

Enology and Viticulture Program
Institute of Food Science and Engineering
University of Arkansas Division of Agriculture, Fayetteville, Arkansas
SERA IEG-14 Progress Report on Research Projects 2003-2004

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INTRODUCTION

Current Research Activities and Areas of Interest in the Institute of Food Science and Engineering effort are as follows:

- ❖ **VINEYARD MECHANIZATION**
- ❖ **INITIATIVE FOR FUTURE AGRICULTURE AND FOOD SYSTEMS**
- ❖ **ROOTSTOCK EFFECTS ON YIELD AND QUALITY**
- ❖ **CULTIVAR EVALUATION**
- ❖ **ENOLOGY**
- ❖ **GRAPE BUDGET**

VINEYARD MECHANIZATION

Since 1966, a great deal of research at the University of Arkansas has been dedicated to defining factors affecting vineyard uniformity and to designing total mechanization systems for grape vineyards that would optimize yield without any detrimental effects on grape juice or wine quality. New equipment has been developed, modified, and evaluated for the mechanization of each viticulture operation. Vineyard operations that have been mechanized include dormant pruning, shoot and fruit thinning, leaf removal, canopy management, and, of course, harvesting. Through a cooperative effort between the U of A researcher Justin Morris and Tom Oldridge, a grape grower and inventor, the Morris-Oldridge Plan for mechanizing vineyards was developed. This Plan offers a systems approach to mechanizing the 12 major trellising systems used throughout the world. Twenty of the machines or attachments already existed in the industry, and the remainder were developed and/or modified to carry out each operation according to defined sequences. The University of Arkansas was issued a patent in April, 2002 for the Morris-Oldridge Vineyard Mechanization Plan.

The OXBO International Corporation has acquired the license to manufacture the Morris-Oldridge Vineyard Mechanization System Patent. The system is currently being manufactured and marketed under their name of vMech[®] Vineyard Mechanization System.

Throughout the 2002, 2003, and 2004 seasons research was conducted at French Camp Vineyards, a 1750-acre, Region III, commercial vineyard near Paso Robles, California to refine the vMech® units and the viticultural management systems that will best compliment them for total vineyard mechanization. Large scale studies (20 to 40-acre blocks) were established to compare hand vs. machine production for both yield and quality on six different cultivars. In each block, the control was hand pruned, hand shoot thinned and hand cluster thinned. A total of 475 acres at French Camp Vineyards were totally machine farmed in 2003. During 2004 we are commercially machine farming at least 900 acres at French Camp Vineyards and are repeating the 2003 research study.

Preliminary results from the 2003 study are presented in Table 1. The actual yields obtained using mechanization were very close to the target yield demanded by the winery. The results for Chardonnay, Sauvignon blanc, Merlot, Syrah, and Zinfandel were extremely encouraging as the fruit quality parameters of the hand and machine treatments were almost identical.

Table1. Comparison of yield, final berry weight, shoot density/foot pruning, pruning weight/foot, and quality on 6 grape cultivars that were either machine farmed or hand farmed at French Camp Vineyards, 2003.

Cultivar/ Trellis	Treat- ment ¹	Yield		Final berry wt (g)	Shoots per foot of cordon	Pruning weight/ foot	Quality parameters ³		
		Target ²	Actual				°Brix	pH	TA (% tartaric)
Chardonnay/ Lyre	H	8.0	6.3	1.23	8.4	0.35	26.1	3.60	0.69
	M	8.0	7.0	0.93	9.4	0.30	25.8	3.70	0.63
Sauv blanc/ Lyre	H	8.0	8.1	1.10	6.3	0.53	22.9	3.83	0.42
	M	8.0	7.0	0.95	9.2	0.53	23.5	3.78	0.42
Merlot/ VSP	H	6.0	5.9	1.04	4.0	0.30	25.7	3.68	0.45
	M	6.0	6.5	1.00	4.0	0.24	25.7	3.69	0.49
Sangiovese/ VSP	H	3.0	3.0	1.28	5.9	0.38	26.4	3.94	0.42
	M	3.0	3.3	1.11	5.4	0.26	27.1	3.68	0.48
Syrah/ Lyre	H	7.0	6.4	0.89	9.5	0.45	25.4	3.79	0.60
	M	7.0	6.5	1.13	10.5	0.43	25.5	3.79	0.58
Zinfandel/ Lyre	H	7.0	7.2	1.51	2.9	0.41	25.0	3.64	0.69
	M	7.0	7.5	1.33	3.9	0.29	24.8	3.64	0.72

¹Treatments H = Hand; M = Mechanical

²Target Yield requested by winery contracting grapes

³°Brix, pH, and TA values represent values taken from the fermentation tank 24 hours after crush of red cultivars or 24 hours after crushing and pressing of the white cultivars.

