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Winegrape Cultivar Trials in Connecticut 2004-2006

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Commercial winegrape cultivation in Connecticut is a relatively recent phenomenon. While pre-Prohibition acreage was about 550 acres, plantings for most of the mid-20th century were small plots for home winemaking. The passage of the Connecticut Farm Winery Act in 1978 allowed growers to make and sell wine at their farms. The winegrape industry has continued to expand since then. Total planted acreage of winegrapes and the number of vineyards and wineries have increased each year. In 2007, there were approximately 41 vineyards cultivating over 270 acres of winegrapes.

A typical vineyard is productive for over 20 years, so cultivar selection is one of the most important factors to consider for long-term productivity. Winegrape growers in the northeastern United States face several challenges that growers in other established areas such as California, France, and Italy typically do not. Connecticut is a cool climate viticultural area, and the growing conditions result in wines with different flavor profiles than those made from grapes grown in warmer climates. The relatively short growing season limits suitable cultivars to those that can produce ripe fruit in a typical growing season. This is especially important for cultivars used for red wine, whose flavors typically require more accumulated heat units to achieve desired flavors than white wine cultivars. Many cultivars, especially most *Vitis vinifera* cultivars, can be damaged or killed by low winter temperature likely to be encountered in non-coastal areas of Connecticut.

Replicated cultivar trials were established at four sites in Connecticut (Table 1). The first trial was planted at Lockwood Farm, Hamden, in 1992. This trial consists of the cultivars ‘Chambourcin’, ‘Seyval Blanc’, ‘Villard Blanc’, and ‘Villard Noir’. Early yield data for this vineyard have been previously reported (Kiyomoto 1995). A second trial, established at the Valley Laboratory in Windsor in 1995, consists of ‘Cabernet Franc’, ‘Cayuga White’, ‘Chambourcin’, ‘Chardonnay’, ‘Marechal Foch’, ‘Riesling’, ‘Seyval Blanc’, ‘Vidal’, ‘Villard Blanc’, and ‘Villard Noir’. A third trial was planted at a commercial vineyard in Colchester in 2000 and includes ‘Cabernet Franc’, ‘Cabernet Sauvignon’, ‘Chambourcin’, ‘Chancellor’, ‘Chardonel’, ‘Chardonnay’, ‘Chelois’, ‘Muscat Ottonel’, ‘Riesling’, ‘Seyval Blanc’, ‘Vidal’, and ‘Vignoles’. The fourth trial was planted at a commercial vineyard in Shelton, also in 2000, with the purpose of comparative testing of the red Bordeaux cultivars ‘Cabernet Franc’, ‘Cabernet Sauvignon’, and ‘Merlot’.

DATA COLLECTED

Data were collected as described below. Deviations from this protocol are noted in the descriptions of individual vineyards. Yield, number of clusters, dormant cane pruning weights, and the number of retained nodes after pruning were collected on a vine-by-vine basis each year. Pruning weights were not collected in 2004. On the day prior to harvest, random berry samples of a minimum of 50 berries were collected from each block by cultivar, weighed, and frozen for later fruit quality analysis. Yield in estimated tons per acre, average cluster weight, average berry weight, and berries per cluster were calculated from the measured values. Yield in tons per acre was based

Table 1. Grape cultivars planted at research vineyards in Connecticut.

Cultivar	Type	Color	Vineyard Sites
Cabernet Franc	*V. vinifera*	Red	Colchester, Shelton, Windsor
Cabernet Sauvignon	*V. vinifera*	Red	Colchester, Shelton
Cayuga White	Hybrid	White	Windsor
Chambourcin	Hybrid	Red	Colchester, Hamden, Windsor
Chancellor	Hybrid	Red	Colchester
Chardonel	Hybrid	White	Colchester
Chardonnay	*V. vinifera*	White	Colchester, Windsor
Chelois	Hybrid	Red	Colchester
Marechal Foch	Hybrid	Red	Windsor
Merlot	*V. vinifera*	Red	Shelton
Muscat Ottonel	*V. vinifera*	White	Colchester
Riesling	*V. vinifera*	White	Colchester, Windsor
Seyval Blanc	Hybrid	White	Colchester, Hamden, Windsor
Vidal	Hybrid	White	Colchester, Windsor
Vignoles	Hybrid	White	Colchester
Villard Blanc	Hybrid	White	Hamden, Windsor
Villard Noir	Hybrid	Red	Hamden, Windsor

on the assumption that there were no missing vines. The Ravaz index, an indicator of vine balance, was calculated on a vine-by-vine basis by dividing the yield in pounds per vine by the pounds of cane prunings from the following spring's pruning weights (Ravaz 1911). The previously frozen berry samples were thawed to room temperature, crushed by hand, and filtered through cheesecloth and filter paper. Each berry sample was measured individually for °Brix, *p*H, and titratable acidity (expressed as tartaric acid equivalents) according the methods of Iland et al. (2002).

Data were analyzed using Statistica software (version 8.0; StatSoft, Tulsa, OK) by the general linear model and F test. There were usually significant cultivar x year interactions, so cultivars were also analyzed by one-way ANOVA for each season. These data are shown in the Appendix. Post-hoc comparisons of means were done using Fisher's LSD.

COLCHESTER

The vineyard is planted on moderately well-draining Paxton and Montauk fine sandy loam soils (USDA/NRCS Web Soil Survey http://websoilsurvey.nrcs.usda.gov/app/). Rows are oriented in a northwest to southeast direction, on a moderate northwest slope. The vineyard is not irrigated. The cultivars are planted in a randomized complete block design with four blocks, and four or five vines in each block. Vines are spaced six feet apart within the rows, with nine feet between rows. Row middles consist of mixed sod and were frequently mowed during the study. Vines were cane-pruned each spring by the grower to two canes per vine for vinifera cultivars and two to four canes per vine for hybrid cultivars. Due to the size of the vineyard and the grower's schedule, only a partial sampling of pruning weights were collected in 2005, and none in subsequent years, so the Ravaz index could not be calculated. Canes were trained laterally to a 34-inch fruiting wire, and shoots were tied to two higher wires at approximately four and five feet during the growing season. Fertilization, pest control, and other cultural practices were at the discretion of the grower. Some leaf removal in the immediate fruit zone was done in July and August each year. Harvest dates were also at the discretion of the grower. Except in 2004, all cultivars were harvested on the same day (Table 2). In 2006, cluster data were estimated on the vine prior to harvest at the request of the grower. Comparison of this method with one block where clusters were actually counted during harvest demonstrated that this method is highly inaccurate, so cluster weights and values calculated therefrom are not reported. Last minute changes of the harvest schedule prevented fruit sampling of some cultivars in each year. Due to a similar change to the harvest schedule in 2004, no data are reported for Vidal for that year.

