Virginia Polytechnic Institute and State University
Proposal Cover Sheet

PROPOSAL INFORMATION

Virginia Winegrowers Advisory Board
Sponsor

Solicitation No.

Wine Grape Cultivar, Clone, and Training System Evaluations
Proposal Title

$9,384.00	7/1/04	6/30/05	☐ New or
Amount	**Begin Date**	**End Date**	☒ **Renewal of** 447109

PRINCIPAL INVESTIGATOR(S)

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Department / Center	Department / Center	Department / Center

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VIRGINIA TECH ENDORSEMENT

	3-30-04	04-1904-03
David W. Richardson	**Date**	**VT Proposal No.**
Director of Sponsored Programs		

A proposal submitted to:

Virginia Winegrowers Advisory Board

for continued funding of

WINE GRAPE CULTIVAR, CLONE, AND TRAINING SYSTEM EVALUATIONS

Principal Investigators:

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Start date: 1 July 2004
(Multi-year project)

Amount requested: $9,384 (current year)

Title: Wine grape cultivar, clone, and training system evaluations

Date: 1 July 2004

Objectives:

1) To evaluate 10 Chardonnay clones for viticultural and enological strengths and weaknesses.

2) To evaluate Traminette, Cabernet Franc, and Viognier under three different training systems in northern Virginia.

3) To evaluate a series of novel wine grape cultivars in the Eastern Piedmont of Virginia.

Justification and practical importance:

Winegrape clones: Clonal variability offers the grower/vintner latitude in adaptation to climate or other growing conditions, while maintaining a recognized variety name. Clonal evaluation is a logical extension of variety evaluation, and growers are increasingly seeking clonal recommendations, rather than simply variety recommendations. While wine grape variety evaluations have been conducted at Virginia Tech's AHS Agricultural Research and Extension Center (AREC) since 1989 (Wolf and Cook, 2000; Wolf et al., 1999; Wolf and Miller, 2001), work with clones was only begun in 1998. The Chardonnay clone evaluation at Winchester, Virginia yielded preliminary fruit quality and yield data in 2000. The information gained from this proposed research will provide growers with objective information about yields, fruit quality, bunch rot susceptibility and, ultimately, wine quality, of different Chardonnay clones.

Training system comparison: Formal grapevine training system comparisons are justified from several bases. First, owing to differences in vigor and growth habit, as well as grower constraints, no one training system is universally suited to all situations. Divided canopy training systems are economically viable when cane pruning weights uniformly exceed 0.4 pounds per foot of canopy, and would not be recommended for smaller vines. High training systems, such as Geneva Double Curtain, may offer advantages of lower cost, as well as enhanced fruit chemistry owing to greater fruit exposure to sunlight. The interactions of grape variety and training system should be investigated in order to substantiate recommendations from an economic, viticultural, as well as enological basis. Traminette, Cabernet Franc, and Viognier either have potential or are currently important to the mid-Atlantic wine industry. Although Traminette may be grown on its own roots, the long-term merit of this route is uncertain; therefore it will be compared grafted and ungrafted. Traminette fruit and wine is aromatic. High phenol levels that impart bitterness to the wine however, can reportedly accompany maximum flavors. The training system comparison will allow us to modify fruit exposure and potentially optimize fruit flavors and phenols. Cabernet Franc is regionally important but shows inconsistent yields due to fruit set and bud fruitfulness variability. Viognier is a high quality white *vinifera* variety. Viognier's weaknesses are low yields due to bud necrosis and inconsistent fruit flavors and aromas, which are due in part to seasonal differences. The several training systems evaluated with each of these varieties are contemporary, efficient designs that are adaptable to mechanization and, with the divided canopy designs, result in efficient land use.

Cultivar evaluation: The outcome and benefits of the cultivar evaluation at the Southern Piedmont Agricultural Research and Extension Center are expected to include several new (for the region) wine

grape cultivars that can be recommended for the Eastern Piedmont, where spring frost, high heat, and abundant precipitation during the fruit maturation period are chronic threats to grape yields and fruit quality. Currently, we have very few cultivars that can be endorsed for this region of the state, and yet many requests for such information are originating from this region, particularly as traditional agricultural products, such as tobacco, are becoming less profitable.

