). Note that the higher-vigor stocks attained full vine size by 1995 or 1996, but medium-vigor vines continued to increase in vine size through 1999. The same was true for all the low-vigor vines except own-rooted ones. Own-rooted vines had high initial vigor, but once phylloxera became established, decreased from more than 0.2 lbs of prunings to about 0.1 lb of cane prunings.

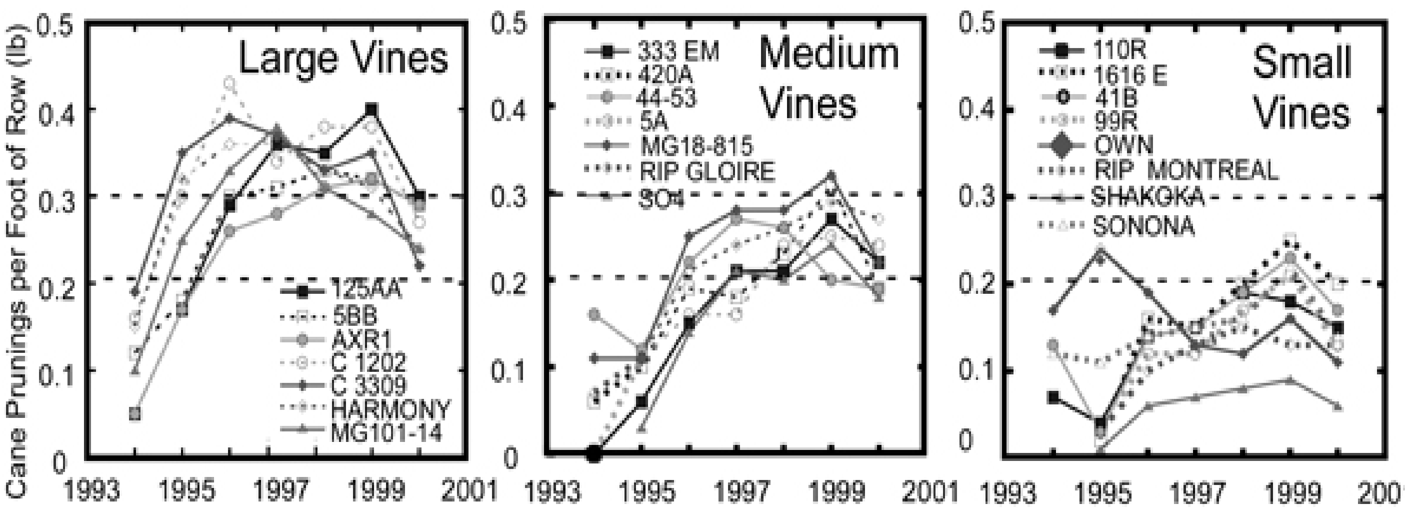

Figure 1. Cane pruning weight per foot of row for Chardonnay grapevines grafted to different rootstocks during the period, 1994 to 2000. Higher vigor vines had mean cane pruning values > 0.26 lbs, medium vigor vines averaged from 0.17 to 2.4 lbs of cane prunings, and low vigor vines averaged less than 0.17 lbs cane prunings per foot of row.

Table 2. Average yield components of Chardonnay for the period, 1994 –2000 for Chardonnay grafted to rootstocks in different vigor categories.

Class	Cane Pruning Wt. (lb./ft of row)	Adjusted Shoots/Vine	Live Nodes (%)	Clusters/ Vine	Berry Wt. (g)	Tons/ Acre	Juice Brix
Large	0.30 a	23.1 a	77.7 a	43.0 a	1.49 b	5.1 a	19.9 a
Med.	0.20 b	23.1 a	77.1 a	38.2 b	1.53 a	5.0 ab	19.7 a
Small	0.13 c	23.2 a	77.8 a	36.8 b	1.49 b	4.8 b	19.2 b
Significance							
Class	0.0001	0.5936	0.5934	0.0001	0.0009	0.0076	0.0001
Year	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cls x Yr	0.0001	0.0358	0.0635	0.0069	0.1218	0.0001	0.6208

Vine performance by vine size category. Data for vines in each category (Table 2, Figure 2) were averaged to show the overall impact of vine vigor on performance. Considering an almost 3-fold range in pruning weight, there were relatively small differences among the overall average yield components for the 3 categories (Table 2). There were no significant differences for adjusted shoots per vine or live nodes. Large vines had more clusters per vine than vines of other categories. Large vines yielded more than small vines, but not more than medium vines. Medium vines had the heaviest berries, and small vines had the lowest soluble solids.

