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**Enology and Viticulture Program
Institute of Food Science and Engineering
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INTRODUCTION

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

- ❖ **VINEYARD MECHANIZATION**

- ❖ **GRAPE PRODUCTION**

- ❖ **ENOLOGY AND PROCESSING**

- ❖ **GRAPE AND WINERY ECONOMICS**

VINEYARD MECHANIZATION

Justin R. Morris, Hank Ashby, Greg Berg, and Paul Ayers

A key component of the IFSE Enology and Viticulture Research Program is the concept of complete systems of vineyard mechanization, i.e. the mechanization of each and every cultural operation throughout the season. This has involved mechanization of all vineyard operations including dormant pruning, canopy management, shoot and fruit thinning, shoot positioning, summer shoot pruning, leaf removal, etc. Through this research, equipment has been developed, modified, and evaluated for the mechanization of each viticulture operation. The University of Arkansas was issued a patent in April, 2002, for the Morris-Oldridge Vineyard Mechanization System. The System incorporates over 40 different machines and attachments and details the appropriate machines to use at the proper time for each viticultural operation for twelve of the major trellising and production systems used throughout the world. The System has been licensed and is currently being commercially manufactured and marketed. Our research is showing that vineyards using this total system can maintain fruit quality and consistently meet target yields.

During the 2005 season, research continues for the fourth year at a commercial vineyard in the Central Coast Region of California. Large scale studies (20 to 40-acre blocks) compare yield and quality of hand vs. machine production with six different

cultivars. The actual yields obtained using mechanization have been very close to the target yield demanded by the winery, with fruit quality parameters almost identical between the hand and machine treatments. Fruit from the acreage has been of high quality and has been sold to major wineries in the past. For each of the study years research lots of 2000 pounds of fruit from each of the plots will be processed into wine. The vineyard data and winemaking results have shown that the commercial mechanization systems can be used by growers to successfully achieve the yield, quality, and canopy management goals that are expected of them by their wineries.

Developments in vineyard mechanization were the topics of two articles in trade journals during 2004-2005. As previously reported, the Morris-Oldridge Vineyard Mechanization System was described in the April, 2004 issue of *Wines and Vines*. This article provided a description of the research currently underway to validate the system's effectiveness in the French Camp Vineyards, a commercial vineyard in California. Preliminary data comparing the yield and quality of six cultivars of grapes farmed either with hand labor or mechanically were presented.

An article in the Jan/Feb, 2005 issue of *Vineyard and Winery Management* presented a more in-depth look at the implementation of mechanization at French Camp Vineyards. Details of the mechanized balanced cropping concept were presented along with a discussion of the procedures for crop estimation using berry weights. This article also offered a brief discussion of the advantages of vineyard mechanization.

Evaluation of Mechanical Pruning on Cynthiana Grape and Wine Composition

Justin R. Morris and Gary L. Main

Vineyard mechanization has the potential to reduce vineyard production costs while maintaining yield, fruit and wine quality, and viticultural soundness. This experiment was established on Cynthiana (*Vitis aestivalis* Michx.) to compare two mechanical pruning methods to hand pruning. The three pruning treatments used were: HAND (hand prune to 50 + 10 with an 80-bud maximum), MPBC (Machine pruning – box cut, leaving 70-80 buds), and MPHT (machine pruning - box cut, hand touch up leaving the best 80 buds). Plant tissue, berry, and cluster samples were collected and laboratory analyses run for each field replicate. Wine was made from each treatment. The three treatments had similar values for plant tissue minerals, yield, fruit sugars,

organic acids, color, minerals, and total phenolics each year for 2002, 2003, and 2004. The MPBC treatment had smaller and fewer clusters per node than the other treatments. Wine composition analysis of 2002 and 2003 wines showed little or no differences between treatments. Sensory analysis of the 2002 wines showed no differences between treatments. Three years of data indicated that MPHT and MPBC pruning produced yield and fruit composition equivalent to HAND pruning. Preliminary results showed there was little or no difference between wines made from the different pruning treatments. The use of mechanical pruning on Cynthiana grapes appears to produce fruit and wine of similar composition to hand pruning.