Timely transfer of knowledge to growers and vintners will be achieved as follows:

- newsletters ("Viticulture Notes" [http://www.ext.vt.edu/vce/specialty/commhort/main.html]) and Vintner's Corner [http://www.fst.vt.edu/zoecklein/index.html)
- seminars and shortcourses (examples include VVA technical meeting (2/2003) and Wineries Unlimited (3/2003)
- trade and scientific publications
- informal industry wine "roundtables"
- electronic dissemination via a viticulture WWW site (http:www.vaes.vt.edu/winchester/faculty/wolf/wolf.html) and Enology Notes site (http:www.fst.vt.edu/zoecklein/index.html).

Background:

Virginia Winegrowers Advisory Board funding in 1987 provided for the establishment of a wine grape variety evaluation planting at the AHS Agricultural Research and Extension Center in Winchester, VA. Twenty-five varieties were evaluated over an eleven-year period. Varieties which generally performed well, both in the vineyard and in the winery, and which have gained some adoption by the Virginia industry or elsewhere, include: Chardonel, Muscat Ottonel, Malvasia bianca, Norton, Petit Verdot, and Viognier. Varieties which may do well under more specific conditions include Sangiovese, Petit Manseng, Tannat, and Fer Servadau. We also learned of specific cultural problems and considerations with many of the varieties. Nebbiolo, for example, must be cane-pruned owing to non-fruitful basal buds. Viognier suffers a high proportion of bud necrosis, which contributed to low yields at Winchester. The information and recommendations generated from the variety planting have been relayed to the region's vineyards and wineries through a number of media, including a symposium in 1995, *Viticulture Notes* newsletters, trade publications, regional and national meetings, and the publication, in 1999, of a 42-page variety recommendation publication. It is our goal to evaluate clones and to present the data generated in much the same manner that the varieties were evaluated and described.Prior to the 2001 grape harvest season Virginia Tech's Department of Food Science and Technology will complete a $180, 000 renovation of the research winery. This renovation will greatly expand and improve our winemaking capability to support this proposed research effort.

Procedures:

1. Chardonnay clone evaluations:

Ten Chardonnay clones are being evaluated for viticultural and enological merits at the AHS Agricultural Research and Extension Center at Winchester, Virginia over a six- to eight-year fruiting period. Clones #4, #5, #6, #15, #17, #25, #76, #95, #96, and #277, which span a range of yield, and known differences in must/wine quality, were planted in 1998. All were grafted to C-3309 rootstock. Each clone is represented by 18 vines, planted in three-vine panels, integral to a training system comparison, described in Section 2. As such, the clones are being compared under three different training systems: vertical shoot positioned, Smart-Dyson, and Geneva Double Curtain. Vine spacing is 8 feet in rows, with rows spaced 10 feet apart. Vines are grown under cultural practices (Wolf and Poling, 1995) and pest management practices (Pfeiffer et al., 1999) common to the region, including shoot positioning, shoot hedging, selective leaf removal from fruit zones, under-trellis herbicide use,

and the use of permanent, mowed sod row middles. Response variables are discussed collectively with other experiments under "**Data Collection**," below.

2. Traminette, Cabernet Franc, and Viognier under three different training systems:

Traminette, Cabernet franc, and Viognier are being evaluated under three different training systems at Winchester, Virginia: two divided canopy systems (Geneva Double Curtain and Smart-Dyson) and the "standard" as used in Virginia, non-divided, Vertical Shoot-Positioned (VSP), all of which are described elsewhere (Capps et al., 1998). The training system comparison was established in 1998 as a split-plot, randomized complete block design comprised of 3 blocks. Each block contains 3 main plots of training systems and 4 sub-plots of grape cultivars in a factorial treatment arrangement. Each cultivar/training system combination consists of three plots of three vines each. Row spacing is at 10 feet while vine spacing is at 8 feet. There are 3 vines per panel for a total of 27 vines per cultivar. Treatment vines are planted in the central row of three-row blocks; border rows are planted to Chardonnay clones, discussed in **Section A**, above. Treatment cultivars are Traminette/own rooted, Traminette grafted to C-3309, Cabernet franc, clone #1, and Viognier, la Jota clone. Cabernet franc and Viognier are grafted to C-3309 rootstock. The rationale for the choice of cultivars is as follows: Traminette is a recently released, white-fruited, hybrid cultivar (Reisch et al., 1997). It has high fruit and wine aroma qualities similar to one of its parents, Gewurztraminer, but possesses much greater cold hardiness and bunch rot resistance than Gewurztraminer does. Preliminary data from our cultivar evaluation at Winchester (our unpublished data), as well as limited commercial experience, suggests that Traminette may be well suited, viticulturally and commercially, to Virginia and other mid-Atlantic states. Our interest in comparing own-rooted and grafted Traminette vines stems from our experience with another *vinifera* hybrid, Chardonel, which was susceptible to phylloxera vine decline in an earlier cultivar evaluation (Wolf and Warren, 2000). Data collection, discussed below, commenced during the 2000 growing season and will continue *ca.* 8 years.