Research lots of 2000 pounds of fruit from each of the plots were processed into wine at the Paso Robles Wine Services winery. Laboratory and sensory analysis of these wines are being conducted at the University of Arkansas.

Hank Ashby, manager of French Camp Vineyards, has estimated that the mechanization system will provide a 50-70% reduction in pruning cost and a 70-90% reduction for shoot thinning and fruit thinning costs over hand labor for the same work.

Cynthiana Vineyard Mechanization Study Part I

This study is in its third year. An experiment was established with 4 treatments and 6 replications: (1) HAND, hand prune to 50 + 10 with an 80 bud upper limit (2) MIN, minimal pruning, skirt at 60 cm, (3) MPBC, Machine pruning – box cut, leaving 70-80 buds, (4) MPHT, machine pruning - box cut, hand touch up leaving best 80 buds. Grapes samples are taken at 19, 21 and 23°B and laboratory analysis run for each field replicate. Wines are made in duplicate for each treatment.

Minimally-pruned vines had additional nutrient requirements in the first year as indicated by tissue sampling. These vines had 31% greater yields in 2002 than the other treatments and matured later with poorer color than the other treatments. Minimally-pruned vines from other grape species self regulate after a few years and reduce yields to become comparable with other pruning methods. This indeed began in 2003. The MIN treatment had 34% lower yield than 2002 and produced a normal, although smaller, crop in 2003 than other treatments with mineral nutrition similar to other treatments.

The HAND, MPHT, and MPBC treatments had almost identical yield, fruit sugars, acids, color and total phenolics in 2002 and 2003. Wine chemistry and sensory analysis of the 2002 wines showed no difference between the HAND, MPHT and MPBC. The MIN treatment was much lighter in color and lower in alcohol and was not included in triangle tests with the other wines. The 2003 wines, including MIN, were all similar at bottling but have not been formally evaluated. The first two years of results indicate that totally mechanized pruning is producing yield and quality results that are equivalent to hand pruning. Viability of this system over multiple years remains to be seen.

Cynthiana Vineyard Mechanization Study Part II: Fruit thinning

This experiment was conducted in 2003 on a double curtain vineyard. Minimally pruned vines have too much fruit in the first year; this has a severe impact on fruit quality and causes severe vine stress. The Morris-Oldridge fruit thinner uses bow rods to strike the canopy and remove fruit. It has been used successfully on other cultivars to reduce fruit load. We machine-thinned at the 7-mm berry stage and also did tests on vines one week before and after this stage seeking better fruit removal. The 7-mm berry stage worked as well as other stages, but it was difficult to determine the amount of fruit removed. A few whole clusters and several berries were removed at the time the machine was run. Due to the tight nature of the clusters and long peduncle on Cynthiana, the trial was not deemed a success at the time the machine was run. The event was filmed, and follow up film was taken at weekly intervals for six weeks. Many berries and even whole clusters dried up and became mummies over a period of several weeks.

Data were collected from twenty MIN and twenty MPHT vines. There were 9 % mummied berries in the MIN cluster samples taken at harvest. Berries per cluster, berry and cluster weights were lower on the MIN treatment than the MPHT treatment. The MIN treatment had more green berries and 60% more clusters per vine than the MPHT treatment. The MIN vines had a beaten look and the fruit was lighter in color. When we harvested the fruit, we found that the MIN treatment had 25.4 tonne/Ha and the MPHT treatment had 25.1 tonne/Ha. This was at least 5 tonne/Ha more than it was estimated these vines should bear for best quality. If we compare the double curtain results to the single curtain results for 2002, we see that we may have removed up to 11 tonne/Ha of fruit with the fruit thinner, although a more conservative estimate would be 5 to 6 tonne/Ha based on mummied fruit and other observations. A better method is needed to alleviate the vine stress associated with moving to minimal pruning in the first year. We will continue to monitor these vines and analyze and evaluate the wines made from this experiment.

USDA INITIATIVE FOR FUTURE AGRICULTURE AND FOOD SYSTEMS

The University of Arkansas, Division of Agriculture, was the recipient of a grant from the USDA's Initiative for Future Agriculture and Food Systems (IFAFS) program. The purpose of the work funded was to provide research and training to assist small- and medium-sized farmers in the state in becoming more profitable and therefore to add stability to the family farm. One approach being used in this project is to help identify alternatives to traditional farming operations, including identification of alternative crops and methods for adding value to new or existing crops.

