Enology and Viticulture Program
Institute of Food Science and Engineering
University of Arkansas Division of Agriculture, Fayetteville, AR
SERA IEG-14 Progress Report on Research Projects 2002-2003

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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**
- **ROOTSTOCK EFFECTS ON YIELD AND QUALITY**
- **CULTIVAR EVALUATION**
- **TABLE GRAPE EVALUATION**
- **ENOLOGY**

VINEYARD MECHANIZATION

Commercial prosperity in an increasingly global market will rely heavily on the successful mechanization of such vineyard operations as thinning, pruning (summer and winter), shoot positioning, and leaf removal that reduce cost without a negative impact on wine quality. The Arkansas Viticulture and Enology research program developed, modified and evaluated systems for the mechanization of each viticultural operation requiring hand labor. The research resulted in mechanized systems that will allow for almost complete mechanization of mature grape vineyards. This vineyard mechanization system includes over 40 different machines and attachments that have been evaluated for the mechanization of 12 different trellising systems.

The Morris-Oldridge Vineyard Mechanization System is the property of the University of Arkansas and was issued a patent in April, 2002. The patent includes 20 of the 40 vineyard apparatuses that are required to mechanize vineyards (others already exist in commercial form). OXBO International has obtained the rights to manufacture equipment required to implement the system.

A vineyard mechanization study has been ongoing for six years with Cornell University, with the U of A as the lead institution. Long-term effects of mechanization on single curtain systems have been higher yields with juice quality equal to that of hand-pruned vines.

In 2003, French Camp Vineyard of San Luis Obispo County, CA, used the system on about 600 of the vineyard's 1,700 acres as part of a large commercial study. The system was used for shoot and fruit thinning and canopy management. The vineyard operators reported that quality was maintained in the one year test, and they believe quality can be improved with mechanization. Grapes and wine from this study are now undergoing laboratory analysis. The research wine was produced by Central Coast Wine Services of Santa Maria, CA.

Viticulturists and winery groups in several other states (Virginia, North Carolina, Missouri, Michigan and Washington State) have also expressed interest in evaluating the system. If only 10% of the approximately 500,000 acres of wine and juice grapes in the

United States had only the pruning and thinning part of the system applied, the savings would be at least $75 million.

Cynthiana Vineyard Mechanization Study

This study, in its second year, has been established with 4 treatments and 6 replications: (1) Hand prune to 50 + 10 with an 80 bud upper limit (2) Minimal pruning, skirt at 60 cm, (3) Machine pruning – box cut, leaving 70-80 buds, (4) Machine pruning - box cut, hand touch up leaving best 80 buds. Grapes were sampled at 19, 21 and 23 °Brix and laboratory analysis run for each field replicate. Wines were made in duplicate for each treatment. Harvest samples indicate that soluble solids and acids were similar among treatments 1, 3 and 4. The minimal prune treatment was picked one week after the other treatments but was 1 to 2 °Brix lower. The malic acid content and color were lower on the minimal prune treatments. Minimally pruned vines had 50% greater yield than the other treatments. Minimal pruning results could have been modified if the excess fruit were mechanically removed 30 days post bloom. Treatments 1 and 2 had higher cluster weights than treatment 3. Cluster weights on the minimally pruned vines were 40% less than treatments 1 and 4. Mechanized pruning appears to hold great promise for Cynthiana grapes; however, mechanical thinning may be required initially in order to help balance the crop load.