HAMDEN

The vineyard is located on well-elevated, flat land consisting of mostly Yalesville soil, a fine sandy loam with moderately low moisture-holding capacity (Reynolds 1979). Rows are oriented in an east to west direction. The plot is a randomized complete block design with six blocks, and four vines in each block. Vines are spaced six feet apart within the rows, with nine feet between rows. Row middles consisted of mixed sod and were mowed as necessary. Irrigation is available if needed, but was not required during the experiment.

The vineyard had received minimal care from the 2001 growing season through spring 2004. In spring 2004, the vines were drastically pruned to reestablish vine structure. Consequently, most one-year-old wood was removed, resulting in very little crop. Therefore, no data are reported for 2004. In subsequent years, half of the vines in each block were cane-pruned each spring, and the other half was pruned to two to three-node spurs as part of another experiment. All vines were pruned to 40 nodes in 2005. In 2006, node number was adjusted to a 30+10 formula based on pruning weights (30 nodes for the first pound of prunings, and 10 additional nodes for each additional pound, with a 60-node maximum). Canes and cordons were trained laterally to a 40-inch fruiting wire, and shoots were trained through three pairs of catch wires at ≈48, 60, and 72 inches. Vines were fertilized lightly with four pounds actual N/acre at bloom each year. Pest management was a standard grape integrated pest management (IPM) program based on the current New York and Pennsylvania Pest Management Guidelines for Grapes (Cornell and Penn State Cooperative Extension). Shoots were thinned to 5 shoots per linear foot of row in late June in both years. Approximately 50% of the leaves in the immediate fruit zone were removed late each July. Light hedging at the top wire was manually done when necessary, typically in early August. A single hedging was usually all that was required. Maturity was estimated using pre-harvest samples for °Brix and *p*H. All cultivars were harvested on the same day in both years (Table 2).

SHELTON

The vineyard site is located on Charlton-Chatfield and Woodbridge soils, both well-drained fine sandy loams (Wolf 1981). Rows are oriented in a northwest to southeast direction, with a southwest-facing slope. The plot is a randomized complete block design with four blocks; there are four to five vines in each block. Vines are spaced six feet apart within the rows, with ten feet between rows. Row middles consisted of mixed sod and were mowed as necessary. Overhead irrigation is available, but was only used once in August, 2005. Vines were spur-pruned each spring to 3-node spurs. Cordons were trained to a ≈30 inch fruiting wire, and shoots were trained as at the Hamden location. Vines were typically hedged three to four times a year by the grower beginning in July. Some fruit was removed from selected vines early each August as a part of another experiment. The target for fruit remaining on those vines was a yield of three tons per acre of mature fruit. Pest management, fertilization, and harvest date were at the discretion of the grower. All cultivars were harvested on the same date each year (Table 2).

Vineyard/Cultivar	Year		
Colchester	**2004**	**2005**	**2006**
Cabernet Franc	Oct. 9	Oct. 8	Oct. 14
Chambourcin	Oct. 9	Oct. 8	Oct. 14
Chancellor	Oct. 9	Oct. 8	Oct. 14
Chardonel	Sept. 25	Oct. 8	Oct. 14
Chardonnay	Oct. 9	Oct. 8	Oct. 14
Chelois	Oct. 9	Oct. 8	Oct. 14
Muscat Ottonel	Oct. 9	Oct. 8	Oct. 14
Riesling	Oct. 9	Oct. 8	Oct. 14
Seyval Blanc	Sept. 25	Oct. 8	Oct. 14
Vidal	Sept. 25	Oct. 8	Oct. 14
Vignoles	Oct. 9	Oct. 8	Oct. 14
Hamden			
All		Oct. 5	Oct. 19
Shelton			
All	Oct. 13	Oct. 19	Oct. 11
Windsor			
Cabernet Franc	Oct. 20	Oct. 12	Oct. 16
Cayuga White	Oct. 1	Sept. 21	Sept. 21
Chambourcin	Oct. 20	Oct. 12	Oct. 16
Chardonnay	Oct. 1	Oct. 4	Oct. 16
Marechal Foch	Oct. 1	Sept. 13	Sept. 14
Riesling	Oct. 20	Oct. 12	Oct. 16
Seyval Blanc	Sept. 20	Sept. 23	Sept. 21
Vidal	Oct. 20	Oct. 12	Oct. 16
Villard Blanc	Oct. 8	Oct. 4	Oct. 16
Villard Noir	Oct. 20	Oct. 4	Oct. 16

Table 2. Dates of grape harvest 2004-2006.

WINDSOR

The vineyard is located on flat Merrimac sandy loam, a sandy terrace soil. This soil is very well drained with limited moisture-holding capacity (Shearin and Hill 1962). Rows are oriented in a northwest to southeast direction. The plot is a randomized complete block design with four blocks; there are four to seven vines in each block. Vines are spaced six feet apart within the rows, with nine feet between rows. Clean cultivation was practiced throughout the vineyard using a combination of light mechanical cultivation and herbicide. Irrigation is available if needed, but was not required during the experiment. The vines were only lightly maintained from the end of the 2001 season until pruning in spring 2004. Vines were spur-pruned each spring, and node number was adjusted using the 30 + 10 formula as in the Hamden plot. Shoots were tied to two upper wires as in the Colchester vineyard. Pest management was a standard grape IPM based on the current New York and Pennsylvania Pest Management Guidelines for Grapes (Cornell and Penn State Cooperative Extension). Shoots were thinned to 5 shoots per linear foot of row in late June in 2005 and 2006. Leaves in the immediate fruit zone were removed each July. Vines were hedged each year by hand in early to mid-August. Maturity was estimated using pre-harvest samples for °Brix and *p*H. Different cultivars were harvested sequentially each year based on maturity (Table 2). Seyval Blanc was harvested before berry samples could be collected in 2004, so only vegetative data are reported.

RESULTS

Extensive year-to-year variation was noted in each vineyard. Also, as shown in the yield data in Table 3, there was likewise considerable variation among common cultivars in different vineyards. Therefore, data for each vineyard are reported separately.

	Vineyard			
Cultivar	**Colchester**	**Hamden**	**Shelton**	**Windsor**
Cabernet Franc	5.8		10.5	14.8
Chambourcin	7.0	10.4		11.4
Chardonnay	4.5			12.9
Riesling	4.2			11.9
Seyval Blanc	8.3	19.8		14.6
Vidal	12.1			14.2
Villard Blanc		19.5		23.1
Villard Noir		7.9		14.2

Table 3. Average yields (pounds per vine) for common cultivars in four Connecticut vineyards 2004-2006.

