THE SARE - CORNELL ORGANIC GRAPE PROJECT

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BACKGROUND

In 1989 Dr. Roger Pearson of Cornell's Department of Plant Pathology was asked to advise the Taylor Wine Company of New York on the feasibility of growing organic grapes in New York state. At that time there was already considerable experience with commercial organic grape and wine production in California and in Europe, but there was much less experience in the eastern US.

In many ways eastern grape production is unique. Grapes are the number one fruit crop in the world, but most grapes are grown in areas with Mediterranean climates, which are characterized by near rainless summers and moderate winter temperatures. New York has summer rains and high humidity during the growing season which greatly increase disease and insect pressure. Our grapevines are also exposed to very low winter temperatures which can injure vines. Because of this, most New York production is based upon different grape varieties than commonly grown elsewhere. Elsewhere varieties of *Vitis vinifera*, the European grape, are grown. They have little resistance to fungal diseases like powdery mildew, downy mildew and black rot which originated in the eastern US and which thrive in our humid climate.

In New York resistant native American varieties developed from wild *Vitis labrusca* and interspecific hybrids produced by crossing American native grape species with the European grapes are most common.

These varieties differ from the common *V. vinifera* varieties in soil and cultural requirements and in sensitivity to fungicides. To some extent New York grapes also differ in composition and are used to produce unique wines and juices. Thus, the experience gained by organic grape producers elsewhere was not directly transferable to New York.

Fortunately, the grape research program at Geneva had many strong research programs in viticulture, plant pathology and entomology directed toward developing improved grape culture methods, and the experiment station was home to Cornell's Integrated Pest Management program which strives to develop and disseminate information on improved, low impact production methods. As a result of the inquiry, Dr. Pearson organized an advisory team of Cornell researchers and organic as well as conventional grape growers to define the problems and devise approaches.

This group then applied for and received funding from the northeastern regional federal research program called LISA (Low-Input Sustainable Agriculture) to explore the feasibility of organic grape production. This group and its successor (SARE, Sustainable Agriculture Research and Education) has supported a five year project to evaluate conversion from conventional to organic grape production. During this period, Cornell faculty have been advised by a committee made up of commercial growers, faculty,

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Cornell IPM and Cornell Cooperative Extension staff.

These advisors include:

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Tom Mitchell, formerly of the Taylor Wine Company.

Walter Pedersen, Four Chimneys Vineyard, Himrod, N.Y.

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Dr. Gerald White, Department of Agricultural, Resource, and Managerial Economics, Cornell University, Ithaca, NY

A major element of the success of this project has been the enthusiastic cooperation of the Taylor Wine Company and the current managers of the property, The Canandaigua Wine Company. Four men in particular should be recognized. Mr. Bill Dunn has been responsible for day to day operations during the five year period. He has never failed to cheerfully and skillfully manage the large research plots. Mr. Tom Mitchell was very instrumental in initiating and encouraging this project, and James Finkle and Richard Riesenberger patiently cooperated following the acquisition of the Taylor Wine Co. by Canandaigua Wines.

METHODS

The primary aim of this project was to explore the feasibility of commercial organic grape culture. Three cultivars were evaluated: Concord, Elvira and Seyval. Concord is the leading grape variety in New York state. In this experi-

ment it was evaluated for juice production. Elvira is the native American wine cultivar with the least stringent cultural requirements; it has broad disease and cold resistance and is harvested at a low sugar concentration to make relatively neutral flavored table and dessert wines. Seyval is a complex interspecific hybrid variety (French Hybrid) which is used for table wine production. Relative to the other varieties, it requires more intense management to avoid excessively large crops which reduce wine quality. The target maturity levels are high (18-21% soluble solids) relative to the other two varieties.

CULTURE

About 10 acre production blocks of each variety were divided; one half was used for organic culture and the other treated with conventional management. In general, the management of these blocks is highly mechanized and reflects the current state of the art technology of New York wine grape production. Vines were trained to high cordons and were pruned using machine hedgers, except existing hand pruned sub-plots were separately evaluated. Crop of Seyval was further controlled by machine thinning after berry fruit-set in July (or August). Extensive soil and petiole testing has been used in these vineyards to monitor nutritional status. Fruit was machine harvested. Our overall goal was to alter the conventional production as little as possible while maintaining and meeting organic culture production standards as defined by the Northeastern Organic Farming Association (NOFA) which certifies New York state organic producers.

