Michigan Grape and Wine Industry Council
Research and Education Advisory Committee

Final Report

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Title**: Influence of Training System Choice and Shoot Density on Yield, Yield Components and Fruit Composition of Cabernet Franc Grapevines.**

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The Michigan climate is reknown for annual freeze damage that can kill vines to the snow-line, spring frosts and poor fruit-set conditions that can reduce yields, and immense annual variability in heat units (growing degree days, GDD). However, when growing Cabernet Franc, we believe there is a training system that best accommodates these climatic challenges. In addition, there is an optimum range of shoot density that can provide the grower the best chance to produce fruit capable of the current premium value per ton, within the constraints of the weather. We believe training systems with greater amounts of perennial wood will produce higher yields at similar shoot numbers, and will do so at comparable fruit composition values, and systems with greater portions of the fruit and renewal zone shaded will be less mature on any given ripening date as measured by sugar and acidity levels.

Given Cabernet Franc's demonstrated ability to produce fine wines in good seasons, we seek to develop means to culture vines to produce good wines every year from this cultivar.

Objectives:

a) To select the single canopy system most effective at producing sustainable production of ripe Cabernet Franc grapes
b) To select a canopy density that minimizes within canopy fruit and renewal zone shading while maintaining adequate leaf area for fruit and vine maturation
c) To select a training-shoot density combination that reduces annual hand labor while keeping production and fruit quality goals

Plot layout:

Mature, bearing Cabernet Franc grapevines are in place at SWMREC. The vines are in a split-plot that uses Training systems as Main Plots and Shoot Densities as Sub-Plots. There are 6-Training systems ranging from Guyot, Low Cordon, Sylvoz, Hudson River Umbrella, and Scott-Henry. Within each training system there are 3-shoot densities that include: a non-thinned Control, and 10- and 15 shoots/ meter of row.

Methods

a) Mature, bearing Cabernet Franc grapevines are in place at SWMREC
b) The vines are in a split-plot that uses Training systems as Main Plots and Shoot Densities as Sub-Plots

c) There are 5-Training systems ranging from Guyot, Low Cordon, Sylvoz, Hudson River Umbrella and Scott-Henry
d) There are 3-shoot densities which include: a non-thinned Control, and 5 and 10 shoots/meter of row
e) Training treatments are in place and shoot thinning is imposed each spring when annual growth is about 3" long and after the last chance of frost

Procedures:

a) Plots are in place
b) Shoot thinning has occurred in spring 2004; only 1-shoot per count node retained
c) Assessment of canopy shading (% of clusters with at least some sunlight exposure at veriason
d) Harvest, measure yield , yield components, fruit composition
e) Each spring access bud mortality; wood damage due to winter cold

There are 5-training systems: Guyot, Low Cordon, Sylvoz, Hudson River Umbrella, and Scott-Henry. Within each training system there are 3-shoot densities that include: a non-thinned Control (35 shoots/meter), and 10- and 15 shoots/meter of row.

Procedures for 2004 growing season:

a) Plots and training systems were in place.
b) In the spring assessed bud mortality; wood damage due to winter cold.
c) Shoot thinning has occurred in spring 2004; only 1-shoot per count node retained.
d) Crop thinning on 29 July; remove the fruit on every 3rd shoot.
e) At harvest we measured yield, yield components, and fruit composition.

Procedures for 2005 growing season:

We repeated all procedures as in the 2004 growing season, and also did a point quadrant assessment of each training system x shoot density treatment combination at veriason.

Results:

a. Training System That Best Accommodates Michigan Conditions

The data in Tables 1-4 and Appendix Tables 5-9 evaluate a range of systems in which the fruiting zone is low (Guyot, Low Cordon and Scott-Henry), high (Hudson River Umbrella and Sylvoz), cane pruned (Guyot and Scott-Henry) and cordon pruned (Low Cordon, Sylvoz and Hudson River Umbrella). Each of these systems has characteristics and data that support its choice. Assessment of productivity over 2000-2005 suggests that cordon systems produce higher yields compared to cane systems (Table 6) and does so with no negative impact on fruit composition values (Appendix Table 7). Of particular interest is the Sylvoz system – never seen by our group in Michigan except in this plot – which has high yield, good fruit numbers and quite favorable data from point quadrat analysis (Table 4) in terms of leaf layers and interior leaves, clusters and shoots.