COLCHESTER

Over half of the Cabernet Sauvignon vines had died by the beginning of the experiment, so data are not reported for this cultivar. Those vines that did survive appeared to produce an acceptable crop in 2006, although yield data were not collected. Muscat Ottonel consistently produced many shoots with little or no fruit, with few berries per cluster. There was no crop at all in 2005. This is consistent with winter cold damage, although the cultivar is rated 'moderately hardy' by the Cornell grape breeding program (according to information provided on their *Vitis vinifera* Grapes for New York State web site http://www.nysaes.cornell.edu/hort/faculty/pool/vinfvar/vardescs/muscatottonel.html). Observations at the Shelton vineyard (not part of the experimental block) also indicate that this cultivar may not be fruitful enough to be economically viable in Connecticut. The vineyard suffered a major early epidemic of fruit powdery mildew (*Erisiphe necator*) in 2004. This prevented the berries from properly expanding during the lag phase of growth, and predisposed fruit to splitting prior to harvest.

Vidal had the highest average yield (Table 4). Chelois, Chardonel, and Seyval Blanc also had average yields over three tons per acre. Except for Seyval Blanc, these cultivars tended to exhibit more year-to-year variability than lower-yielding cultivars (Appendix Table 1), indicating possible overcropping in high-yielding years. Cluster thinning has frequently been recommended for these cultivars to prevent overcropping. Riesling and Chardonnay produced less than two tons per acre on average, due largely to very low yields in 2004. All other cultivars had average yields of between two and three tons per acre.

Late maturing cultivars such as Chambourcin, Chelois, and Riesling consistently produced relatively low sugar, high acid fruit. This is likely the consequence of the practice of harvesting all cultivars at the same time, and illustrates the importance of managing each cultivar individually. Vignoles also produced high acid fruit, but this is characteristic of the cultivar, whose soluble solids were consistently high. There was no significant correlation between yield and fruit quality as might be expected from overcropping, however.

HAMDEN

All vines planted in 1992 were still in place during the course of the experiment, indicating that they are highly adapted to the local growing conditions. Both white cultivars greatly outyielded red cultivars in both years (Table 4, Appendix Table 2). This was due to a combination of all the components of yield: number of clusters (in 2005 only), cluster weight, berries per cluster and, to a lesser extent, berry weight. Pruning weights were higher for both white cultivars, indicating greater vine size. There were no significant differences between the performance of Seyval Blanc and Villard Blanc for any of these parameters. Chambourcin outyielded Villard Noir both years, but the difference was not significant. The Ravaz index for 2006 was lower for both red cultivars, and may be indicative of undercropping.

Chambourcin had the highest soluble solids, followed by Villard Noir. Seyval Blanc and Villard Blanc had lower soluble solids. However, the white cultivars had less titratable acidity than the red cultivars. Except for slightly high acidity in the red cultivars in 2006, both *p*H and titratable acidity were well within accepted values for good wine quality.

There was a significant negative correlation between yield and soluble solids and titratable acidity. This was the only vineyard that demonstrated this relationship. There was no significant correlation between yield and *p*H.

SHELTON

Cabernet Franc had the highest yields on average and in

Table 4. Vegetative and fruit quality parameters for four Connecticut vineyards, 2004-2006.

Cultivar	Yield, Pounds per Vine	Yield, Tons per Acre	Pruning Weight (lbs)	Number of Retained Nodes	Ravaz Index	Clusters per Vine	Average Cluster Weight (g)	Average Berry Weight (g)	Berries per Cluster	°Brix	pH	Titratable Acidity (g/100 ml)
Colchester Vineyard												
Cabernet Franc	5.80 cde	2.34 cde				32 ab	71.6 b	1.38 de	32 abc	20.5 ab	3.48 cd	0.672 b
Chambourcin	6.96 bc	2.81 bc				30 abc	98.4 ab	2.17 ab	30 bc	17.8 e	3.16 h	1.076 f
Chancellor	5.06 cde	2.04 cde				27 bcd	73.7 b	1.59 cd	27 bc	20.2 bc	3.42 cde	0.770 de
Chardonel	8.14 abc	3.28 abc				26 bcd	137.1 a	2.29 a	26 ab	21.5 ab	3.33 ef	0.820 e
Chardonnay	4.82 de	1.95 de				23 cd	66.6 b	1.51 d	23 bc	21.1 ab	3.60 b	0.634 b
Chelois	8.55 ab	3.45 ab				29 abc	114.8 a	2.26 ab	29 ab	17.4 e	3.13 h	1.015 f
Muscat Ottonel	0.45 f	0.18 f				6 e	27.2 c	2.12 ab	6 d	20.5 b	3.77 a	0.506 a
Riesling	4.16 ef	1.68 ef				20 de	68.4 b	1.34 de	20 ab	17.9 e	3.39 de	0.741 cd
Seyval Blanc	8.31 ab	3.35 ab				32 ab	102.6 ab	1.33 e	32 a	18.9 cd	3.41 de	0.674 b
Vidal	12.12 a	4.89 a				44 a	125.5 a	1.92 bc	44 ab	18.4 de	3.52 c	0.734 cd
Vignoles	5.01 cde	2.02 cde				25 bcd	69.8 b	1.48 de	25 bc	21.7 a	3.29 fg	1.016 f
Lockwood Farm, Hamden												
Chambourcin	10.38 b	4.19 b	1.13 b	36 b	8.1	41 c	116.6 b	2.22 b	52 b	20.5 a	3.54	0.810 b
Seyval Blanc	19.82 a	8.00 a	2.55 a	41 a	10.5	54 a	166.1 a	2.44 ab	68 a	18.5 c	3.58	0.656 a
Villard Blanc	19.47 a	7.86 a	2.52 a	40 a	11.0	51 ab	171.8 a	2.48 a	69 a	18.4 c	3.59	0.655 a
Villard Noir	7.94 b	3.20 b	0.77 b	36 b	7.9	44 bc	82.6 c	2.34 ab	35 c	19.9 b	3.55	0.824 b
Shelton Vineyard												
Cabernet Franc	10.52	4.24	3.86 a	38.5	3.0 b	48	102 ab	1.48 ab	68	19.5	3.73	0.684
Cabernet Sauvignon	8.31	3.35	3.46 ab	30	2.2 b	45	92 b	1.42 b	64	19.1	3.71	0.708
Merlot	9.89	3.99	2.67 b	36	4.1 a	43	104 a	1.56 a	67	19.5	3.71	0.586
Valley Laboratory, Windsor												
Cabernet Franc	14.78 b	5.96 b	2.54 abc	42 abcd	7.8 cd	62 bc	117.9 b	1.50 fg	77.9 a	21.4 a	3.52 a	0.599 a
Cayuga White	13.06 b	5.27 b	1.95 bcd	39 bcd	7.3 cd	54 bc	111.4 b	3.05 a	35.9 e	19.3 c	3.32 b	0.695 ab
Chambourcin	11.43 b	4.61 b	1.36 d	34 de	8.7 c	50 c	104.6 bc	2.18 c	48.3 cde	21.5 a	3.35 b	0.761 cd
Chardonnay	12.89 b	5.20 b	2.77 ab	45 abc	4.5 d	54 bc	108.6 bc	1.64 ef	66.6 ab	22.0 a	3.58 a	0.697 ab
Marechal Foch	13.94 b	5.62 b	3.05 a	48 a	4.7 d	102 a	63.5 d	1.19 g	53.7 bcd	21.1 ab	3.66 a	0.809 cd
Riesling	11.87 b	4.79 b	2.63 abc	44 a	4.9 d	62 bc	87.0 c	1.66 def	52.5 bcd	17.4 d	3.39 b	0.634 a
Seyval Blanc	14.64 b	5.91 b	0.95 e	31 e	16.9 a	57 bc	115.9 bc	1.85 d	63.5 bc	19.9 bc	3.53 a	0.650 a
Vidal	14.22 b	5.74 b	1.59 d	35 de	9.2 bc	51 bc	129.3 b	1.76 de	73.8 ab	21.4 a	3.35 b	0.786 bcd
Villard Blanc	23.05 a	9.30 a	1.94 bcd	41 abcd	12.4 b	57 bc	185.8 a	2.99 b	62.0 bc	19.5 bc	3.29 b	0.756 abc
Villard Noir	14.15 b	5.71 b	1.85 cd	38 cd	7.7 cd	72 b	87.3 c	2.41 c	36.2 de	20.7 bc	3.41 b	0.835 d