3. Wine grape cultivar evaluation in Virginia's southern Piedmont:

Formal cultivar evaluations in Virginia have been performed only at Winchester, in northern Virginia. The southern and eastern Piedmont regions are warmer (day and night temperatures) and receive greater precipitation, particularly during the fruit ripening months of August-October (NOAA, 1985). While the threat of winter injury is lessened, bud break is advanced relative to the northern part of the state, increasing the risk of spring frost injury. The climatic uniqueness of the region warrants specific cultivar evaluations to support the existing and potential grape and wine producers in southern Virginia and the northern Piedmont region of North Carolina. Accordingly, a wine grape cultivar evaluation was established at Virginia Tech's Southern Piedmont Agricultural Research and Extension Center in Blackstone, Virginia in spring, 2001. Cultivars include NY73.0136.17, Vidal, Traminette, Norton, Tannat #1, Mourvedre, Viognier #1, Rousanne #1, Cabernet Sauvignon #7, Cabernet Sauvignon #337, Chardonnay #96, Tempranillo, Petit Manseng, Touriga nacionale, Tinta cao, Aleatico, and Muscat blanc. Norton is ungrafted. All others are grafted either to C-3309, 5C, or 101-14. Cultivar rationale is based on favorable performance (P. Manseng, Mourvedre, Vidal, Viognier, Cabernet Sauvignon) at Winchester (Wolf et al., 1999), a late-bud break characteristic (e.g., Vidal, Cabernet, Tannat, Mourvedre), pronounced aromas or flavors that might persist under less than optimal ripening conditions (e.g., Muscat blanc, P. Manseng), limited, but favorable commercial experience (e.g., Norton, Tinta cao, Touriga), or combinations of those reasons. Plantings consist of three-vine plots (8 feet between plants), replicated six times in a completely randomized design. Drip irrigation and deer exclusion fencing are installed. Row width is 10 feet. Vines and vineyard are being managed following commercially recommended practices.

Data collection (all experiments, or experiment-specific as noted):
Vine management: Vine management will follow locally recommended practices. Typically, shoot density is set by dormant pruning and shoot thinning to approximately 15 shoots per meter of canopy. Some crop control will be applied to heavy producing cultivars (cultivar evaluation), or in other experiments to limit yields with non-divided canopies to 3.0 to 4.0 tons/acre, slightly more (up to 6.0 tons/acre) with GDC- or Smart-Dyson-trained vines (training system comparison). Pest management, particularly fungal disease management will aim to keep vines free of disease, rather than intentionally evaluate disease susceptibility.

Fruit sampling and components of yield: A minimum of 50 berries will be randomly collected from each cultivar or clone replicate, as well as from the cultivars used in the training system comparison. Fruit samples will be collected at 7- to 10-day intervals beginning at approximately 18 °Brix, until and including harvest. To allow treatment comparison, clones, cultivars and training system plots will be harvested at approximately 22 to 23 °Brix (season permitting), rather than at a fixed time. Harvest decision will also be predicated upon disease incidence, fruit aroma and taste, and imminent climatic or wildlife threats. Yield components for all experiments will include clusters per vine, cluster weight, berries per cluster, berry weight, and fruit weight per vine.

Fruit chemistry: Basic fruit chemistry analyses will be performed at the AHS AREC in Winchester and, commencing in 2003, at the Southern Piedmont AREC in Blackstone. Soluble solids and pH will be determined on fresh (non-frozen) berry samples within 24 hours of collection. Titratable acidity will be determined either on fresh juice, or on frozen, diluted juice samples. For Cabernet franc (training system comparison), fruit total anthocyanins (abs. @520 nm) and total phenolics (abs. @280 nm) will be measured spectrophotometrically at the AHS AREC following established practices.

Wine making: Wine making is integral to the overall goals of this project. An independent proposal from Dr. Bruce Zoecklein will address funding requests to support wine making.