Flower Cluster and Shoot Thinning for Crop Control in French-American Hybrid Grapes

Justin R. Morris, Gary L. Main, and Otto L. Oswald

Overcropping of French-American hybrid winegrapes changes fruit composition and reduces vine vigor. Simulated mechanized methods of crop control involving entire shoot and cluster thinning were tested for Aurore, Chancellor, and Villard noir cultivars. The experimental design was a 3 x 2 factorial examining three thinning treatments (none, flower cluster, and shoot thinning) and two shoot-bearing positions (count and noncount). The “count” position was determined as shoots from canes and renewal spurs retained during balanced pruning, and “noncount” shoots were those from positions other than count nodes. Thinning treatments had little effect on cluster or berry weights, berries per cluster, or berry composition. Shoot thinning decreased cluster numbers for all three cultivars, but flower cluster thinning affected only red cultivars. The effects of thinning method and shoot position on fruit composition varied with cultivar. These preliminary data indicate that crop control of the cultivars studied can be accomplished by flower cluster thinning and shoot thinning; however, the response to thinning treatments varies with cultivar.

For additional information on cooperative efforts between the University of Arkansas Enology and Viticulture Program and the Mid-America Viticulture and Enology Center, please refer to pages 44-54 of this compilation.

GRAPE PRODUCTION

Rootstock Effects on Sunbelt Productivity and Fruit Composition

Justin R. Morris, Gary L. Main, and R. Keith Striegler

Sunbelt is a Concord-type juice grape suitable for warm climates that was developed at the University of Arkansas. Initial reports indicated that yields for Sunbelt were in the 2.5 to 5 ton/acre range. This is somewhat low for production on a commercial scale. An experiment was initiated to examine the potential for rootstocks to increase vine capacity and yield of Sunbelt grapes. Treatments included own-rooted Sunbelt and Sunbelt grafted onto Couderc 3309, 1103 Paulsen, and Extra rootstocks. Data was collected for two years on a bilateral cordon (BC) training system and then vines were converted to a Geneva Double Curtain (GDC) training system, and an additional two years of data were collected. Vines on BC were severely out of balance (low yields and high pruning weights), but vines were better balanced on GDC. There were few statistically significant differences in either yield or fruit composition among rootstocks for either BC or GDC. Yields in the second year on each training system and among rootstocks were 3.6 to 6.1 tons/acre on BC and 10 to 12.9 tons/acre on GDC. This suggests that Sunbelt can produce adequate yields when grown on its own roots with proper canopy management and that rootstocks are not needed to increase vine capacity and achieve higher yields.

Effect of Rootstock on Fruit Composition, Yield, Growth, and Vine Nutritional Status of Cabernet Franc

R. Keith Striegler, Justin R. Morris, Gary L. Main, and Chris B. Lake

An experiment was designed to evaluate the impact of selected rootstocks on fruit composition, yield, vegetative growth, and vine nutritional status of Cabernet franc grapevines in the Altus viticultural area. This experiment shows results for three seasons (2000-2002) in a commercial vineyard near Altus, Arkansas. Cabernet franc vines grafted onto 3309 Couderc (control), 110 Richter, Freedom, and 44-53 Malegue rootstocks were planted in 1998. The trellis system was a four-arm Kniffen, and the vineyard was not irrigated. Few statistically significant differences between rootstocks were observed for yield, fruit composition, or nutritional status. Vines grafted onto 3309

Couderc rootstock sustained winter injury in 2000/2001 likely due to severe water deficit at veraison. Vegetative growth, as indicated by dormant pruning weight, was greatest for vines grafted onto 110R and Freedom. Fruit from vines grafted to Freedom had higher pH as compared to fruit from the other treatments. Vegetative growth and field observations suggest that vines grafted onto Freedom might benefit from conversion to a divided canopy due to increased vine size.

Leaf Removal Effects on Cynthiana Yield, Juice Composition, and Wine Composition

Gary L. Main and Justin R. Morris.

Cynthiana (*Vitis aestivalis* Michx.) grapes typically have high acidity (8.5 – 13 g/L as tartaric) and high pH (3.4 – 3.8) at harvest. The must is high in malic acid (4 - 6 g/L), and the wines normally undergo malolactic fermentation that further increases pH. Leaf-removal treatments were applied for four years to determine if leaf-removal would affect yield, or fruit or wine composition. Vines trained to a single high bilateral cordon in north-south rows were used to establish three leaf removal treatments: no leaf removal, leaf removal on the east side of canopy, and leaf removal on both the east and west sides of canopy. Leaf-removal was applied in a 36-cm fruiting zone when berry size reached 7 mm. Year had the greatest impact on yield, fruit, and wine composition of any of the variables studied. Leaf-removal did not affect yield or yield components in any year. There was little or no impact on juice composition in 1997 or 1999 due to leaf-removal. Wines had darker and increased red color, in all years, when made from fruit of vines that had leaves removed. In 2000, a year with 13 consecutive days of temperatures 35°C or above during veraison, leaf removal was a successful tool to reduce pH and malic acid in Cynthiana grapes. There was no advantage to removing leaves from both the east and west sides of the canopy as opposed to removing leaves from the east side only.