For each vineyard and cultivar, and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$.

two of the three years of the study. Yields of Merlot were slightly less, and Cabernet Sauvignon had the lowest yield, but the differences were not significant (Table 4). Overall yields would presumably have been slightly higher had fruit thinning had not been done on selected vines. Differences in the components of yield, when present, were slight. The vines were very vigorous, as reflected in the pruning weights and very low Ravaz index values. This was also reflected in the need for multiple hedgings each year. There were only significant differences in soluble solids in 2006 (Appendix Table 3). Cabernet Sauvignon had titratable acidity slightly above the ideal range in 2004 and 2006, as did Cabernet Franc in 2006. The fruit of all three cultivars in 2005 was characterized by unusually low acidity and high *p*H, although soluble solids were only slightly above average. Although it is not reflected in the fruit quality data presented, observations during sampling and harvest indicated that Cabernet Sauvignon fruit was frequently excessively herbaceous, possessing the ‘bell pepper’ flavor caused by methoxypyrazines (de Boubée et al. 2002).

WINDSOR

Villard Blanc had the highest yields of all cultivars in each year (Table 4, Appendix Table 4). The difference was most pronounced in 2004. Although yields of Villard Blanc were actually higher in 2005 and 2006, the differences were not as great, as yields on several other cultivars, most notably Cabernet Franc, Cayuga White, Marechal Foch, Vidal, and Villard Noir, increased from 2004 levels. Yield of Riesling was quite high in 2006. Except for Cabernet Franc and Riesling in 2004, all cultivars produced acceptable to excellent yields in each year.

Pruning weights were also good for every cultivar except Seyval Blanc. Due to its tendency to overcrop, it produced good quantities of acceptable fruit each year, although the vines always had the fewest nodes retained after pruning. This also accounts for the very high Ravaz index for Seyval Blanc, and may not be sustainable over the course of several years. Ravaz values for Chardonnay and Marechal Foch were slightly lower than optimum, as were those for Riesling in 2004 and 2005. Components of yield factors varied considerably among cultivars (Appendix Table 5), although the substantial increases in yield for Cabernet Franc and Riesling can mostly be attributed to increased number of clusters.

Soluble solids also varied considerably among cultivars, but, except for Cabernet Franc in 2004 and Riesling in 2005 and 2006, values were acceptable for the cultivar. *p*H was also variable, but always within acceptable ranges. Total acidity was slightly high for Villard Noir in 2004, Vidal in 2005, and Chambourcin in 2006. It was quite high for Marechal Foch and Villard Noir in 2006.