Accomplishments/Benefits to Date:
Data have been collected from the Chardonnay clone and training system comparison at Winchester since 2000. These data have been presented to the VWAB in quarterly reports, and the most current report is attached here in **Appendix A**. In addition, wines have been made from the training system and Chardonnay clone experiments by Dr. Bruce Zoecklein in 2001, 2002, and 2003.

Major conclusions to date include:
- Chardonnay clones show a large variation in crop yield components including berry weight and cluster weight. Wines have been made for two seasons and preliminary sensory data has provided descriptors of the 2001 wines. Clones express *different* aromas and tastes, but that is not to say that one is necessarily better than another. We have been able to harvest clones at very similar sugar (Brix) levels to avoid the confounding influences of differences in maturity.
- The divided canopy training systems (Geneva Double Curtain and Smart-Dyson) result in crop yield increases of 50 to 70% over non-divided canopy training, *without* adversely affecting primary fruit chemistry (Brix, pH, TA). This has obvious implications for vineyard economics.
- Fruit color of Cabernet franc has been greatest with Geneva Double Curtain training, perhaps due to greater sunlight measured in the fruit zone of these vines
- We see no delay of fruit maturation with the downward-trained canopy of the Smart-Dyson-trained vines. This has important implications for wine quality.
- We have measured slight increases in fruitfulness (e.g., clusters per shoot) with both of the divided canopy systems, relative to the non-divided canopy (VSP) system.
- Wine quality has was either unaffected by training (despite large yield differences) or was slightly improved with Geneva Double Curtain.

- Grafting has clearly increased the vigor and yields of Traminette, even though vines were only in their 5th season in 2002

Personnel and facilities:

T,K. Wolf will oversee all viticultural aspects of work at Winchester and Blackstone. The AHS AREC has all field and laboratory equipment to accomplish the proposed effort.

B.W. Zoecklein will oversee all enological aspects of work at the Enology-Grape Chemistry Laboratory and research winery in the Department of Food Science and Technology, Virginia Tech, Blacksburg.

M. Morales is a newly hired Small Fruit and Specialty Crops Specialist at the Southern Piedmont AREC. Dr. Morales will oversee day-to-day activities associated with the cultivar evaluation planting at Blackstone.

Other entities: None involved

Source of other funds:

The enological and wine sensory portion of this project will be supplemented from research funds obtained from the California Competitive Grants Program. Viticultural funding **for wages only** (to Tony Wolf) has previously been provided by the North Carolina Grape Council and by the Viticulture Consortium: East.

Budget: (Budget for 2003-2004 fiscal year)

VWAB Funding record: $33,048 was provided for 2001-2002 season, split among three PIs.
$24,183 was provided for 2002-2003 season, split among three PIs.
$35,794 was provided for 2003-2004 season, split among three PIs.

Note to Virginia Tech's Office of Sponsored Programs: If this project is funded, please establish two separate accounts as indicated below:

Budget item	**Winchester (AHS AREC)**	**Blackstone (Southern Piedmont AREC)**
Principal Investigator	*Dr. Tony Wolf*	*Dr. Mario Morales*
Wages	***	4,760
Wage fringe (7.3%)	***	348
Salary	2,135	
Salary fringe (30%)	641	
Travel, domestic	***	1,000
Materials and supplies	***	500
Location total	**$2,776**	**$6,608**
Grand total	**$9,384**	

Budget justification and description:

Winchester (Wolf): Wage support, travel and supplies have been provided by a grant from the Viticultural Consortium:East (March 2004). Not covered by the Viticultural Consortium:East grant, and sought here, is approximately one month of funding of an existing, salaried employee (Leon Combs) to assist with harvest data collection, statistical data analysis, and preparation of presentation data from this project.

Blackstone (Morales): Funds are requested for wage support of the wine grape variety evaluation vineyard at SPAREC during the 2004 and 2005 growing seasons. Wages are figured at $8.50/hr. x 20 hrs./week x 28 weeks = $4,760. Wage fringe rate is 7.3%. Travel funds and a nominal supplies budget is also included to cover vineyard operations and to support some viticulture extension efforts in southside Virginia, and to travel to Winchester at least three times in 2004-2005.