The caveat for Sylvoz is its novelty in Michigan, and the danger of vine loss to the snow-line when severe winter cold returns. Any site (most Michigan sites) with such a hazard would likely do better to select a system that requires minimal labor to re-establish canopy and is compatible with our concern about "spare parts". This reduces our positive suggestion for Sylvoz, although it is the common training system for Bordeaux reds in the Hawk's Bay region of New Zealand.

We were surprised and disappointed by the performance of the much-hyped system Scott-Henry. It was only average in-yield and below average in °Brix (Tables 6 and 7)

although the point quadrat numbers were equivalent or better than Sylvoz, with much higher % gaps.

Based on these data and Michigan conditions requiring spare parts approach to culture, we suggest that either Low Cordon or Guyot be the systems of choice.

b. Shoot Density Choice

The impact of varying shoot density is 2-fold: 1) reduced density improves canopy microclimate, especially sunlight penetration to the fruiting region and leaves near the fruit; and 2) reduced density also lowers yield.

This report considers years 2003-2005 to be most useful as treatments were at or near equilibrium for the period. Yields by the Control (33 shoots/meter) were excessive (Tables 1-3, Appendix Tables 5-9) while °Brix and yield were nearly identical for both 15 and 10 shoots/meter treatment vines. The yields, especially noted for 2005 (Table 1) are in the 4.5 ton/acre range which is adequate, even in a fine season like 2005, and may be excessive in cool years like 2003.

The point quadrat data are also persuasive (Table 4). % gaps (at 10 shoots/meter) are best for all training systems except Scott-Henry, and we doubt that the difference there is real. Similar responses are noted for leaf layer # and % interior leaves, clusters and shoots. For these reasons, we suggest careful trials of 10-shoots/meter (~ 3/foot of row).

Note the fact that the 4.5 T/A achieved here is based on zero missing vines/acre. That is a condition not met in any Michigan vineyard cl have seen. It is critical to remember that 4.5 T/A with 100% of producing vines becomes 9.0 T/A for a vine is 50% of vines are missing. Grapevine produce yield, not acres.

Table 1. Response of Cabernet Franc Grapevines to Different Training Systems and Shoot Densities in 2005. Yield and Yield Components. I. Main Effects

I. Training Systems	Yield (kg/vine)	Yield T/A	Clusters/Vine	Berry Weight (g)	Cluster Weight (g)	Berries/ Cluster
Guyot	6.62	5.30	67	1.6	99	64
Low Cordon	7.43	5.94	78	1.6	95	63
Sylvoz	7.57	6.06	88	1.6	86	56
HRU	7.28	5.82	78	1.6	93	66
SH	6.74	5.39	69	1.6	98	59
F	ns	ns	ns	ns	ns	ns
II. Split-Plot						
Shoot Density						
Control	8.92 a	7.14 a	104 a	1.6	86 b	54 b
15 sh/m	7.00 ab	5.59 ab	70 b	1.6	100 a	64 a
10 sh/m	5.56 b	4.45 b	56 b	1.6	99 a	67 a
	***	***	***	ns	**	***

, * and ns indicate statistically significant at the 0.01, and 0.001 levels of probability and not significant, respectively.

Table 2. . Response of Cabernet Franc Grapevines to Different Training Systems and Shoot Densities in 2005. Vegetative Growth and Growth Components. Main Effects.

I. Training Systems	Int Vine Size (kg/2004)	Nodes Retained/Vine	Shoots Retained/Vine	2005 Vine Size	Vegetation 2005 VS/Shoot Retained (g)
Guyot	1.41	58	35	1.31	39
Low Cordon	1.65	60	35	1.29	37
Sylvoz	1.30	60	35	0.98	28
HRU	1.24	60	35	1.02	29
SH	1.38	59	35	1.20	34
F	ns	ns	ns	ns	ns
II. Split-Plot					
Shoot Density					
Control	1.26 b	60	60 a	1.17	20 c
15 sh/m	1.56 a	60	27 b	1.22	45 b
10 sh/m	1.36 ab	60	18 c	1.08	60 a
F	*	ns	***	ns	***

, * and ns indicate statistically significant at the 0.01, and 0.001 levels of probability and not significant, respectively.

Table 3. Response of Cabernet Franc Grapevines to Different Training Systems and Shoot Densities in 2005. Yield and Vine Growth Relationships, and Fruit Composition.