Changes in pruning weight over the test period (Figure 2) revealed trends similar to those seen in Figure 1. Small vines first lost, then increased vine size, until the combined effects of poor growing conditions in the 1998 and 1999 seasons resulted in low 2000 pruning weights. There were significant differences in cane pruning weight between the large and small class vines in every year except 1994.

Bud survival following the very cold 1993/94 winter (live buds for 1994) did not differ among rootstock vigor classes, but large vines had higher survival rates than medium or small vines in 1995. In 1996, survival was better in large than in small vines, bud survival of medium vines was not significantly different from either large or small vines. Subsequently, there was very little variation in bud survival among the various vine size categories.

There were significant differences in clusters per vine and in clusters per shoot in 4 of the 7 growing seasons. Large vines always had the highest values for both yield components. This is likely because large vines produced more nodes, and we had more shoots to select from when we adjusted shoot number (when shoots were 4 to 6 inches (10 – 15 cm) long. Differences in clusters per vine or per shoot were much less when small and medium size vines were compared. Commonly, the yield component most impacted when comparing effect of canopy character on node fruitfulness is clusters per shoot. There is little evidence here that larger vine size negatively impacted clusters per shoot.

Although cluster number was little affected by large vine size, there was a greater impact on cluster weight. In 4 of the 7 years, clusters on large vines were lighter than those on small or medium size vines. This was due to fewer, not smaller berries on the clusters of large size vines. The overall average of berries per cluster was 66.4 for large vines, 73.0 for medium vines and 73.5 for small vines. Variation in berry number can be due to differences in cluster size (a function ofprevious season growing conditions) or in flower quality. Flowers develop in the same season they bloom, and early season carbohydrate supply or light environment may influence flower quality.