Aspects of the project were lead by separate Cornell faculty as follows:

Overall vine growth and yield (Dr. Robert Pool,viticulturist from Geneva)

Crop records of each row were obtained by measuring bin depth during mechanical fruit harvest. Detailed sub-blocks were established throughout each major grape block. Detailed follow-up pruning to remove dead and diseased wood was done to half the machine pruned vines in the sub-plots to evaluate its impact on disease development. Node, shoot, and cluster counts were made for each vine. Each vine was separately hand harvested; fruit was weighed and sub-samples taken for juice analysis. The hand harvested fruit was transported to Geneva for processing into wine or juice.

Nutrition/Soils (Dr. David Peterson, Cornell Cooperative Extension Grape Specialist for the Finger Lakes area)

Conventional nutrition involved annual applications of ammonium nitrate, and periodic applications of potassium based upon petiole analysis. Organic plots received annual applications of manure. Legume (clover) sub-plots were established to evaluate the role and impact of legumes on vine growth and nutrition. Details on nutrition and soil analysis will be given in a separate paper.

Disease (Drs. Roger Pearson, David Gadoury and Chris Becker, plant pathologists, from Geneva)

Environmental data was monitored by a field computer acquisition system, and models used to predict black rot infection. Other environmentally driven disease models were used as decision tools for fungicide application. A combination of preventative and post infection applications were made. In some years dormant season fungal eradicants were evaluated. Sulfur and fixed copper were used to control disease in the organic blocks. Vines were frequently monitored for disease development. Details on methods and results are given in a separate paper.

Insects (Drs. Timothy Dennehy and Timothy Martinson,entomologists from Geneva)

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The primary insect of concern was grape berry moth. Decision to treat conventional blocks was based upon insect trap counts and a risk assessment model. Primary control for organic blocks was by pheromone disruption, but *bacillus thurengiensis* (BT) was applied to one block in one year. Grape leaf hopper populations were primarily controlled by encouraging *Anagrus* wasp egg parasites. Grape leaf hopper populations were monitored using sticky traps and assessing injury. When required, insecticidal soap treatments were made to organic blocks to suppress leaf hoppers. Details and results are presented in a separate paper.

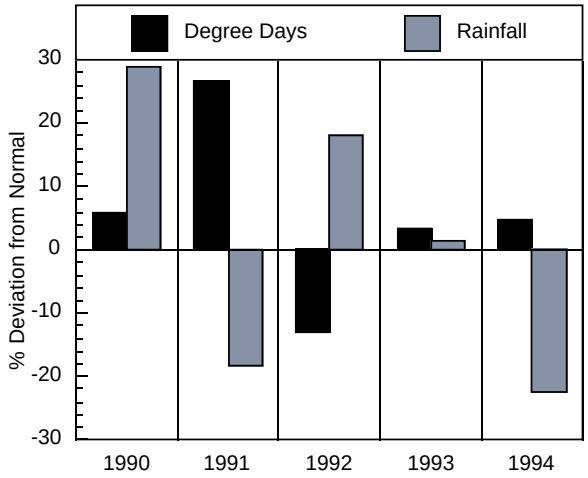

Figure 1. Deviation in seasonal degree day and rainfall accumulation during the years 1990-94

Weed and Vineyard Floor Management (Dr. Robert Pool, viticulturist from Geneva)

Conventional in-row weeds were controlled by pre-emergence herbicides and spot treatment with post-emergence herbicides where required. In-row weed management in the organic blocks was by cultivation (grape hoeing) combined with propane weed burning. Conventional between-the-row floor management used a single near grape bloom application of glyphosate (round-up) to kill established weeds and ensure low weed competition for the month following bloom. Organic blocks had sod row middles which were cultivated during periods of maximum drought stress. Separate cover crop trials were established to evaluate 10 different cover crop systems. Details will be given in a separate paper.

Table 1. Effect of cultural method on average yield per acre of machine harvested blocks for the period 1990-1994

	Method	Tons/ Acre	Significance
Concord	Conventional	6.1	0.0001
	Organic	4.9	
Elvira	Conventional	7.8	0.1511
	Organic	7.5	
Seyval	Conventional	7.5	0.0001
	Organic	5.2	

Enology and Juice Processing (Dr. Thomas Henick-Kling, enologist from Geneva)

Fruit from the hand harvested plots was processed into separate lots of hot pressed grape juice (Concord) or must (Elvira and Seyval). Musts were fermented, clarified and evaluated using trained panels. Juice and wine chemical analyses were performed. Results will be summarized in a separate paper.