ENOLOGY AND PROCESSING

The Muscadine Experience: Adding Value to Enhance Profits

Justin R. Morris and Pamela L. Brady

The University of Arkansas Division of Agriculture received a grant from the USDA's Initiative for Future Agriculture and Food Systems (IFAFS) program. The purpose was to help small- and medium-sized farmers and entrepreneurs become more profitable and therefore add stability to the family farm. One approach to doing this is to investigate opportunities to enhance profits by adding value to traditional raw products. This publication looks at efforts by the UA Grape and Wine Research Program to enhance the profitability of muscadine grapes, an alternative agricultural product. 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, vinegar, and dried products. The skin and seeds of muscadines have traditionally been considered waste; however, recent research has shown that they contain nutraceutical components. Reports are included of research to quantify these nutraceuticals and to develop products containing them.

Yield, Quality and Nutraceutical Potential of Selected Muscadine Cultivars Grown in Southwest Arkansas

R. Keith Striegler, P.M. Carter, J.R. Morris, J.R. Clark, R.T. Threlfall, and L.R. Howard

A muscadine grape (*Vitis rotundifolia*) planting was established in 1996 at the Southwest Research and Extension Center in Hope, Arkansas, to provide information on the performance of muscadine grape cultivars in a region where cold hardiness is not a major limitation. This research evaluated harvest parameters, fruit and juice quality, and nutraceutical potential of selected muscadine cultivars grown in southwestern Arkansas. The cultivars evaluated were 'Black Beauty', 'Carlos', 'Cowart', 'Doreen', 'Early Fry', 'Fry', 'Granny Val', 'Ison', 'Jumbo', 'Late Fry', NC67A015-17, NC67A015-26, 'Nesbitt', 'Scarlett', 'Southern Home', 'Sterling', 'Sugargate', 'Summit', 'Supreme', and 'Tara'. Muscadine cultivars differed in productivity and fruit quality. In 2002 and 2003, juice was produced from 'Carlos', 'Granny Val', 'Ison', 'Nesbitt', 'Southern Home',

'Summit', and 'Supreme' grapes. Juice from 'Black Beauty' grapes was also produced in 2003. In 2002, 'Nesbitt' grapes had the highest juice yield, 520 L t⁻¹ (124.6 gal/ton). 'Ison' and 'Supreme' juice had the highest soluble solids level. In 2003, 'Granny Val' grapes had the highest juice yield, 551 L t⁻¹ (132.0 gal/ton). 'Southern Home' juice had the highest soluble solids. The press materials of muscadine grapes were a potential source of high levels of nutraceutical compounds. Dried seeds had the highest total phenolic and Oxygen Radical Absorbance Capacity (ORAC) levels followed by the dried skins, the grapes, and then the juice. The skins of the black cultivars had the highest total anthocyanins level. 'Supreme' seeds had the highest total phenolic and ORAC levels while 'Ison' skins had the highest total anthocyanin levels. Based on yield, harvest, and juice quality, cultivars recommended to growers in southwestern Arkansas and other areas with a similar climate include 'Black Beauty', 'Carlos', 'Fry', 'Granny Val', 'Nesbitt', 'Southern Home', 'Summit', and 'Supreme'.

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

Renee T. Threlfall, J.R. Morris, L.R. Howard, C.R. Brownmiller, and T.L. Walker

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, brown/yellow pigments, 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, brown/yellow pigments, and darkness. Black Beauty nonheated must had the largest press fraction (43%) but the lowest red color, brown/yellow pigments, 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 $\mu\text{mol TE/g}$) were 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.

Laboratory Handling of Red Grapes to Estimate Wine Composition from Microvinification

Renee Threlfall, Gary L. Main, and Justin R. Morris

Winemakers sample grapes to predict wine quality. Researchers with hundreds of samples to analyze have time and labor restrictions during harvest that make it advantageous to store grape samples (either fresh or frozen) prior to analyses. This experiment compares storage and sample preparation methods to determine the most accurate and repeatable method to estimate wine composition from microvinification. Two storage methods for samples (fresh and frozen grapes) and two must preparation treatments (21°C and 71°C) on Cabernet Franc (*Vitis vinifera*), Cabernet Sauvignon (*Vitis vinifera*), Chambourcin (interspecific hybrid), and Cynthiana (*Vitis aestivalis*) grapes were examined and compared to a wine fermented by microvinification. Heating the must caused increased extraction of acids and some color components as compared to the wine. In all cultivars, the titratable acidity, potassium level and red color (520 nm) of the juice from the frozen grapes processed at 21°C had means that were most similar to the wine. Freezing the grapes prior to analysis (regardless of not heating or heating the sample) provided the best approximation of composition in new red wine produced from microvinification in the red cultivars evaluated.