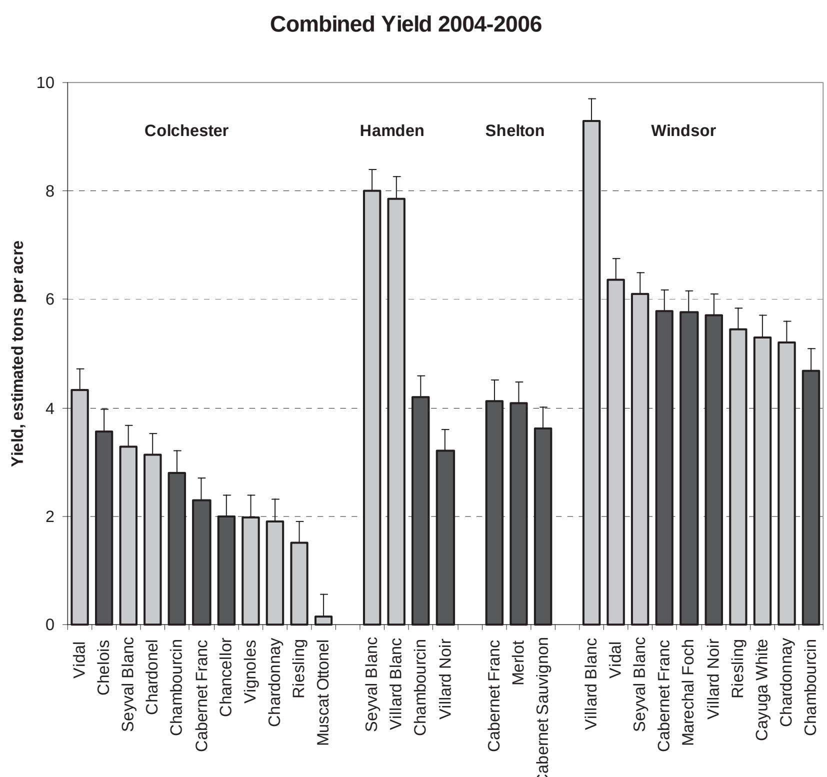


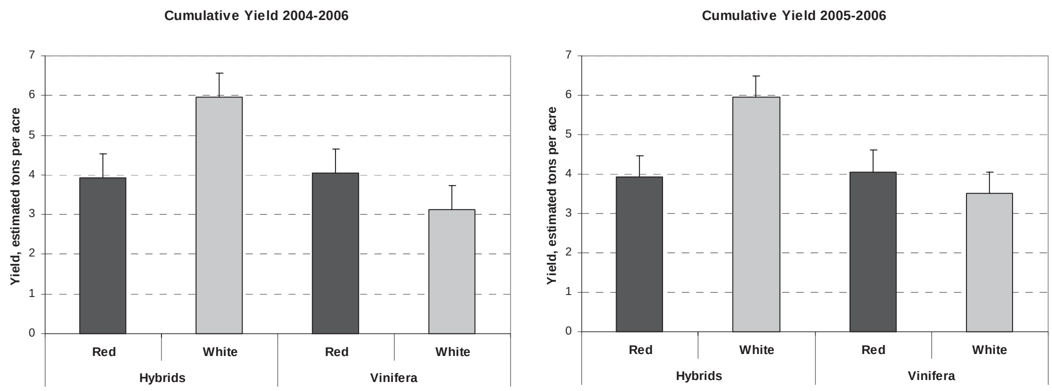
Figure 1. Combined winegrape yield data from four Connecticut vineyards 2004-2006. White cultivars are designated by light bars, red cultivars are dark bars.

OVERALL

Yield data from all years were combined to provide an overview of overall productivity (Figure 1). Windsor was the most productive vineyard, followed by Hamden, Shelton, and Colchester.

Overall, white hybrid cultivars had much higher yields than the other categories (Figure 2). There was no significant difference between red hybrid and red vinifera cultivars. White vinifera cultivars had the lowest yield. However, white vinifera cultivars as a group performed poorly in 2004, and Muscat Ottonel had very little fruit in any year. The difference

Figure 2. Relative yields of hybrid and vinifera red and white winegrape cultivars from four Connecticut vineyards. The chart on the right omits data on white vinifera cultivars from 2004 and all data on Muscat Ottonel.



between red and white vinifera cultivars was not as great in 2005 and 2006.

DISCUSSION

Overcropped vines in one season can sometimes result in reduced yield in the subsequent season. Most of the cultivars that exhibited marked increases from 2004 to 2005 did not show a significant decrease in yield in 2006, indicating that the vines were undercropped in 2004. In extreme cases, overcropping can result in a biennial bearing cycle. Chardonel at Colchester was the only cultivar that strongly demonstrated this characteristic. Riesling at Colchester and Seyval Blanc at Windsor also had decreased yield in 2006 after significant increases from 2004 to 2005, although the fluctuations were not as dramatic. Given the relatively brief period of the study, it is impossible to determine whether these fluctuations were the result of the overcropping/undercropping cycle or just natural fluctuations. There was a large decrease in yield of Vidal in Colchester from 2005 to 2006, but since yield data are not available for 2004, it is impossible to infer a trend.

Optimum cane pruning weights, an estimator of vine size, are typically considered to be about three pounds. Cane pruning weights of less than two pounds indicate a relatively weak vine, and more than four pounds is considered excessive. All of the cultivars from which the limited data were collected in spring 2005 at Colchester had pruning weights of less than one pound. This indicates that the vines could be more productive if vine size could be increased. Pruning weights at Hamden were correlated with yield, with the white cultivars having pruning weights within the acceptable range, and the red cultivars having lower weights. All cultivars from Shelton were within the desired range each spring. There was a lower correlation with yield at Windsor, where most vines had acceptable or just below acceptable pruning weights. Those of Chambourcin, Vidal, and, especially, Seyval Blanc were below acceptable levels, although there was no apparent affect on yield.

The range of acceptable values for the Ravaz index is quite large. Kurtural (2007) states the optimum to be between five and 14, although Reynolds (2000) indicates that 12 is the maximum for optimum wine quality. The Ravaz values for the vines at Hamden were all within the accepted range except for Villard Noir in 2006, indicating that they were generally in balance. However, it might be desirable to increase the bud number over that of the 30+10 formula on the red cultivars to increase yield, as Ravaz index values are within the low range of acceptable values for hybrid cultivars. Except for Merlot in 2004, Ravaz values at Shelton were well below the desired range, indicating overly vegetative vines. This was also indicated by the requirement for multiple hedgings each season. Canopy division might result in decreased vigor as well as higher yields. Values were consistently acceptable for several cultivars at Windsor. Cabernet Franc had an exceptionally high value in 2005 following a very low one in 2004. This was probably the result of undercropping in 2004, and is reflected in the yield data. By 2006, the index value was acceptable. The consistent, but slightly low values for Chardonnay and Marechal Foch indicate that they were probably slightly undercropped. This is especially true for Marechal Foch, as acceptable values for hybrid cultivars are generally higher than those for vinifera cultivars. Using a different pruning formula that would leave more retained nodes should help improve vine balance. Riesling had low values in 2004 and 2005, but an acceptable value in 2006. This corresponded to a dramatic increase in yield, also indicating undercropping in previous years. The high values for Seyval Blanc were the result of the low pruning weights. However, yields and fruit quality were good, so possibly the high Ravaz values are appropriate for Seyval Blanc in this vineyard.

Vineyard floor vegetation competes with grapevines for water and nutrients (Palliotti et al. 2007). It is possible that the clean cultivation practiced at the Windsor vineyard was partially responsible for the high yields there. However, the site is unusual for Connecticut vineyards in that the site is almost perfectly flat and therefore relatively resistant to erosion. Most non-coastal Connecticut vineyards are planted on sloping land which would be very subject to erosion without some form of within-row vegetation. Also, the fairly coarse soil texture allowed for easy equipment access to the vineyard, even after significant rain events. Many Connecticut vineyards would not be accessible at critical periods for pest control without the traction afforded by cover crops. Therefore, clean cultivation is not a viable option for most vineyards.

°Brix is not necessarily the best indicator of fruit maturity. It is the most traditional indicator because it is easy to measure in the vineyard, and the portable technology has existed for some time. Also, traditional European wines required adequate sugar levels to produce wines with stable levels of alcohol, as chaptalization (the addition of sugar) was regarded as resulting in inferior wines, and is still prohibited in some areas. Many hybrid cultivars rarely achieve the 'classic' 22°Brix in most years, and chaptalization is widely practiced in Connecticut and other areas of the Northeast and Midwest. Several cultivars with significant *V. labruscana* heritage, such as Cayuga White, develop undesirable flavors if left to mature to high °Brix levels. Low °Brix levels for cool climate grapes such as those in this experiment should only be deemed unacceptable if accompanied by excessively low *p*H or high titratable acidity levels.