Economics (Dr. Gerry White, agricultural economist from Ithaca)

Taylor Wine Company maintains detailed records of labor, machine and material inputs for each block. These data were used for a complete economic analysis of the two different culture methods for each variety. Details are given in a separate paper.

organically grown Seyval was inferior to the conventional soil. The primary difference was

Table 2. Effect of culture method on 1990-1994 yield components of hand harvested sub-plots of three grape varieties growing at Dresden, New York.

Date	Variety	Method	Clusts/ Vine		Cluster Wt. (g)		Berries/ Clust.		Berry Wt. (g)		Tons/ Acre		Soluble Solids (%)	
1990	Concord	Conv.	169.4	***	65.7	ns	19.9	ns	3.35	ns	7.2	**	14.0	**
		Org.	136.9		70.4		21.9		3.22		6.0		15.2	
	Elvira	Conv.	191.5	***	55.0	*	29.5	**	1.95	**	6.7	**	13.0	ns
		Org.	248.2		48.9		22.9		2.19		8.0		13.3	
	Seyval	Conv.	203.0	***	103.4	***	61.9	***	1.69	ns	13.4	***	14.7	***
		Org.	112.6		132.4		75.4		1.79		8.9		16.0	
		Variety	**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**	
		Method	**0.0118**		**0.0005**		**0.0327**		0.1039		**0.0001**		**0.0001**	
		VxM	**0.0001**		**0.0001**		**0.0001**		**0.0030**		**0.0001**		0.1229	
		Follow	0.4689		0.9075		0.9243		0.9604		0.3358		0.3296	
		Vx F	0.2514		0.5156		0.9311		0.4417		0.3148		0.2201	
		Mx F	0.6888		0.7360		0.2451		0.1925		0.6533		0.2969	
		VxMxF	0.2766		0.7276		0.5808		0.6264		0.2029		0.7476	
1991	Concord	Conv.	259.4	ns	61.7	ns	26.3	ns	2.34	ns	10.1	***	14.0	***
		Org.	185.5		58.3		25.0		2.33		7.0		15.6	
	Elvira	Conv.	325.9	***	43.5	ns	25.3	ns	1.71	***	9.2	***	15.7	ns
		Org.	222.1		46.0		24.4		1.89		6.5		15.4	
	Seyval	Conv.	103.2	ns	120.9	***	76.5	**	1.59	**	8.2	***	21.3	***
		Org.	83.4		94.9		66.2		1.43		5.0		22.5	
		Variety	**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0003**		**0.0001**	
		Method	**0.0001**		**0.0001**		**0.0010**		0.9555		**0.0001**		**0.0001**	
		VxM	**0.0108**		**0.0001**		**0.0042**		**0.0001**		0.8707		**0.0001**	
		Follow	0.8327		0.0731		0.5719		**0.0283**		0.6735		0.9337	
		Vx F	0.6454		0.3089		0.9555		0.1683		0.8482		0.8635	
		Mx F	0.8871		0.9900		0.5403		0.2306		0.6282		0.8569	
		VxMxF	0.8297		0.9295		0.9386		0.8165		0.9492		0.6603	
1992	Concord	Conv.	134.3	ns	63.0	*	19.4	ns	3.26	***	5.5	ns	13.7	ns
		Org.	143.5		57.6		19.3		2.98		5.3		13.6	
	Elvira	Conv.	192.5	ns	64.9	***	31.3	***	2.07	ns	8.0	ns	11.7	**
		Org.	207.1		52.2		24.7		2.13		7.0		10.7	
	Seyval	Conv.	122.9	ns	100.7	*	62.7	ns	1.62	ns	8.1	ns	15.1	*
		Org.	104.3		114.2		67.5		1.70		7.5		14.4	
		Variety	**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**	
		Method	0.8060		0.4701		0.5569		0.1575		0.0989		**0.0137**	
		VxM	0.2079		**0.0001**		**0.0034**		**0.0001**		0.6483		0.4079	
		Follow	**0.0001**		**0.0155**		0.7896		**0.0001**		**0.0001**		0.1096	
		Vx F	0.3285		0.4021		0.9743		0.7977		0.9265		0.1597	
		MxF	0.8146		0.8587		0.9947		0.5305		0.9851		0.4699	
		VxMxF	0.8867		0.3932		0.9454		**0.0281**		0.9556		0.6628	