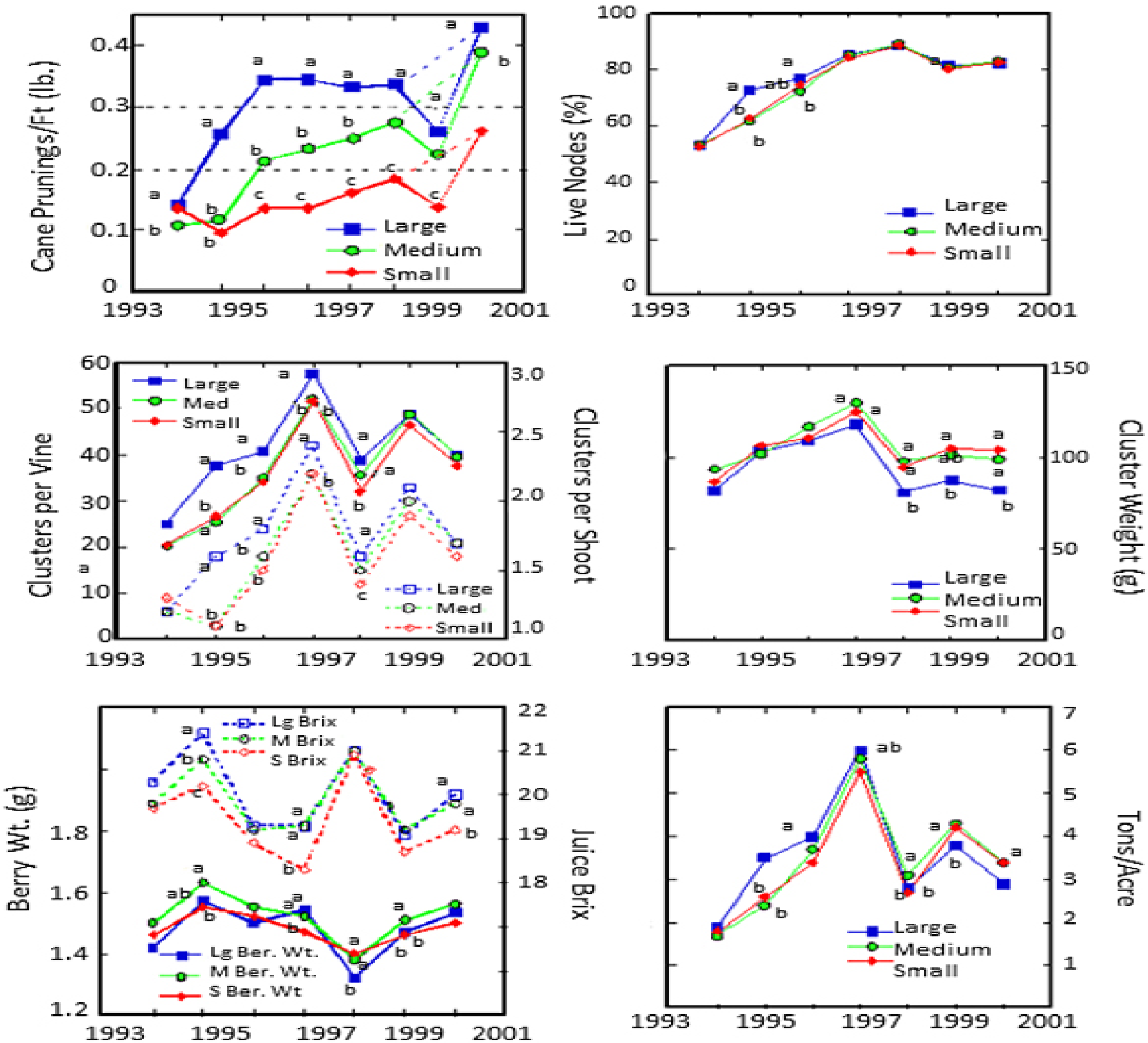

Figure 2. Changes in yield components for Large, Medium and Small Chardonnay vines for the period, 1994 – 2000. Data are averages for vines as classified in table 3 and figure 1. For any year, different letters indicate significant differences among the components for the different size categories.

Berry weight was most often larger on medium vines than on large or small vines. Berry weight is sensitive to water stress during the period fruit-set to the beginning of the lag phase of berry development. Large vines may have produced so many leaves that water use induced stress early in the season. Berries on small vines might have had growth limited by photosynthate supply or by small root systems that were not able to supply sufficient water to maintain growth.

In the early years when vine size was rapidly increasing, large vines produced the highest crops. However, in the later years when vine size was maximal, large vines produced smaller crops. Years when the large vines had significantly lower yields were also years when they had significantly lighter clusters. There was only one year (1998) when there was a significant yield difference between small and medium vines, and in that year small vines had higher yield than medium vines. Although vigor class had statistical significance, their viticultural significance is doubtful. There was only a 2-ton difference in cumulative total yield between vines in large and small categories over the entire 7 year period.

There were significant differences in fruit soluble solids (brix) in only 3 of the 7 years. Except for two years, small vines had the lowest soluble solids values. Large vines most commonly had the highest values, and small vines always had the lowest numeric soluble solids value. This suggests that, although crop size was not severely affected, low vigor vines were cropped at or beyond their capacity to fully ripen the fruit.