Impact of Minimal Pruning on Vignoles Grapevines

Vignoles is a grapevine cultivar commonly used to produce wines in Eastern and Southern USA viticulture districts. Common problems associated with culture of Vignoles are susceptibility to the summer bunch rot complex or botrytis bunch rot due to the cultivar having small, compact clusters and low to moderate yield because of low bud fruitfulness. Minimal pruning is a production system that has no dormant season pruning and almost complete mechanization of vineyard operations. This system has been demonstrated in California and Australia to reduce labor requirements, maintain or improve yield, and reduce the incidence of certain fungal disease including bunch rot. Under the leadership of Keith Striegler, currently at the Mid-America Viticulture and Enology Center, Mountain Grove, Missouri, a study was established at the Arkansas Agricultural Research and Extension Center, Fayetteville, Arkansas to evaluate the impact of minimal pruning on yield, fruit composition, and incidence of summer bunch rot complex of Vignoles grapevines. In this study, minimal pruning was evaluated against hand pruning in a randomized compete block experimental design. Minimal pruning produced significantly higher yield in two of three years studied. Clusters per vine were higher for minimal pruned vines while hand-pruned, control vines displayed greater cluster weight. Percentage rot was similar between treatments for two of three years studied. These results indicate that minimal pruning can be used for commercial Vignoles production. However, minimal pruning did not consistently reduce the incidence of summer bunch rot complex in Vignoles grapevines.

ROOTSTOCK EFFECTS ON YIELD AND QUALITY

Rootstock Effects on Chardonel Productivity, Fruit and Wine Composition

A cooperative study was initiated between the University of Arkansas and California State University, Fresno (Keith Striegler), to determine the effect of rootstock on

productivity, fruit and wine composition. Viticultural data were collected for four years in Arkansas and three years in California, and wine was made one year. Chardonel scion wood was bench grafted on Cynthiana, Freedom, Kober 5BB, and Richter 110 rootstock. Grafted vines and own-rooted vines were planted in Fayetteville, AR, and Fresno, CA. Vineyard establishment, trellis systems, and cultural practices were standardized between locations. The two locations have different soils and climates, and results differed between locations. Grapes grown in Fresno (3 year means) had higher total soluble solids (23.5 °Brix) and titratable acidity (TA; 8.0 g/L) and lower pH (3.44) than grapes grown in Fayetteville (4 year means): 20.5 °Brix, 6.4 g/L TA and 3.60 pH. The greatest benefits of using rootstocks were seen in Fayetteville, where yield increases of 40 and 19% were obtained with 5BB and 110R, respectively, as compared to own-rooted vines. Cynthiana produced the lowest yields, and Freedom produced the largest vine size at both locations. Grapes from vines grafted to 110R had a lower pH than own-rooted vines at Fayetteville. Otherwise, there were few composition differences between own-rooted, Freedom, 5BB, and 110R rootstocks. Wines produced from fruit of vines grafted to Freedom had the highest pH at both locations. There were few differences in wine pH or acidity among grapes that were not attributable to fruit maturity. There was not a major advantage to using rootstock in Fresno. The use of 110R seems to hold an advantage in Fayetteville over own-rooted vines due to higher yield and lower pH.

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

(Co-PIs Keith Striegler and Justin Morris)

Grape rootstocks influence resistance to soil borne pests and diseases, adaptation to soil problems, and a myriad of vine physiological processes and functions. The choice of a rootstock for a particular site depends on the complex interactions between soil type, depth, physical and chemical properties, presence of soil pests, presence of soil diseases, water availability, environmental factors and management factors. Use of rootstocks in eastern USA viticulture is increasing. More information on performance of rootstocks under Ozark Mountain Region conditions would be beneficial for growers. The objective of this experiment was to evaluate the impact of selected rootstocks on the vegetative growth, yield, fruit composition, and vine nutritional status of 'Cabernet Franc' grapevines. This experiment was conducted for three seasons (2000-2002) in a commercial vineyard near Altus, AR. 'Cabernet Franc' vines grafted on 110 Richter, 3309 Couderc (control), Freedom, and 44-53 Malegue rootstocks were planted in a Linkers fine sandy loam soil. Vineyard spacing was 2.1 x 3.1 m (vine x row) and row orientation was east-west. A four-arm Kniffen trellis system was used and the vineyard block was non-irrigated. Few statistically significant differences have been observed between the rootstock treatments. Vines grafted onto 3309 Couderc rootstock had lower yield in 2000 due to winter injury. Vegetative growth as indicated by dormant pruning weight, was greatest for vines grafted on Freedom. There was a trend for fruit from 110 Richter vines to have delayed maturity (lower soluble solids and pH) as compared to fruit from the other treatments.