Date	Variety	Method	Clusts/ Vine		Clust Wt. (g)		Berries/ Clust.		Berry Wt. (g)		Tons/ Acre		Soluble Solids (%)	
1993	Concord	Conv.	307.9	***	38.8	ns	20.9	ns	1.85	ns	7.7	***	13.7	*
		Org.	193.8		41.4		22.1		1.85		4.8		12.5	
	Elvira	Conv	322.2	ns	26.6	ns	22.4	ns	1.19		5.5	ns	12.3	ns
		Org.	319.6		28.8		20.8		1.38	**	5.7		12.0	
	Seyval	Conv	82.1	**	75.5	ns	46.0		1.64	***	3.7	**	18.5	***
		Org.	56.5		69.1		56.0	*	1.25		2.5		14.4	
		Variety	**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**	
		Method	**0.0001**		0.7821		**0.0354**		**0.0282**		**0.0001**		**0.0001**	
		VxM	**0.0001**		0.2488		**0.0050**		**0.0001**		**0.0001**		**0.0001**	
		Follow	0.4349		0.6718		0.9057		0.4444		0.4576		0.9461	
		Vx F	0.3116		0.9090		0.9998		0.6951		0.2554		0.3747	
		MxF	0.9094		0.5984		0.6170		0.7868		0.5934		0.1139	
		VxMxF	0.8811		0.9071		0.9606		0.3315		0.9598		0.1197	

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Date	Variety	Method	Clusts/ Vine		Clust Wt. (g)		Berries/ Clust.		Berry Wt. (g)		Tons/ Acre		Soluble Solids (%)	
1994	Concord	Conv.	58.5	ns	60.6	ns	22.0	ns	3.0	ns	2.1	ns	17.6	ns
		Org.	57.7		60.3		20.9		2.9		2.4		18.3	
	Elvira	Conv	133.4	ns	48.3	ns	29.6	ns	1.6	*	4.4	ns	10.5	ns
		Org.	134.3		78.7		44.7		1.7		5.2		10.1	
	Seyval	Conv	105.8	***	151.8	ns	88.8	ns	1.8	ns	10.4	***	15.3	***
		Org.	52.3		138.6		80.6		1.7		4.6		16.9	
		Variety	**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**		**0.0001**	
		Method	**0.0273**		0.4761		0.6848		0.9541		**0.0010**		**0.0429**	
		VxM	**0.0125**		0.0802		0.1511		0.2282		**0.0001**		0.0897	
		Follow	**0.0158**		0.2567		0.8028		0.4484		0.3042		0.6092	
		Vx F	0.1492		0.5376		0.2015		**0.0035**		0.6742		0.1814	
		MxF	0.5975		0.5127		0.4978		0.1308		0.4004		0.3533	
		VxMxF	0.8039		0.2015		0.4381		0.6331		0.2928		0.2561	

ns=no significant difference, * p=0.05, ** p=0.01, *** p=0.001

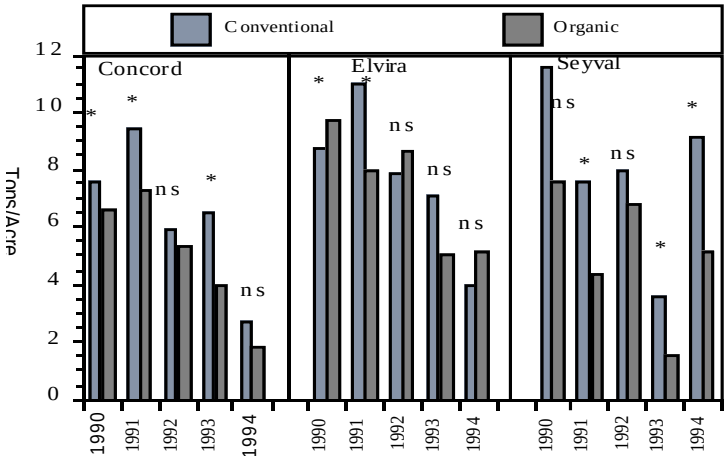

Figure 2. Annual yield of hand harvested plots in the organic viticulture project for the years 1990-94. * = significant difference between organic and conventional yield for that variety and year; ns = no significant difference

RESULTS

Details about different aspects of the project will be given in separate papers in this proceedings; this section will primarily concern vine yield and growing conditions.

Weather : Figure 1 summarizes growing season weather during the five year period of the project. Although New York is noted for variable weather, variation in growing conditions during the five year period was unusually large. Seasonal summations can only convey a certain amount of information and should be interpreted with caution. Two of the 5 years had above average total rainfall, but only 1990 could be considered really high in rainfall, and it was only during that year that fungal disease pressure was above average.