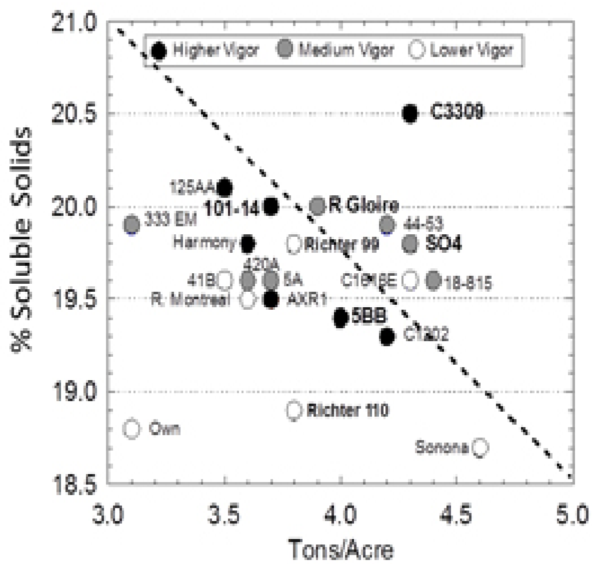

Figure 3. Relationship between average yield and fruit soluble solids for Chardonnay grafted to different rootstocks for the period 1994 – 2000.

So which do I use? Well, which ones can you find? Most nurseries propagate only a few rootstocks that they think their customers want. If you want something special, you will probably have to arrange for vines to be custom grafted. That will mean at least an extra year.

Table 3 lists the average yield data for each rootstock, and Figure 3 is a summary of sorts. It plots the average yield for the experiment versus fruit maturity for the same vines. The dotted line has no scientific meaning, but values above the line have a better combination of yield and maturity than values below the line. Stocks that I think will be more commonly available are shown in bold on the figure. Three “available” stocks are above the line, C. 3309, SO4 and Riparia gloire. MgT 101-14 is a little below the line, but probably more importantly, has lower yield than the other “available” stocks. I’m not really sure that 5BB is all that available, but it produced pretty good crops, although the maturity wasn’t all that great.

What about the other stocks for vinifera? Two that look interesting are 44-53 and 18-815. The descriptions of the first in Appendix A raise one point of caution for the Finger Lakes, potential lack of lime tolerance. Appendix A doesn’t say anything about 18-815 that makes me question the good results we had. Barring better results by others, I see no reason to try the other stocks at this time. I will express my strong opinion about planting vinifera on its own roots in the Finger Lakes. DON’T DO IT! In the past people hoped they could overcome the low vigor by increasing planting density and being generous with fertilizer. It doesn’t work.

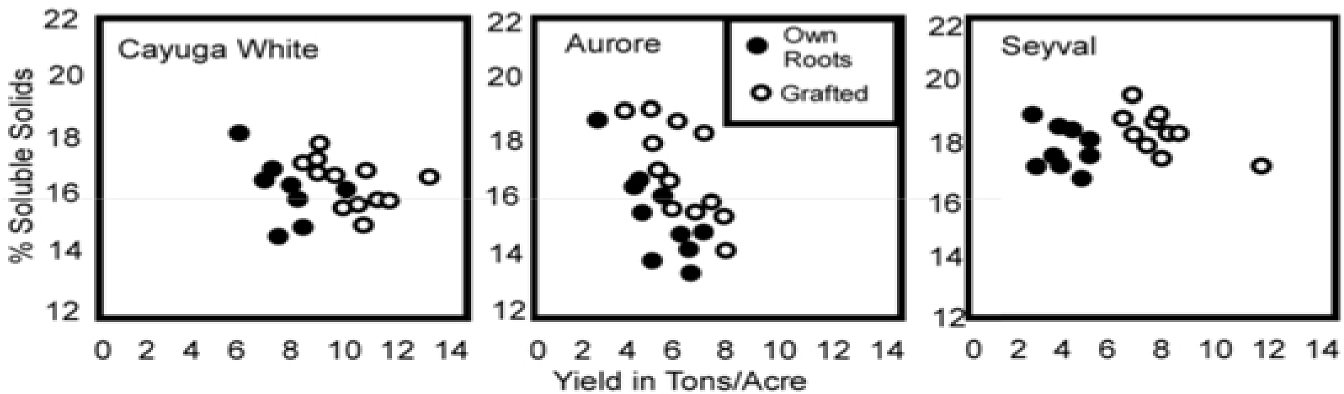

Figure 4. Yield/maturity relationship for three hybrid varieties growing on their own roots or grafted to a phylloxera resistant rootstock.