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Appendix A: Detailed Progress Report

Progress:

1. Chardonnay clone evaluations

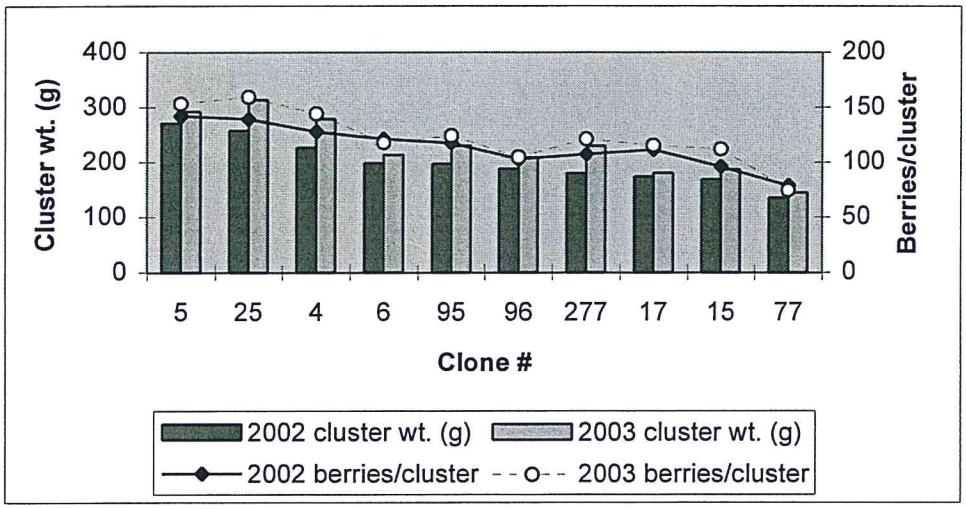
Background: Ten Chardonnay clones are being evaluated for viticultural and enological merits at the AHS Agricultural Research and Extension Center at Winchester, Virginia. Clones #4, #5, #6, #15, #17, #25, #77 (musqué), #95, #96, and #277 were planted in 1998. The clones are being compared under three different training systems: vertical shoot positioned (VSP), Smart-Dyson, and Geneva Double Curtain. Vines are grown under cultural and pest management practices common to the region, including shoot positioning, shoot hedging, selective leaf removal from fruit zones, under-trellis herbicide use, and the use of permanent, mowed sod row middles.

Progress during 2003: Despite a profoundly challenging year, all plots were harvested with very clean fruit in the period from 30 Sep to 8 Oct. The 8-day period of harvest reflected our intent to harvest all plots at or about 21.0°Brix (Table 1), which we generally achieved. Data collection at harvest included all components of crop yield, fruit chemistry (pH, TA, and Brix), degree of fruit rot, and we are currently evaluating the cold hardiness of dormant buds. As with previous years, extra effort was taken in 2003 to sample the two Smart-Dyson canopies separately. Sugar concentrations in 2003 were down about 2.0° Brix at harvest, and titratable acidity levels were up about 2.0 g/L, compared with the 2002 season (Table 1). Wines were again made in 2003. A report on the sensory evaluation of the 2001 and 2002 wines is available from Bruce Zoecklein (bzoeckle@vt.edu). As with 2002 season results, the GDC plots had greatest sugar concentration, and the opposing Smart-Dyson canopies did not differ from each other in any feature of fruit composition (Table 1).

Certain trends are apparent as multiple years of this trial are compared. We have collected four years' of harvest data, and would hope to collect at least one more, partly because the 2002 and 2003 seasons were so different in terms of temperature and precipitation (see Sept/Oct 2003 Viticulture Notes, www.ext.vt.edu/news/periodicals/viticulture/03septemberoctober/03septemberoctober.html#l)

The 10 Chardonnay clones evaluated at Winchester each falls into one of three, arbitrary cluster size categories: Large-clustered, potentially high-yielding clones are 4, 5, and 25 (Figure 1). These clones also have a relatively large number of berries per cluster. Berries per cluster appears to contribute more to cluster weight than does individual berry mass (1.76 to 1.85 grams/berry in 2003). A second (moderate) category of cluster weight comprises clones 6, 95, 96, and 277, while a third (small) category would comprise clones 15, 17, and 77.

Figure 1. Average cluster weights and berries per cluster for VSP-trained Chardonnay clones during the 2002 and 2003 seasons, Winchester, Virginia.