There was a great demand for Connecticut-grown fruit during the course of this study. Consequently, good quality fruit usually sold at an acceptable price of about $2,000 per ton. The price was frequently the same for vinifera and hybrid cultivars. As vineyard acreage increases and the industry matures, prices may fall more into line with those of nearby states with more established industries, such as New York. If so, the price paid for vinifera fruit could be about double that of hybrid fruit, making the planting of red vinifera cultivars more profitable than hybrids, and making the profitability of vinifera and hybrid white cultivars approximately equal.

CONCLUSIONS

These trials demonstrate that appropriately selected white hybrid cultivars are a good choice for growers who desire maximum yield. The performance of white vinifera cultivars was more variable, but Chardonnay and Riesling are capable of producing acceptable yields under good conditions. Lack of cold hardiness limits the range of vinifera plantings in Connecticut, however. In areas where cold hardiness is not limiting, suitable red vinifera cultivars were equal in yield and fruit quality to hybrid cultivars.

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APPENDIX

Appendix Table 1. Vegetative and fruit quality parameters for a vineyard in Colchester, CT, 2004-2006.

Yield, Pounds per Vine

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	3.91 b	6.27 cd	7.23 bc
Chambourcin	7.00 a	7.08 cd	6.81 bc
Chancellor	3.04 bc	6.25 cd	5.88 bcd
Chardonel	5.50 ab	13.49 ab	5.43 cd
Chardonnay	1.71 bc	6.17 d	6.58 c
Chelois	7.41 a	7.06 cd	11.18 a
Muscat Ottonel	0.24 c		0.65 e
Riesling	1.29 c	6.97 cd	4.21 d
Seyval Blanc	7.08 a	9.71 bc	8.13 bc
Vidal		15.20 a	9.03 ab
Vignoles	3.66 b	5.96 d	5.40 cd

Yield, Estimated Tons per Acre

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	1.58 b	2.53 cd	2.92 bc
Chambourcin	2.82 a	2.86 cd	2.75 bc
Chancellor	1.23 bc	2.52 cd	2.37 bcd
Chardonel	2.22 ab	5.44 ab	2.19 cd
Chardonnay	0.69 bc	2.49 d	2.66 c
Chelois	2.99 a	2.85 cd	4.51 a
Muscat Ottonel	0.10 c		0.26 e
Riesling	0.52 c	2.81 cd	1.70 d
Seyval Blanc	2.86 a	3.92 bc	3.28 bc
Vidal		6.13 a	3.64 ab
Vignoles	1.48 b	2.40 d	2.18 cd

Number of Clusters per Vine

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	26 ab	38 ab	33 a
Chambourcin	32 a	33 ab	24 abcd
Chancellor	19 bc	38 ab	24 abcd
Chardonel	20 abc	41 ab	18 cde
Chardonnay	17 bc	32 b	20 cd
Chelois	26 ab	32 b	30 ab
Muscat Ottonel	4 c		7 e
Riesling	12 c	36 ab	12 e
Seyval Blanc	30 a	45 a	22 bcd
Vidal		55 a	32 a
Vignoles	25 ab	37 ab	14 de

Average Cluster Weight (g)

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	68.3 cde	74.9 b	
Chambourcin	99.3 abc	97.4 ab	
Chancellor	72.6 bcd	74.7 b	
Chardonel	124.9 a	149.4 ab	
Chardonnay	45.7 e	87.5 b	
Chelois	129.4 a	100.2 ab	
Muscat Ottonel	27.2 e		
Riesling	48.8 de	87.9 ab	
Seyval Blanc	107.1 ab	98.0 ab	
Vidal		125.5 ab	
Vignoles	66.5 cde	73.1 b	

Average Berry Weight (g)

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	1.38 cd		
Chambourcin	2.17 a		
Chancellor	1.59 bc		
Chardonel		2.26 a	2.32 a
Chardonnay	1.17 e	1.67 b	1.69 cd
Chelois	2.10 a	2.42 a	
Muscat Ottonel	1.92 ab		2.32 a
Riesling	1.28 de	1.51 bc	1.24 e
Seyval Blanc		1.40 c	1.25 e
Vidal		1.93 a	1.90 bc
Vignoles	1.35 d	1.56 bc	1.52 de

Berries per Cluster

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	49 ab		
Chambourcin	46 ab		
Chancellor	46 ab		
Chardonel		66 ab	
Chardonnay	39 b	52 ab	
Chelois	62 a	41 bc	
Muscat Ottonel	14 c		
Riesling	38 b	58 ab	
Seyval Blanc		70 a	
Vidal		65 ab	
Vignoles	49 ab	47 b	

°Brix

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	20.4 ab		20.6 abc
Chambourcin	17.4 e		18.2 ef
Chancellor	19.9 abc		20.4 bcd
Chardonel		21.0 b	22.0 a
Chardonnay	20.8 a	21.3 b	21.3 ab
Chelois	18.1 de	17.0 c	17.1 f
Muscat Ottonel	19.4 bcd	21.7 ab	20.4 bcd
Riesling	17.9 e	16.7 c	19.1 de
Seyval Blanc	19.0 cd	17.2 c	20.5 abc
Vidal		16.5 c	20.2 cd
Vignoles	20.6 ab	23.1 a	21.3 abc

***p*H**

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	3.46 bc		3.49 c
Chambourcin	3.04 f		3.27 de
Chancellor	3.33 cd		3.50 c
Chardonel		3.30 cd	3.36 d
Chardonnay	3.56 b	3.65 a	3.60 b
Chelois	3.01 f	3.14 d	3.25 e
Muscat Ottonel	3.70 a	3.79 a	3.81 a
Riesling	3.36 cd	3.24 d	3.56 bc
Seyval Blanc	3.26 de	3.42 c	3.55 c
Vidal		3.51 b	3.52 c
Vignoles	3.14 ef	3.39 c	3.33 de

Titratable Acidity (g/100 ml)

		Year	
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	0.640 b		0.704 bc
Chambourcin	1.056 e		1.097 d
Chancellor	0.794 cd		0.746 bc
Chardonel		0.799 d	0.841 c
Chardonnay	0.689 b	0.568 a	0.645 b
Chelois	0.979 e	1.013 e	1.052 d
Muscat Ottonel	0.492 a	0.584 ab	0.442 a
Riesling	0.860 d	0.685 bc	0.677 b
Seyval Blanc	0.706 bc	0.668 bc	0.647 b
Vidal		0.696 c	0.771 c
Vignoles	0.971 e	0.966 e	1.112 d

For each cultivar and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$.

Appendix Table 2. Vegetative and fruit quality parameters for Lockwood Farm, Hamden, CT, 2005-2006.