Should I plant grafted hybrid or native vines? Grafted vines increase the cost of vineyard establishment, but I encourage you to consider using them, especially for hybrid varieties. There are two reasons. The first is that no fruit variety can be selected for both optimal fruit characteristics and optimal root function. Most hybrids have higher growth capacity when grafted. Figure 4 compares yield and maturity of own rooted and grafted hybrid vines. Note that in every case yield, maturity or both was improved by grafting.

The second reason that grafting can prevent susceptible hybrid vines from becoming infected with the ringspot virus complex. Dennis Gonsalves reported that most commonly available rootstocks are hypersensitive to the virus. When infected nematodes feed on roots, the infected cells die, preventing the vine from becoming infected.

With natives, the issue is less clear. I don't know of any ringspot sensitive native varieties. Vine size is usually increased, but especially when fruit maturity is important, the increased vine size may come at the cost of delayed soluble solids accumulation.

Table 3. Effect of Rootstock on average yield components of Chardonnay grafted to different rootstocks.

Rootstock	Cane Pruning Wt. (lb./ft row)	Live Nodes (%)	Clusters/ Shoot	Cluster Wt. (g)	Berry Wt. (g)	Tons/ Acre	Juice Soluble Solids (5)
C 1202	0.33a	80.3 abc	2.0 a	96.8 gh	1.45 efgh	4.2 abde	19.3 bcd
C 3309	0.32 ab	79.6 abcd	1.9 ab	104.7 defg	1.45 fgh	4.3 abc	20.5 a
Harmony	0.31 abc	80.9 abc	1.8 abce	99.2 fgh	1.47 defgh	3.8 bcfg	19.8 abc
125 AA	0.29 bcd	70.3 e	1.8 bcde	95.1 gh	1.58 abc	3.5 fg	20.1 ab
101-14	0.29 bcd	80.5 abc	1.8 abde	98.5 fgh	1.49 defgh	3.7 cdfg	20.0 ab
5BB	0.28 cde	82.2 ab	1.9 ab	104.8 defg	1.55 abcd	4.0 abcef	19.4 bcd
AXR 1	0.26 de	77.3 bcd	1.8 abc	97.2 gh	1.50 cdefg	3.7 cdef	19.5 abcd
18-815	0.24 ef	75.4 cde	1.9 abc	121.3 abc	1.54 bcde	4.4 ab	19.6 abcd
Rip. Gloire	0.22 fg	78.8 bcd	1.8 abde	105.6 defg	1.50 cdefg	3.9 adef	20.0 ab
44-53	0.22 gh	79.1 abcd	1.8 bcde	112.2 bcde	1.50 cdefg	4.2 abcef	19.9 abc

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Table 3. Effect of Rootstock on average yield components of Chardonnay grafted to different rootstock (Cont.)							
Rootstock	**Cane Pruning Wt. (lb./ft row)**	**Live Nodes (%)**	**Clusters/ Shoot**	**Cluster Wt. (g)**	**Berry Wt. (g)**	**Tons/ Acre**	**Juice Soluble Solids (5)**
420A	0.19 gh	74.8 cde	1.7 bcde	100.9 efg	1.48 defgh	3.6 defg	19.6 abcd
333 EM	0.18 ghi	77.2 bcd	1.5 e	99.6 fgh	1.50 cdefg	3.1 g	19.9 abc
5A	0.18 ghi	78.2 bcd	1.6 cde	114.4 abcd	1.55 abcd	3.7 defg	19.6 abcd
SO4	0.17 hij	75.0 cde	1.7 bcde	125.4 a	1.60 ab	4.3 abcd	19.8 abc
1616 E	0.16 hijk	85.1 a	1.8 abcd	114.5 abcd	1.55 abcd	4.3 abcd	19.6 abcd
41 B	0.15 ijkl	76.1 bcde	1.6 de	113.5 bcd	1.48 defgh	3.5 efg	19.6 abcd
Sonona	0.15 ijkl	79.2 abcd	2.0 a	111.8 bcde	1.45 efgh	4.6 a	18.7 d
110 R	0.14 ijkl	73.4 de	1.6 de	122.6 ab	1.58 abc	3.8 defg	18.9 cd
99 R	0.13 kl	77.0 bcd	1.6 cde	109.9 cdef	1.54 bcdef	3.6 defg	19.8 abc
R. Montreal	0.11 l	79.1 abcd	1.7 bcde	99.3 fgh	1.43 gh	3.6 defg	19.5 abcd
Shakoka	0.07 m	78.7 bcd	1.6 e	112.4 bcd	1.40 h	3.5 fg	18.7 d

Appendix A. Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein.