Crop per vine for each of the three training systems is shown in Figure 2 for the 2001-2003 seasons. We felt that vines were somewhat over-cropped in 2001 and therefore attempted through cluster thinning to constrain VSP yields to about 7.5 to 8.5 kg/vine (4.5 to 5.0 tons/acre). Crops on Smart-Dyson and GDC-trained vines were correspondingly thinned to target levels of 11.0 (SD) to 12.0 (GDC) kg/vine, or about 6.5 to 7.0 tons/acre, equivalent. These crop rates were generally achieved, with the exceptions of clones #17 and #77, which were somewhat less than desired.

Table 1. Fruit soluble solids (°Brix), titratable acidity, and pH of 10 Chardonnay clones trained to Geneva Double Curtain (GDC), Smart-Dyson (SDY), or Vertical Shoot Positioning (VSP), 2003 growing season, Winchester, VA.

Clone	Harvest date[z]	°Brix				Titratable acidity (g/L)				pH			
		GDC	SD-up	SD-down	VSP	GDC	SD-up	SD-down	VSP	GDC	SD-up	SD-down	VSP
4	8 Oct	22.1	20.8	20.8	20.7	10.7	11.1	11.1	12.2	3.17	3.15	3.10	3.11
5	6 Oct	21.2	20.9	20.9	20.8	10.4	10.5	10.0	11.8	3.18	3.13	3.11	3.16
6	7 Oct	21.4	20.6	20.8	20.4	8.2	9.6	9.1	8.9	3.30	3.26	3.27	3.29
15	2 Oct	20.7	20.5	20.7	20.7	7.8	8.1	8.2	7.9	3.36	3.34	3.34	3.31
17	3 Oct	.[Y]	20.7	20.7	20.9	.[Y]	7.5	7.3	7.6	.[Y]	3.28	3.29	3.27
25	6 Oct	21.6	20.9	21.0	20.7	10.8	10.6	11.7	11.6	3.16	3.19	3.18	3.14
77	30 Sep	20.3	20.5	20.6	20.4	8.2	8.2	8.0	8.2	3.29	3.30	3.30	3.29
95	3 Oct	20.4	20.8	20.6	20.3	8.8	8.6	8.1	8.7	3.25	3.24	3.22	3.24
96	7 Oct	20.7	21.1	20.6	20.5	8.1	8.0	7.8	8.2	3.35	3.33	3.32	3.36
277	2 Oct	20.9	20.1	21.0	20.2	6.6	6.9	6.6	7.0	3.24	3.24	3.25	3.23

Significance[x]		**Prob>F**		**Prob>F**		**Prob>F**
Clone		0.0105	Clone	<0.0001	Clone	<0.0001
Training		0.0118	Training	0.0455	Training	ns
	GDC	21.0 a	GDC	8.9 ab		
	SD-UP	20.7 b	SD-UP	8.9 ab		
	SD-DOWN	20.7 b	SD-DOWN	8.8 b		
	VSP	20.5 b	VSP	9.2 a		

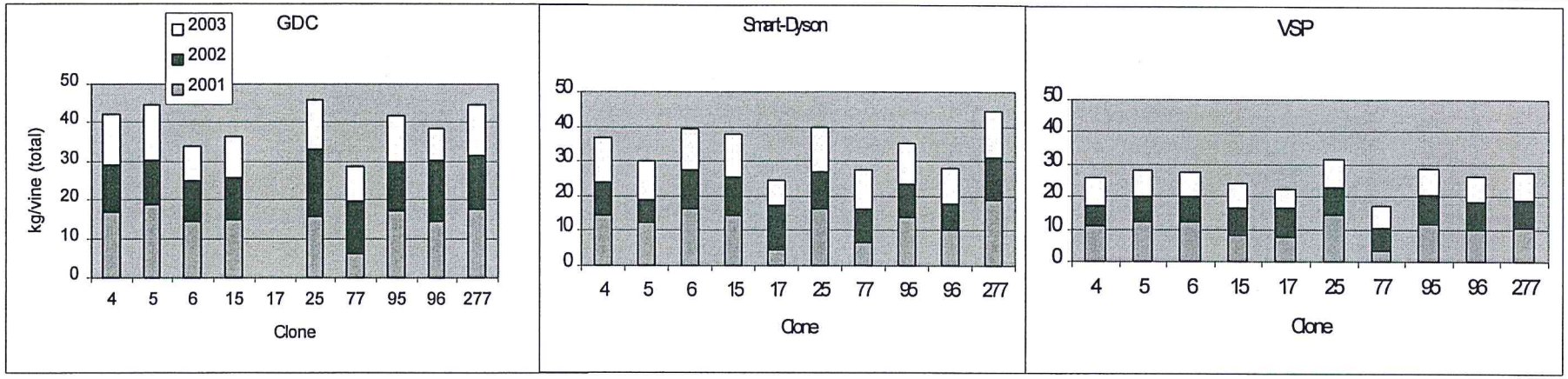


Figure 2. Crop (kg/vine) of 10 Chardonnay clones trained to GDC, Smart-Dyson, or VSP training system at Winchester VA over a 3-year period.