Yield, Pounds per Vine

Cultivar	2005		2006	
Chambourcin	11.68	b	9.08	b
Seyval Blanc	24.27	a	15.37	a
Villard Blanc	23.13	a	15.81	a
Villard Noir	8.75	b	7.12	b

Yield, Estimated Tons per Acre

Cultivar	2005		2006	
Chambourcin	4.71	b	3.66	b
Seyval Blanc	9.79	a	6.20	a
Villard Blanc	9.33	a	6.38	a
Villard Noir	3.53	b	2.87	b

Pruning Weight (lbs)

Cultivar	2005		2006	
Chambourcin	1.21	b	1.04	b
Seyval Blanc	2.99	a	2.11	a
Villard Blanc	3.03	a	2.01	a
Villard Noir	0.77	b	0.77	b

Number of Retained nodes

Cultivar	2005		2006	
Chambourcin	40		32	b
Seyval Blanc	40		41	a
Villard Blanc	40		40	a
Villard Noir	40		31	b

Ravaz Index

Cultivar	2005		2006	
Chambourcin	10.0		6.1	b
Seyval Blanc	11.5		9.5	a
Villard Blanc	11.7		10.3	a
Villard Noir	11.4		4.3	b

Number of Clusters per Vine

Cultivar	2005		2006	
Chambourcin	40	c	41	
Seyval Blanc	60	a	47	
Villard Blanc	55	ab	47	
Villard Noir	46	bc	41	

Average Cluster Weight (g)

Cultivar	2005		2006	
Chambourcin	132.6	b	100.5	b
Seyval Blanc	183.6	a	148.5	a
Villard Blanc	190.9	a	152.7	a
Villard Noir	86.4	c	78.8	c

Average Berry Weight (g)

Cultivar	2005		2006	
Chambourcin	2.42	b	2.02	b
Seyval Blanc	2.72	a	2.16	a
Villard Blanc	2.79	a	2.17	a
Villard Noir	2.48	b	2.19	a

Berries per Cluster

Cultivar	2005		2006	
Chambourcin	55	b	50	b
Seyval Blanc	68	a	69	a
Villard Blanc	68	a	70	a
Villard Noir	35	c	36	c

°Brix

Cultivar	2005		2006	
Chambourcin	20.2	a	20.8	a
Seyval Blanc	18.5	bc	18.4	c
Villard Blanc	18.4	c	18.4	c
Villard Noir	19.5	ab	20.2	b

***p*H**

Cultivar	2005		2006	
Chambourcin	3.61		3.47	b
Seyval Blanc	3.62		3.54	a
Villard Blanc	3.62		3.55	a
Villard Noir	3.61		3.49	ab

Titratable Acidity (g/100 ml)

Cultivar	2005		2006	
Chambourcin	0.741	b	0.880	b
Seyval Blanc	0.616	a	0.695	a
Villard Blanc	0.624	a	0.685	a
Villard Noir	0.781	b	0.868	b

For each cultivar and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$.

Appendix Table 3. Vegetative and fruit quality parameters for a vineyard in Shelton, CT, 2004-2006.

Yield, Pounds per Vine

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	10.33	10.77	10.46
Cabernet Sauvignon	7.51	8.15	9.28
Merlot	10.92	9.83	8.93

Yield, Estimated Tons per Acre

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	4.17	4.35	4.22
Cabernet Sauvignon	3.03	3.29	3.74
Merlot	4.41	3.97	3.60

Pruning Weight (lbs)

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc		3.86 a	3.86 a
Cabernet Sauvignon		3.46 ab	3.46 ab
Merlot		2.67 b	2.67 b

Number of Retained nodes

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc		41 a	36 a
Cabernet Sauvignon		30 b	30 b
Merlot		38 ab	34 ab

Ravaz Index

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	3.6 ab	2.9	2.4
Cabernet Sauvignon	1.6 b	2.4	2.7
Merlot	5.6 a	3.7	3.1

Number of Clusters per Vine

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	40	50	53 a
Cabernet Sauvignon	26	57	52 ab
Merlot	41	49	40 b

Average Cluster Weight (g)

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	117	98	90
Cabernet Sauvignon	131	65	81
Merlot	121	91	101

Average Berry Weight (g)

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	1.65 b	1.49	1.31
Cabernet Sauvignon	1.68 ab	1.38	1.20
Merlot	1.85 a	1.51	1.33

Berries per Cluster

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	71	66	68
Cabernet Sauvignon	78	47	68
Merlot	65	60	76

°Brix

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	18.9	20	19.6 a
Cabernet Sauvignon	18.8	19.4	19.1 b
Merlot	18.6	19.9	19.9 a

***p*H**

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	3.61 a	4.02 a	3.55
Cabernet Sauvignon	3.64 ab	3.95 ab	3.54
Merlot	3.69 b	3.86 b	3.59

Titratable Acidity (g/100 ml)

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	0.705 ab	0.460	0.887 b
Cabernet Sauvignon	0.825 b	0.430	0.869 b
Merlot	0.612 a	0.455	0.690 a

For each cultivar and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$.

Appendix Table 4. Yield and vegetative data for the Valley Laboratory, Windsor, 2004-2006.

Yield, Pounds per Vine

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	6.09 b	19.79 ab	18.45 ab
Cayuga White	8.48 b	13.29 bc	17.40 ab
Chambourcin	11.02 b	10.16 c	13.10 b
Chardonnay	11.07 b	14.26 bc	13.33 b
Marechal Foch	11.56 b	13.68 bc	16.58 ab
Riesling	6.17 b	9.32 c	20.12 ab
Seyval Blanc	11.17 b	18.54 b	14.21 b
Vidal	10.16 b	16.45 bc	16.05 ab
Villard Blanc	20.25 a	26.03 a	22.87 a
Villard Noir	8.36 b	14.30 bc	19.78 ab

Yield, Estimated Tons per Acre

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	2.46 b	7.99 ab	7.44 ab
Cayuga White	3.42 b	5.36 bc	7.02 ab
Chambourcin	4.45 b	4.10 c	5.29 b
Chardonnay	4.47 b	5.75 bc	5.38 b
Marechal Foch	4.66 b	5.52 bc	6.69 ab
Riesling	2.49 b	3.76 c	8.12 ab
Seyval Blanc	4.51 b	7.48 b	5.73 b
Vidal	4.10 b	6.64 bc	6.48 ab
Villard Blanc	8.17 a	10.50 a	9.23 a
Villard Noir	3.37 b	5.77 bc	7.98 ab

Pruning Weight (lbs)