Name	Parentag e	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
Couderc 1616E	*Vitis solonis* X *Vitis riparia*	Good **phylloxera resistance**, moderate lime tolerance, **induces early scion maturity**, **tolerates wet and salty soils**– 1616E refers to a selection of C1616 made at Emmendigen, Alsace – it is used in Germany	Moderate phylloxera resistance, sensitive to drought, moderate lime tolerance. Used in France in sandy, slightly saline soils. **Useful for fertile, poorly drained soils with <11%lime**.

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
Couder 1202	Mouvedre X *V. rupestris* (Ganzin)	Roots show many tuberosities and so is not fully phylloxera resistant, however vines seem to grow well in spite of the damage. It is especially recommended for highly calcareous and deep sandy soils.	Very vigorous vines, some salt and lime tolerance, but lack of phylloxera resistance indicates it should not be used as a rootstock where phylloxera is present.
Harmony	From USDA grape breeding program Fresno - cross of a C1616 seedling X a Dogridge seedling	Good nematode tolerance	Good nematode tolerance, but as a seedling of two phylloxera susceptible parents, it cannot be phylloxera resistant.
C3309	*Vitis riparia* (Couderc Z) X *Vitis rupestris* (Martin)	**Good phylloxera resistance**. Sensitive to nematodes. Only moderate lime tolerance, and poor drought and salt tolerance. It does not induce early wood maturation or reduce vine growth in Burgundy, but is reported to **produce early fruit maturation in other regions**. It is widely used in the vineyards of Alsace and the Loire.	A **good rootstock for deep, well drained, cool soils which are well supplied with moisture**. Sensitive to drought and not recommended for poorly drained soils. Medium lime tolerance poor nematode tolerance.

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
Millardet and de Grasset 101-14	*Vitis riparia* X *Vitis rupestris*	Good phylloxera resistance and moderate lime tolerance. Similar to C. 3309 but less drought tolerance.	More vigorous than Riparia gloire and a shorter vegetative cycle than C 3309 so preferred where early ripening is important. Tolerates poor drainage better than drought.
Kobe 125AA	*Vitis berlandieri* X *Vitis riparia*	A berlandieri seedling grown by Teleki, Kober selected 125AA. It **has good phylloxera resistance**, but only **moderate lime tolerance**. It is grown commonly in **heavier, wet soils**. Kober selected it for its high vigor.	
AXR1 (Ganzin 1)	*V. vinifera* (Aramon) X *Vitis rupestris*	One of the first interspecific hybrids. Phylloxera form tuberosities on the roots, but the vine is so vigorous that it tolerates the pest except where soils become dry. It has some tolerance to virus and good lime tolerance. It has been grown widely, but has failed to maintain sufficient phylloxera resistance over time.	Once widely planted in France where very vigorous vineyards resulted, the stock succumbed to phylloxera even in sandy soils. Has repeatedly failed everywhere it has been grown due to poor phylloxera tolerance.