For a number of years, the Grape and Wine Research Program at the University of Arkansas has been involved in work to identify muscadine cultivars most suitable to commercial production in Arkansas, appropriate handling of these grapes, the formulation of products from them, and markets for both fresh fruit and processed products. A publication has been developed that reviews research findings from University of Arkansas Division of Agriculture work on growing, marketing, and processing muscadine grapes. This publication was not intended as a "how-to" book on muscadines, but rather uses muscadines as an illustration of the kinds of information a farmer would need to collect to establish a nontraditional, value-added, agricultural enterprise. Included are discussions of research designed to develop the market potential of muscadines as fresh fruit and as value-added products such as juice, wine, sweet spreads, and dried products. Also included are reports of research to quantify the nutraceutical content of muscadines and to develop products containing these nutraceuticals. Appendices contain more detailed information on the technology of muscadine grape processing, offer suggestions to help in developing value-added muscadine products, provide lists of helpful resources for those exploring alternative agricultural activities, and include a glossary of scientific and technical terms used in the text. This publication is currently being printed and is expected to be available for distribution by early October.

ROOTSTOCK EFFECTS ON YIELD AND QUALITY

A number of rootstock studies are being done in cooperation with the Mid-America Viticulture and Enology Center and are reported in its section of these reports.

Effect of Rootstock on Sunbelt Grape Yield and Composition

The yield of Sunbelt grapes grown in Arkansas tends to be lower than Sunbelt yields in California. In an effort to increase fruit yield, a rootstock study was established in 1998 in cooperation with Keith Striegler, on Sunbelt grapes with own-rooted, Paulsen 1103, Couderc 3309, and T.V. Munson Extra vines. Due to extreme vegetative growth at our site, the experiment was converted from a high wire bilateral curtain to a Geneva Double Curtain system in 2002. Data collected for a two year period on the bilateral cordon vines showed an increase in cluster number and yield when vines were grown on 3309C as compared to own-rooted vines with no difference in soluble solids.

CULTIVAR EVALUATION

A number of cultivar evaluations are being done in cooperation with the Mid-America Viticulture and Enology Center and are reported in its section of these reports.

ENOLOGY

Quality, Sensory, and Cost Comparison for pH Reduction of Syrah Wine Using Ion Exchange or Tartaric Acid

pH reduction treatments (nonadjusted control, two resins in column systems, three membranes in a prototype electrochemical ion-exchange unit, and tartaric acid addition) were evaluated on Syrah (*Vitis vinifera*) wine. Wine was analyzed after six months at 21°C. Treatments lowered wine pH from 4.24 to 3.48, improved color attributes and raised titratable acidity, but lowered total phenolics and potassium levels. A descriptive sensory panel identified and evaluated purple color, aroma (berry, grape kool-aid, dried fruit, spicy, barnyard/leather, and smoky), and flavor (dried fruit, earthy, sourness/acidity, and astringency) attributes of Syrah wine. The panel noticed more differences between the nonadjusted control and the pH reduction treatments rather than within the pH reduction treatments. A costing model of the treatments showed that tartaric acid addition for adjusting pH was more economical than ion exchange systems. Tartaric acid adjustment did not enhance the wine's color attributes as well as the ion exchange treatments. Although use of ion exchange systems are more costly than

tartaric acid addition, ion exchange could be used to maintain or improve premium wine quality.

Pressing Effects on Yield, Quality, and Nutraceutical Content of Juice, Seeds, and Skins from Black Beauty and Sunbelt Grapes

The effects of hot and cold (nonheated) pressing on yield, quality components, and nutraceutical content of juice, grapes, and press fractions (seeds and skins) from Black Beauty (*Vitis rotundifolia*) and Sunbelt (*Vitis labrusca L.*) cultivars were evaluated. Heating the must prior to pressing increased juice yield, titratable acidity, red color, and darkness and decreased the press fraction yield and juice pH in both cultivars. Sunbelt juice from the heated must had the highest yield (786 L/t), red color, and darkness. Black Beauty nonheated must had the largest press fraction (43%) but the lowest red color and darkness in the juice. The juice generally had less total phenolics, total anthocyanins, and oxygen radical absorbance capacity (ORAC) than the whole grapes. The juice from heated Black Beauty and Sunbelt must had the highest total phenolics (1354 and 1937 mg/L, respectively) and anthocyanins (414 and 513 mg/L, respectively). Although the data for seeds and skins is on a dry basis, the press fractions had higher levels of phenolics and ORAC than the whole grapes and juice. The dried seeds had more phenolics and less anthocyanins than the skins. The highest total phenolic level (95338 mg/kg) and ORAC level (1100 TE/g) was in Black Beauty seeds from nonheated must. The skins of nonheated Sunbelt had the highest anthocyanins (11889 mg/kg). Since the press fraction of both cultivars had high ORAC values and total phenolic levels, products with nutraceutical benefits could be developed.