I. Main Effects										
						Fruit Composition				
Training System	**Yield (kg)**	**Shoots Retained**	**Yield/Shoots Retained (g)**	**Clusters/Shoot**	**Ravaz Index**	**Brix**	**pH**	**TA**	**Brix:Acid**	**Sugar/Vine (kg)**
Guy	6.62	35	189	1.9	5:1	23.3	3.51	5.6 ab	4.2:1	1.5 c
LC	7.43	35	212	2.2	6:1	23.3	3.49	5.5 ab	4.2:1	1.7 ab
Syl	7.57	35	216	2.5	7:1	23.4	3.42	5.7 a	4.1:1	1.8 a
HRU	7.28	35	208	2.2	8:1	23.3	3.45	6.0 a	3.9:1	1.7 ab
SH	6.74	35	193	2.0	6:1	22.8	3.51	5.3 b	4.3:1	1.6 bc
F	ns	ns	ns	ns	-	ns	ns	***	-	*
II. Split-Plot										
Control	8.92 a	60 a	149 c	1.7 c	9:1	22.7b	3.42	5.7	4.0:1	2.0 a
15 sh/m	7.00 ab	27 b	259 b	2.6 b	7:1	23.3a	4.09	5.5	4.2:1	1.6 b
10 sh/m	5.56 b	18 c	309 a	3.1 a	6:1	23.3a	3.48	5.7	4.1:1	1.3 c
F	***	***	***	***	-	*	ns	ns	-	**

, * and ns indicate statistically significant at the 0.01, and 0.001 levels of probability and not significant, respectively.

Table 4. Results of point quadrat assessment of Cabernet Franc grapevines trained to five different systems and three shoot densities, 2005.

Training System	Shoot Density (# Shoots/Meterof Row)		
	Control (33)	(15)	(10)
A. Guyot			
% Gaps	4.0	4.0	5.0
Leaf Layer #	3.0	2.9	2.7
% Interior Leaves	52	33	40
% Interior Clusters	74	62	70
% Interior Shoots	68	80	50
B. Low Cordon			
% Gaps	0.0	0.0	6.0
Leaf Layer #	3.7	3.4	2.8
% Interior Leaves	51	49	42
% Interior Clusters	82	94	86
% Interior Shoots	74	72	42
C. Sylvoz			
% Gaps	0.0	4.0	4.1
Leaf Layer #	3.0	2.1	2.2
% Interior Leaves	41	37	33
% Interior Clusters	84	48	76
% Interior Shoots	76	42	54
D. Hudson River Umbrella			
% Gaps	0.0	0.0	2.0
Leaf Layer #	5.9	4.0	3.4
% Interior Leaves	64	53	47
% Interior Clusters	95	100	96
% Interior Shoots	100	80	79
E. Scott-Henry			
% Gaps	1.2	15.2	10.3
Leaf Layer #	2.4	1.9	2.0
% Interior Leaves	29	27	21
% Interior Clusters	78	77	72
% Interior Shoots	100	100	64

Appendix Tables 5-8.

TABLE 5. Differences in yield for the duration of the Cabernet Franc training X crop level trial at SWMREC

			Yield (Kg/vine)					
			2000	2001	#2002	2003	##2004	##2005
Training System								
Guyot			6.69a	0.37c	6.02b	5.58b	4.6b	6.22
LC			5.97ab	2.87ab	7.12ab	6.99ab	5.1ab	7.43
Sylvoz			5.34b	1.59bc	9.18a	9.21ab	6.1a	7.29
HRU			5.70ab	0.64c	7.57ab	9.79a	5.4ab	6.65
SH			6.69a	4.46a	6.48b	8.73ab	4.8ab	6.44
			*	***	***	***	*	ns
Crop Level	Shoot Density a	Shoot Density b						
2	Control	control	6.23	1.55		9.85a	5.66a	8.82a
4	5 sht/m	Hand width	6.16	1.97	7.13ab	6.58b	4.87ab	5.93b
6	10 sht/m	10 sht/m	5.92	1.83	7.80ab	7.32b	4.64b	5.93b
8	15 sht/m	15 sht/m	6.22	1.75	8.24a	7.57b	5.11ab	6.79b
			ns	ns	***	***	*	***

Treatment was changed from shoot density a to shoot density b (number shoots per meter row) in 2004

Treatment was changed from crop level to shoot density (number shoots per meter row) in 2002

F values significant at 5% (*), 1% (**), 0.1% (***), or not significant (ns).

Mean Separation within columns using LSD Test.