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

Renee Threlfall and Justin R. Morris

The ability of yeast supplements (GO-FERM and Fermaid K) to enhance fermentation of sterile juice was evaluated. GO-FERM (recommended level of 0.3 g/L) contains vitamins, minerals and amino acids and is used during yeast rehydration. Fermaid K (recommended level of 0.24 g/L) contains nitrogen, sterols, fatty acids, yeast hulls, vitamins and magnesium and is added to the juice before or during fermentation.

Sterile Chardonnay juice was used for micro-fermentations. Fermentation rate was monitored daily by weight changes (g/day) due to carbon dioxide (CO₂) loss. Nitrogen, minerals, organic acids, sugars, and ethanol levels were evaluated before and after fermentation. The experiments were (1) GO-FERM addition (0, 0.3 and 0.6 g/L), Fermaid K (0 and 0.24 g/L), and fermentation temperature (15 and 25°C); (2) GO-FERM (0, 0.3 and 0.6 g/L), Fermaid K (0 and 0.24 g/L), and nitrogen levels (original and semi-model juice) fermented at 15°C; and (3) pH levels (3, 3.5 and 4), GO-FERM (0 and 0.6 g/L), and Fermaid K (0 and 0.24 g/L) fermented at 15°C. The addition of Fermaid K increased nitrogen and the addition of GO-FERM increased sodium in the juice prior to fermentation. Fermentation at an increased temperature was faster but had more CO₂ loss/day during early 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 stress conditions to challenge the performance of yeast supplements, the supplements enhanced fermentation rates of the juice and resulted in a finished wine.

Comparison of Methods to Increase Sugars for Production of White Table and Dessert Style Wines

Gary L. Main, Justin R. Morris, and Renee Threlfall

Increasing the sugar content of juice is sometimes necessary due to low fruit sugars or for production of a desired wine style. White table wines were produced by adjusting soluble solids from 17.2 to 20.6 °Brix with cane sugar addition, freeze concentration or concentration using thin-film centrifugal evaporation (Evapor). In addition, a dessert-style wine was produced by concentrating juice from 17.2 to 30.5 °Brix using freeze concentration or Evapor. Few compositional differences were measured between treatments. Wines made using concentrating methods as compared to sugar addition had more malic acid and calcium. Compositional differences in the dessert-style wines were marked by a more complete fermentation in the Evapor treatment. In both wine styles, wines made from juice concentrated with the Evapor were more yellow-brown than wines made from freeze concentrated juice. This was most evident in the dessert style wine. A sensory panel could not differentiate wines made from the sugar adjustment methods in either style of wine. This research showed

that either concentration method investigated was an alternative for the adjustment of low sugar wines.

Influence of Macerating Enzymes and Grape Seed Tannin on Color Extraction and Retention in Cynthiana Wine

Gary L. Main and Justin R. Morris

Cynthiana, *Vitis aestivalis*, a red wine grape, was fermented using macerating enzymes and grape seed tannin to evaluate their effect on color extraction, phenolics and color retention. In experiment 1, the absorbance spectrum was measured from 220 to 640 nm on 6 days during fermentation on the skins and after pressing. Five commercial macerating enzymes, (Trenolin color DF, Lallzyme EX-V, Crystalzyme Tinto, Rohapect VR-C, Vinozyme G) and no-added enzyme were tested at the maximum recommended level. Daily absorbance spectra were similar for all enzyme treatments. Maximum red color occurred on day three of fermentation then declined. The highest phenolic levels, absorbance at 280 and 330 nm, occurred on day five of fermentation then declined. Experiment 2 was established by combining three replicates within each enzyme treatment from experiment 1. This wine was divided into two replications with and without grape seed tannin (Grap'Tan PC). Analysis of the newly bottled wine indicated there were few color differences due to macerating enzymes or tannin addition. All wines from enzyme treatments had more polymeric pigment than the no enzyme treatment. Addition of seed tannin also increased polymeric pigments. Upon aging for one and two years, the wine lost red color and the pigments became more polymerized. The differences seen in the newly bottled wines continued through aging.

GRAPE AND WINERY ECONOMICS

Production Budgets for Arkansas Wine and Juice Grapes

Emilio Noguera, Justin R. Morris, Keith Striegler, and Michael Thomsen

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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