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
Kober 5BB	*Vitis berlandieri* X *Vitis riparia*	Another Kober selection of the Teleki seedlings. It has **good phylloxera resistance** and some tolerance to nematodes. It is best **adapted to heavier, clay soils**. It produces very vigorous growth and can enhance set problems. In some cases it delays fall wood maturation and can be subject to winter cold. In areas of cold, it should only be planted where soils are less rich or shallower.	Not recommended for dry soils but good for humid, compact, calcareous clay soils. Used widely where early ripening is important. Reported to have some nematode resistance.
Couderc 18-815	*Vitis monticola* X (*V. berlandieri*?)	Good **phylloxera and lime resistance**. The *V. monticola* hybrids are little studied.	
Riparia Gloire (R. Gloire de Montpellier)	*Vitis riparia*	Good phylloxera resistance. Short vegetative cycles; hastens wood and fruit maturity and favors full flower-set. Reduces vine vigor. Does not tolerate drought	It prefers fresh, deep, fertile soil well supplied with water. In poor sandy soils, it is useless. Resistant to phylloxera and somewhat nematode resistant. Tolerates 6% lime.

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
MALEGUE 44-53	Riparia Grand Glabre X Malegue 144 (*V. cordifolia* X *V. rupestri*s)	Resistance to phylloxera, drought and nematodes, but sensitive to Mg deficiency	Less vigorous than berlandieri X rupestris hybrids such as 110 R and 99 R. **Phylloxera resistant, reported to have good drought and nematode tolerance** but only moderate lime tolerance.
Millardet and de Grasset 420A	*V. berlandieri* X *V. riparia*	**Good phylloxera resistance**. Low vigor only slightly greater than R. Gloire**. Hastens fruit and wood maturity**. Does not tolerate drought.	Not a vigorous grower. **Resists phylloxera** and some nematode resistance. Does not like "wet feet" but **does well in heavy loams and clays.**
333 EM (Foex 333)	*V. vinifera* (Cabernet Sauvignon) X *V. berlandieri* No 329)	Phylloxera tuberosities are found on the roots. It has very good lime tolerance. It is vigorous and used primarily in places with very high lime content.	Not fully phylloxera resistant. It has very high lime tolerance. Should only be used where the lime tolerance outweighs the phylloxera susceptibility.
Teleki 5A	*Vitis berlandieri* X *Vitis riparia*	One of the Teleki seedlings – 5A may be from the same seed lot as 5BB or 5BB may be a selection of 5A	

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
SO4	*Vitis berlandieri* X *Vitis riparia*		Has good lime tolerance and phylloxera resistance. Does not tolerate drought. In suitable soils it ensures good set and advances maturity.
Own	*Vitis vinifera* (Chardonnay)	**Good phylloxera resistance** and **moderately high lime tolerance**. Produces very vigorous scion growth and may induce problems with nutrient imbalance, set and botrytis infection.	
41B (Millardet et de Grasset)	*Vitis vinifera* (Chasselas) X *V. berlandieri*	Not fully phylloxera resistant, but vines are long lived in Champagne. Very high lime tolerance. Moderately vigorous vine.	Has good lime tolerance but inadequate phylloxera resistance. Should only be grown where the lime tolerance is needed.
Richter 99	*Vitis berlandieri* (Las Sorres) X *Vitis rupestris* (du Lot)	Phylloxera resistance, moderate lime tolerance, and has low drought tolerance	Very vigorous, prefers well-drained, deep, fertile soils well supplied with water. Does not tolerate salt, but does tolerate lime. Recommended for nematode infected soils

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Descriptions of characteristics of rootstocks used in the Geneva experiment and reported herein (Cont.)

Name	Parentage	Comments from P. Galet, Cepages et Vignobles de France – Volume 1.	Comments from D. P. Pongrácz Rootstocks for Grape-vines
Richter 110	*Vitis berlandieri* X *Vitis rupestris*	**Good phylloxera resistance**. Very vigorous vines. Not widely grown at present	Accommodates to all kinds of soils and is an excellent rootstock in warm grape-growing regions with a dry climate. Moderately nematode resistance and tolerates up to 17% active lime. Vines start slowly but out grow those on 99R or 101-14 by the end of the first season.

Comments below are not from Galet or Pongrácz notes

Sonona	*V. labrusca* (Lady) X *Vitis riparia*	From the South Dakota grape breeding program of Hansen; reported by some to control vigor and increase cold hardiness.	
R. Montreal	*Vitis riparia*	A wild selection from Quebec, Canada, shorter vegetative cycle than Riparia Gloire	