TABLE 6. Differences in soluble solids for the duration of Cabernet Franc training X crop level trial at SWMREC
Results are averages due to insufficient repetitions.

			Soluble Solids					
Treatment			2000	2001	#2002	2003	##2004	##2005
Training System								
Guyot			21.6	19.9	19.7c	21.8a	20.92b	23.3
LC			20.4	19.6	20.1bc	20.9b	20.06c	23.3
Sylvoz			19.6	18.9	21.0b	21.5a	21.75a	23.4
HRU			21.6	20.0	20.4bc	20.1c	21.53a	23.2
SH			20.6	20.2	22.2a	20.0c	21.22ab	22.8
			ns	ns	***	***	***	Ns
Crop Level	Shoot Density a	Shoot Density b						
2	control	control	20.6	20.2	20.5	20.1b	20.13b	22.72b
4	5 sht/m	Hand width	21.1	20.9	21.3	20.9ab	21.32a	23.39a
6	10 sht/m	10 sht/m	21.1	20.7	20.3	21.2a	20.98ab	23.33a
8	15 sht/m	15 sht/m	20.8	20.4	20.6	21.3a	21.20a	23.33a
			ns	ns	ns	**	**	*

Treatment was changed from shoot density a to shoot density b (number shoots per meter row) in 2004

Treatment was changed from crop level to shoot density (number shoots per meter row) in 2002

F values significant at 5% (*), 1% (**), 0.1% (***), or not significant (ns).

Mean Separation within columns using LSD Test.

TABLE 7. Differences in crop load for the duration of Cabernet Franc training X crop level trial at SWMREC

			Crop Load (yield / vine size)					
Treatment			1999	2000	2001	#2002	##2003	##2003
Training System								
Guyot			2.6ab	4.2b	0.6	0.38c	5.05b	3.66ab
LC			2.3ab	5.0ab	1.2	0.74c	6.47ab	3.82ab
Sylvoz			3.5ab	3.5b	3.3	3.09b	10.09ab	4.81a
HRU			2.1b	3.1b	1.8	5.20a	11.55a	4.61ab
SH			5.4a	8.3a	1.9	1.58bc	9.13ab	5.41a
			**	***	ns	***	***	*
Crop Level	Shoot Density a	Shoot Density b						5.78a
2	control	control	3.4	5.0		1.91	9.56a	3.70b
4	5 sht/m	Hand width	2.7	4.7	3.4	1.96	7.66b	3.78b
6	10 sht/m	10 sht/m	3.7	4.6	3.6	1.78	7.66b	3.51b
8	15 sht/m	15 sht/m	4.0	5.6	3.0	2.05	7.24b	**
			ns	ns	ns	ns	*	

Treatment was changed from shoot density a to shoot density b (number shoots per meter row) in 2004

Treatment was changed from crop level to shoot density (number shoots per meter row) in 2002

F values significant at 5% (*), 1% (**), 0.1% (***), or not significant (ns).

Mean Separation within columns using LSD Test.

TABLE 8. Differences in vine size for the duration of Cabernet Franc training X crop level trial at SWMREC

			Vine Size					
			1999	2000	2001	#2002	##2003	##2003
Training System								
Guyot			1.06ab	1.80ab	0.61ab	0.99b	1.17ab	1.42ab
LC			0.81abc	1.28cd	0.60b	0.93b	1.19ab	1.57ab
Sylvoz			0.77bc	1.46bc	0.95ab	1.00b	0.94ab	1.33ab
HRU			1.23a	1.99a	0.48b	1.04b	0.90b	1.25b
SH			0.57c	0.94d	1.16a	1.20ab	1.13ab	1.33ab
			***	***	***	**	**	*
Crop Level	Shoot Density a	Shoot Density b						
2	control	control	0.99a	1.52ab		1.11	1.20a	1.38
4	5 sht/m	Hand width	0.92ab	1.62a	0.88	1.13	1.06ab	1.36
6	10 sht/m	10 sht/m	0.87ab	1.57a	0.75	1.09	1.01b	1.37
8	15 sht/m	15 sht/m	0.78b	1.23b	0.66	1.01	1.14ab	1.57
			**	**	ns	ns	*	ns

Treatment was changed from shoot density a to shoot density b (number shoots per meter row) in 2004

Treatment was changed from crop level to shoot density (number shoots per meter row) in 2002

F values significant at 5% (*), 1% (**), 0.1% (***), or not significant (ns).

Mean Separation within columns using LSD Test.

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