Yeast Rehydration Aid and Nutrients to Enhance Initiation and Completion of Wine Fermentation

The ability of a yeast rehydration aid (GO-FERM[®]) and a yeast nutrient (Fermaid K) added to the juice to enhance wine fermentation was evaluated. GO-FERM[®] is an inactivated yeast while Fermaid K contains inactivated yeasts plus diammonium phosphate and other nutrients. Sterile juice was used for micro-fermentations to monitor percent carbon dioxide loss/d. Nitrogen, minerals, organic acids, sugars,

glycerol, and ethanol levels were evaluated before and after fermentation. The experiments included different levels of GO-FERM[®] used with or without Fermaid K in juice fermented at (1) 15 and 25°C, (2) 15°C in the original juice and a juice with lower nitrogen levels, and (3) 15°C at pH 3, 3.5 and 4. The addition of Fermaid K increased nitrogen components in the juice prior to fermentation. The juice with 0.6 g/L GO-FERM[®] only and with 0.6 g/L GO-FERM[®] + Fermaid K benefited the fermentation. Although lowering the pH and fermentation temperature provided conditions to challenge the performance of yeast supplements, the supplements enhanced fermentation rates of the juice and resulted in a finished wine.

A comparison of white table and late harvest wines made from sugar ameliorated and concentrated juice

White table wines were made by adjusting the soluble solids level from 17.2 to 20.5 °Brix with either use of cane sugar addition, freeze concentration or a thin-film centrifugal evaporator. A late harvest style wine was also produced by concentrating juice from 17.2 to 30.5 °Brix using freeze concentration or thin-film evaporation. In both styles of wine, wines made by concentrating juice with the thin-film evaporator were slightly more yellow and more brown than wines made from freeze concentrated juice. This was most evident in the late harvest style. A sensory panel could not detect the difference in wines made from the different sugar adjustment methods in either style of wine. This research showed that any of the three methods were adequate alternatives to the adjustment of inadequate soluble levels of juice for table and late harvest style wines.

Laboratory Preparation Methods for Fresh and Frozen Red Cultivar Grapes as Compared to Wine

During a busy harvest season, time and labor restrictions for researchers make it advantageous to freeze grape samples for analysis at a later date. Two storage methods for grape harvest samples (fresh and frozen grapes) and two must preparation treatments (21°C and 71°C) on two cultivars (Cabernet franc (*Vitis vinifera*) and Cynthiana (*Vitis aestivalis*) grapes) were preformed to determine the most accurate and repeatable method to estimate the levels found in wine. Freezing the grapes prior to

analysis provided breakdown of the grape berry structure, enhanced the extraction of components, and provided a must sample similar to the wine. Heating the must of the fresh or frozen grapes caused increased extraction of acids and some color components in both varieties as compared to the wine but did provide a good estimate of wine pH. Using juice extracted from frozen Cabernet franc and Cynthiana grapes ground with a blender for five seconds provided the closest estimate of the level of components of a new wine but use of the different must processing temperature may depend on the particular component of interest in the wine.

PRODUCTION BUDGETS FOR ARKANSAS WINE AND JUICE GRAPES

The study estimates the costs, net returns, and break-even points for wine and juice type grapes suitable for production in Arkansas. The purpose of the study is to update earlier cost and returns studies released by the Arkansas Agricultural Experiment Station (Kirchner, Price, and Morris, 1988; McCollum, Price, and Morris, 1996) and meet the following objectives:

1. Provide cost information to growers, wineries, and processors considering a new wine or juice grape enterprise or expanding an existing enterprise
2. Provide background on the economic situation facing Arkansas producers
3. Communicate best practices specific to Arkansas climatic conditions for selected varieties of wine or juice grapes

Production budgets are presented for wine and juice grapes suitable for cultivation in Arkansas. Varieties examined include *V. labruscana*, French-American and American hybrids, *V. aestivalis*, *V. rotundifolia*, and *V. vinifera*. Important production considerations specific to each of these varieties are summarized. Results indicate considerable variation in profit potential among varieties. However, one or more varieties can be profitably grown in most regions of the state. With the exception of Sunbelt, *V. labruscana* varieties showed the least profitability. *V. rotundifolia* (muscadine) varieties hold promise as a new crop for the warmer southern regions of Arkansas while Chambourcin shows strong profit potential as a red wine grape in parts of the state with more temperate climates. Other promising varieties include Chardonel, Traminette, and Cynthiana. *V. vinifera* varieties also show strong profit potential but are

limited by their intense management requirements and can only be grown on the best sites.

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PRESENTATION

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