2. Traminette, Cabernet Franc, and Viognier under three different training systems:

Traminette, Cabernet franc, and Viognier are being evaluated under three different training systems at Winchester, Virginia: two divided canopy systems (Geneva Double Curtain and Smart-Dyson) and the "standard" as used in Virginia, non-divided, Vertical Shoot-Positioned (VSP). The training system comparison was established in 1998 as a split-plot, randomized complete block design comprised of 3 blocks. Each block contains 3 main plots of training systems and 4 sub-plots of grape cultivars in a factorial treatment arrangement. Each cultivar/training system combination consists of three plots of three vines each. Row spacing is at 10 feet while vine spacing is at 8 feet. There are 3 vines per panel for a total of 27 vines per cultivar. Treatment cultivars are Traminette/own rooted, Traminette grafted to C-3309, Cabernet franc, clone #1, and Viognier, la Jota clone. Cabernet franc and Viognier are grafted to C-3309 rootstock.

As in previous years, and not surprisingly, training system significantly affected crop per vine (Table 3) For report brevity, the individual training system and variety contrasts are omitted from Table 3, with only main effects reported). GDC and Smart-Dyson training increased crop from 45 to 65%, on average, above VSP training. We continued to measure a significant and positive effect of grafting on crop yield with Traminette. Part of the increased yield stems from an increased fruitfulness (flower clusters per shoot) which was measured in the spring, prior to fruit-thinning (data not shown). We attribute the increased fruitfulness of GDC and Smart-Dyson training to an enhanced light environment in the renewal zone of vines.

Table 3. Crop yield/vine (lbs/vine) of three cultivars trained either to Geneva Double Curtain (GDC), Smart-Dyson (SDY), or Vertical Shoot Positioned (VSP) canopies, 2001-2003, Winchester VA.

	Crop/vine (lbs)*								
	GDC			SDY			VSP		
Cultivar	2001	2002	2003	2001	2002	2003	2001	2002	2003
Traminette/own	27.1	27.9	26.4	32.3	24.6	16.7	19.9	16.6	11.0
Traminette/C-3309	33.5	37.7	28.0	34.5	33.1	18.5	21.0	24.6	12.4
Cab. franc/C-3309	26.0	33.8	27.0	24.0	29.1	29.9	13.8	19.6	19.8
Viognier/C-3309	18.6	31.1	24.6	19.9	28.2	19.6	9.7	18.3	11.1

* Multiply figure by 0.27 to obtain equivalent tons/acre.

Main effects and interactions (Pr > F)	2001	2002	2003
Block	ns	ns	0.04
Training (T)	0.002	0.003	0.0004
Variety (V)	< 0.0001	< 0.0001	<0.0001
Training*Variety	ns	ns	0.01

One of the more interesting responses measured in 2003 was a significant rootstock effect on fruit rot severity with Traminette. Rot severity on GDC-trained vines was 9.3% (own-rooted) vs. 1.4% for vines grafted to C-3309. Corresponding figures for Smart-Dyson were 8.2% vs. 1.3% and, for VSP, 3.0% vs. 0.2%. All comparisons were highly significant.

Fruit soluble solids (Brix) data from the 2003 season are provided in Table 4. Again, we felt that we were fortunate to obtain the degree of ripeness that we did in 2003 but the contrast with the 2002 season is obvious. We harvested at a common Brix level (about 20°Brix for all but Viognier in 2003), thus, there are minimal differences among training systems. This raises an important quandary about training system comparisons of this nature. We are intentionally constraining the yields of all vines (less so with Viognier) in this study, as we would expect growers who are attempting to optimize the quality and yield relationship to do. At 15 shoots per meter of canopy, the vines have the potential to produce more crop than can be adequately matured – if high quality fruit is the goal. If we limit crop by restricting shoot density to, say, 8 shoots foot of canopy, we would anticipate increased labor needs with shoot hedging to deal with the extra vigor. We will again constrain yields in 2004, but may choose to all full cropping potential in 2005, to determine the relative differences in crop, and crop maturity when harvested at a common *date*, rather than common Brix value.