Although the figure makes it look as if 1991 was a year of water deficits, in general rains were well distributed and vine growth and function was excellent because of the very warm and sunny weather. The excellent growing conditions during 1991 caused the buds that developed for the 1992 growing season to be much more fruitful than normal. This large crop potential was coupled with a very cool and wet 1992 growing season. The result was not only increased disease pressure, but low sunlight which made it difficult to achieve fruit maturity and reduced the fruitfulness of the canes and buds which bore the 1993 crop.

The 1993 growing season illustrates why simple seasonal totals can be so misleading. Although total rainfall was average, the summer was divided into an early season where rainfall was much above average and a late season drought. The result was considerable early season disease pressure and severe water stress during the fruit maturation period. Many leaves had ceased to function by harvest, and the crop ripened at the expense of vine reserves. As a result there was an inadequate number of buds to produce a normal crop in 1994. Any conditions which increased water stress in 1993 further impacted 1994 cropping. The winter of 1993/94 was probably the coldest in more than 50 years, but there was no evidence of winter cold injury to buds or trunks. Again, the data would lead one to think that water stress was a great problem in 1994, but well timed rains meant that stress symptoms did not develop until very late in the growing season. Because the leaf canopy was reduced in size as a result of the 1993 growing conditions, the vines did not require as much late season water as they normally would.

To sum up the weather, there were two wet years and three dry ones. Disease pressure was only really above average during the 1992 growing season, but accumulated effects of water stress resulted in yearly reductions in the vine's ability to produce large crops (Figure 2, Table 1). Any factors which increased water stress resulted in further reductions in yield especially during the last two years of the experiment.

Yields and quality **:** Because row by row yield records had been recorded in 1989, we were able to show that there had been no significant yield differences between the experimental areas in the year previous to the initiation of the project for any of the three cultivars. Figure 2 and Tables 1 and 2 show that the yields were not always affected by culture method during each year, but that in general, yields of organic grapes were lower than yields of conventional grapes in years following a period of drought stress. An exception was Elvira. For Elvira overall yield did not differ significantly between the two systems (Table 2), and in the two years when yield did differ, organic vine yield was higher than conventional yield in one year and lower in the other (Figure 2). Overall yields of organically grown Concords was about 20% lower than conventionally grown Concord and organic Seyval yield was reduced by about 30%.

There are two primary reasons for the difference among varieties. Even though we attempted to match blocks, it was apparent that the soil of the

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the extent of erosion in the organic section which meant that some areas had shallow soils with less water holding capacity and a greater requirement for potassium addition. We saw no similar difference in the Concord soils, but in general soil in the Concord blocks had higher pH.

Because nutritional management is more complicated for Concord grapevines growing in a higher soil, and because organic management tended to increase soil pH and magnesium content, the organic vines may have suffered in the short range. It would be very interesting to observe these vineyards during the next five year period when the benefits of five years of soil building by the organic management would be expected to increase the yield. A similar pattern of five years inferior yield followed by 5 to 10 years of equal or better yield of organically managed soils has been observed with annual crops.

The primary reason for the reduced yield of organic grapes was increased competition from weeds and cover crops. Until less competitive organically acceptable weed control measures are identified, growers must expect lower yield potential from organically managed vineyards.

Effect of management on fruit quality will be covered in more detail in a later paper, but in brief, there were differences in fruit composition and product quality, but they primarily reflected crop load rather than culture method differences. There was some concern about increased levels of copper in products produced from organically grown grapes.

CONCLUSIONS

Disease and insect management during the five year period was adequate under both culture systems. There is some concern about long term build-up of disease when there are no really effective organically acceptable fungicides available. These include black rot and phomopsis cane and leaf spot. Although arthropods did not become problematic, there is concern that as growers discontinue use of broad spectrum insecticides, formerly minor pests may tend to become more serious. An example is grape root worm which was formerly controlled by treatments targeted at grape berry moth, and may become more serious in the future. This is not a problem solely for organic grape growers, as conventional practice is to discontinue prophylactic treatment with broad spectrum insecticides.

As has been observed with other crops, yields have tended to be lower in the organic blocks, but only when vines have suffered drought stress. This primarily reflects the effect of less precise weed management. We are investigating alternate cover crop systems to reduce vine competition from weeds. Growers who have irrigation available should be less vulnerable to the increased competition from weeds.

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