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc		1.75 bcd	3.33 a
Cayuga White		1.53 cd	2.36 abcd
Chambourcin		1.24 cd	1.47 de
Chardonnay		2.68 b	2.86 abc
Marechal Foch		3.05 a	3.04 ab
Riesling		2.00 abcd	3.25 ab
Seyval Blanc		0.96 d	0.93 e
Vidal		1.52 cd	1.65 cde
Villard Blanc		2.00 bc	1.88 bcde
Villard Noir		1.67 bcd	2.02 abcde

Number of Retained nodes

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc		38 bcd	45 a
Cayuga White		35 cd	42 ab
Chambourcin		33 cd	35 bc
Chardonnay		47 ab	42 ab
Marechal Foch		51 a	44 a
Riesling		43 abc	45 a
Seyval Blanc		30 d	32 c
Vidal		36 bcd	34 bc
Villard Blanc		42 abc	39 abc
Villard Noir		36 bcd	40 abc

Ravaz Index

	Year		
Cultivar	**2004**	**2005**	**2006**
Cabernet Franc	3.3 c	14.3 ab	5.7 de
Cayuga White	7.1 abc	5.7 c	9.2 bcd
Chambourcin	9.3 ab	7.2 bc	9.6 bcd
Chardonnay	4.3 bc	5 c	4.2 e
Marechal Foch	3.9 c	4.6 c	5.6 cde
Riesling	2.1 c	4.4 c	8.1 bcde
Seyval Blanc	11.5 a	20.9 a	18.4 a
Vidal	7.4 abc	10.9 bc	9.4 bcd
Villard Blanc	10.2 a	14.7 ab	12.4 b
Villard Noir	5.2 bc	7.4 bc	10.6 bc

For each cultivar and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$

Appendix Table 5. Components of yield and fruit quality data for the Valley Laboratory, Windsor, 2004-2006.

Number of Clusters per Vine

Cultivar	2004	2005	2006
Cabernet Franc	21 d	65 ab	100 bc
Cayuga White	53 bc	42 c	67 cd
Chambourcin	49 bc	43 c	57 d
Chardonnay	46 bcd	56 bc	60 cd
Marechal Foch	89 a	81 a	137 a
Riesling	37 bcd	42 c	108 ab
Seyval Blanc	45 bcd	62 abc	65 cd
Vidal	33 cd	66 ab	54 d
Villard Blanc	49 bc	55 bc	67 cd
Villard Noir	60 b	69 ab	86 bcd

Average Cluster Weight (g)

Cultivar	2004	2005	2006
Cabernet Franc	131.7 b	138.2 bc	83.8 de
Cayuga White	72.6 cd	143.7 b	117.9 bc
Chambourcin	102.1 bc	107.3 cde	104.3 cd
Chardonnay	109.3 bc	115.6 bcd	100.9 cde
Marechal Foch	59.0 d	76.7 e	54.9 f
Riesling	75.7 cd	100.7 cde	84.6 e
Seyval Blanc	112.7 bc	135.8 bc	99.3 de
Vidal	139.8 bcd	113.2 bcd	134.9 b
Villard Blanc	187.6 a	214.9 a	155.0 a
Villard Noir	63.3 cd	94.1 de	104.4 cd

Average Berry Weight (g)

Cultivar	2004	2005	2006
Cabernet Franc	1.56 cd	1.55 f	1.39 e
Cayuga White	2.63 b	3.34 a	3.19 a
Chambourcin	1.92 c	2.20 cd	2.43 c
Chardonnay	1.62 c	1.55 f	1.75 d
Marechal Foch	1.20 d	1.12 g	1.26 e
Riesling	1.58 cd	1.65 ef	1.74 d
Seyval Blanc		1.90 de	1.79 d
Vidal	1.65 c	1.81 ef	1.82 d
Villard Blanc	3.15 a	2.99 b	2.84 b
Villard Noir	2.35 b	2.27 c	2.60 c

Berries per Cluster

Cultivar	2004	2005	2006
Cabernet Franc	84 a	89 a	60 b
Cayuga White	28 c	43 d	37 e
Chambourcin	53 ab	49 cd	43 de
Chardonnay	67 ab	75 ab	58 bc
Marechal Foch	49 ab	68 ab	44 de
Riesling	48 ab	61 bcd	49 cd
Seyval Blanc		71 ab	55 bc
Vidal	85 a	63 bc	74 a
Villard Blanc	60 ab	72 ab	55 bc
Villard Noir	27 c	41 d	40 de

°Brix

Cultivar	2004	2005	2006
Cabernet Franc	19.7 abc	22.8 a	21.6 ab
Cayuga White	18.6 bc	20.7 ab	18.6 d
Chambourcin	21.8 a	21.3 ab	21.4 abc
Chardonnay	21.3 a	22.3 a	22.3 a
Marechal Foch	20.5 abc	22.2 a	20.5 bc
Riesling	18.0 c	16.6 c	17.7 d
Seyval Blanc		19.4 b	20.3 c
Vidal	21.3 a	20.8 ab	22.1 a
Villard Blanc	18.5 c	19.2 b	20.9 bc
Villard Noir	21.3 a	20.6 ab	20.2 c

***p*H**

Cultivar	2004	2005	2006
Cabernet Franc	3.48 ab	3.55 abc	3.68 ab
Cayuga White	3.23 c	3.41 cd	3.40 d
Chambourcin	3.32 bc	3.38 cd	3.42 d
Chardonnay	3.54 a	3.62 ab	3.75 a
Marechal Foch	3.53 a	3.78 a	3.62 ab
Riesling	3.41 abc	3.37 cd	3.54 bcd
Seyval Blanc		3.53 bc	3.48 cd
Vidal	3.34 bc	3.35 cd	3.56 bc
Villard Blanc	3.30 bc	3.28 d	3.45 cd
Villard Noir	3.43 ab	3.39 cd	3.46 cd

Titratable Acidity (g/100 ml)

Cultivar	2004	2005	2006
Cabernet Franc	0.585 a	0.521 a	0.692 a
Cayuga White	0.742 cd	0.581 a	0.762 abc
Chambourcin	0.762 cd	0.687 ab	0.835 c
Chardonnay	0.726 bcd	0.633 ab	0.731 ab
Marechal Foch	0.764 cd	0.748 abc	0.915 d
Riesling	0.602 ab	0.584 ab	0.716 ab
Seyval Blanc		0.610 ab	0.690 a
Vidal	0.716 bc	0.855 c	0.789 bc
Villard Blanc	0.756 cd	0.766 abc	0.745 ab
Villard Noir	0.803 d	0.782 bc	0.921 d

For each cultivar and within each column, values followed by the same letter are not significantly different at $p \leq 0.05$.

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