Table 4. Crop yield/vine (lbs/vine) of three cultivars trained either to Geneva Double Curtain (GDC), Smart-Dyson (SDY), or Vertical Shoot Positioned (VSP) canopies, 2001-2003, Winchester VA.

	Brix					
	GDC		SDY*		VSP	
Cultivar	2002	2003	2002	2003	2002	2003
Traminette/own	22.1	19.7	22.2	20.2	23.5	20.3
Traminette/C-3309	22.4	19.9	22.2	20.3	21.4	20.4
Cab. franc/C-3309	23.2	20.3	22.7	20.6	22.9	20.5
Viognier/C-3309	24.1	21.2	24.1	21.3	23.9	20.9

* Data averaged for two canopies of Smart-Dyson.

The individual Smart-Dyson canopies were sampled and harvested separately to assess possible asynchrony of fruit maturation. As in previous years, we obtained similar primary fruit chemistry values from the two canopies at a common harvest date (Table 4) for a given variety. It is, however, important to point out that we intentionally crop the lower canopy at about two-thirds the crop level of the upper canopy.

Conclusions to date: Sensory evaluations of 2001 and 2002 wines have indicated that wines from GDC- or Smart-Dyson-trained vines are comparable to or *superior* to the lower-yielding VSP-trained vines. Grafting has increased the vine size and cumulative yields of Traminette,

without adversely affecting crop quality; in fact, fruit rot severity was less in 2003 on grafted vines, compared to non-grafted vines. We have not measured a difference in primary fruit chemistry between the two Smart-Dyson canopies, so long as the lower canopy is cropped at about two-thirds the level of the upper canopy. Fruitfulness is enhanced by divided canopy training, as is crop level.

3. Grape cultivar evaluation in the Eastern Piedmont of Virginia:

Formal cultivar evaluations in Virginia have been performed only at Winchester, in northern Virginia. The southern and eastern Piedmont regions are warmer (day and night temperatures) and receive greater precipitation, particularly during the fruit ripening months of August-October. While the threat of winter injury is lessened, bud break is advanced relative to the northern part of the state, increasing the risk of spring frost injury. The climatic uniqueness of the region warrants specific cultivar evaluations to support the existing and potential grape and wine producers in southern Virginia and the northern Piedmont region of North Carolina. Accordingly, a wine grape cultivar evaluation was established at Virginia Tech's Southern Piedmont Agricultural Research and Extension Center in Blackstone, Virginia in spring, 2001. Cultivars include NY73.0136.17, Vidal, Traminette, Norton, Tannat #1, Mourvedre, Viognier #1, Rousanne #1, Cabernet franc #1, Cabernet franc #313, Cabernet Sauvignon #337, Chardonnay #96, Tempranillo, Graciano, Petit Manseng, Touriga nacionale, Tinta cao, Aleatico, and Muscat blanc. Norton is ungrafted. All others are grafted either to C-3309, 5C, or 101-14. Cultivar rationale is based on favorable performance (P. Manseng, Mourvedre, Vidal, Viognier, Cabernet Sauvignon) at Winchester (Wolf et al., 1999), a late-bud break characteristic (e.g., Vidal, Cabernet, Tannat, Mourvedre), pronounced aromas or flavors that might persist under less than optimal ripening conditions (e.g., Muscat blanc, P. Manseng, Aleatico), limited, but favorable commercial experience (e.g., Norton, Tinta cao, Touriga), or combinations of those reasons. Plantings consist of three-vine plots (8 feet between plants), replicated six times in a completely randomized design. Drip irrigation and deer exclusion fencing are installed and used. Vines and vineyard are being managed following commercially recommended practices.

We had excellent growth in the first three years of this trial and vines will be pruned in March 2004. We anticipate our first full year of data collection to occur in 2004 (phenology, yield, fruit chemistry). The data collected from this trial will be quite applicable to the piedmont of North Carolina.

Presentations:
The Principal Investigator made two industry presentations of the training system data during 2003:
1) Feb 14, 2003, Virginia Vineyards Association annual technical conference, Charlottesville, VA. (a Powerpoint presentation can be downloaded from http://filebox.vt.edu/vaes/AHSMITHJAREC)
2) Mar 17, 2003, Wineries Unlimited, Lancaster, PA.