Effect of Rootstock on Performance of Chambourcin and Vignoles Grapevines

(Co-PIs Keith Striegler and Justin Morris)

Two of the more important wine grape cultivars for the Ozark Mountain Region are Chambourcin (red) and Vignoles (white). These cultivars are generally planted as own-rooted vines since the use of rootstocks is not widespread in this district nor is there sufficient information on the appropriate combinations of scion/rootstock for optimum

productivity and adaptation to the environmental stresses found in the region. A study was established in 2000 at the Arkansas Agricultural Research and Extension Center, Fayetteville, AR to determine the effect of rootstock on productivity, fruit composition and wine composition of Chambourcin and Vignoles. Vines were planted in a drip-irrigated vineyard with plant spacing of 2.4 m x 3.1 m (vine x row) and a Captina silt loam soil. Vines are trained to a Geneva Double Curtain trellis system and row orientation is north to south. Rootstock treatments are: own-rooted, 5BB Kober, Freedom, 3309 Couderc, 1103 Paulsen, 44-53 Malegue, and 110 Richter. Initial data were collected during the 2002 season. Data are being statistically analyzed and summarized.

Effect of Rootstock on Vegetative Growth, Yield, Fruit Composition, Wine Composition, and Vine Nutritional Status of Cynthiana/Norton Grapevines

(Co-PIs Keith Striegler and Justin Morris)

This study was established in 2001 at the Arkansas Agricultural Research and Extension Center, Fayetteville, AR. Own-rooted Cynthiana/Norton vines and Cynthiana/Norton vines grafted on 3309 Couderc, 101-14 Millardet et de Grasset, 5C Teleki, 1103 Paulsen, and 44-53 Malegue rootstocks were planted into a Captina silt loam soil. Vine spacing is 2.4 m x 3.1 m (vine x row) and vines are trained on a Geneva Double Curtain trellis system and row orientation is north to south. Data collection will include yield, components of yield, dormant pruning weight, shoot density, fruit composition, wine composition, and vine nutritional status (tissue samples). Initial data collection has begun during the 2003 season.

Effect of Rootstock on Sunbelt Grape 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, California State University – Fresno, 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

Evaluation of Grape Breeding Lines For Wine and/or Juice Production

This is a cooperative research program between IFSE and the grape breeding program of Dr. John Clark, Department of Horticulture. In this program, wine and juice grape breeding lines are evaluated for both viticultural and/or juice and enological suitability. The juice grape Sunbelt (A-1335) was patented and released from this program in 1993. In 2002, wines made from all advanced selections were evaluated by University researchers and representatives of the Arkansas wine industry. As a result, five white and two red breeding lines remain in advanced trials with commitments by Arkansas wineries to expand the trials to commercial size. In addition to testing of Arkansas breeding lines, breeding lines and new releases from other breeding programs in the Eastern United States are being evaluated. For example, GW-9, a white grape resulting from a cross of

Seyval blanc and Chardonnay made by the New York Agricultural Experiment Station, Geneva, NY had a late maturity date that did not fit the short growing season of New York. However, evaluations at both Michigan State and the University of Arkansas showed that fruit chemistry was good and that it made excellent still and sparkling wines. As a result, Dr. Bruce Reisch, grape breeder at Geneva, released GW-9 as Chardonel.

Evaluation of Selected *Vitis vinifera L.* Wine Grape Cultivars for Arkansas

(Keith Striegler, Project Leader)

Cultivar selection is a key element for successful and profitable viticulture. Growing the right cultivar is critical if growers are to achieve consistent production of high quality fruit. The right cultivar must be adapted to regional environmental conditions, soil conditions, and pest problems. In addition, management and economic factors are important and must be considered.

Vitis vinifera L. cultivars have been grown commercially in the Altus region of Arkansas for over thirty-five years. There is increasing interest in wine production from *V. vinifera* cultivars, especially from newer cultivars. The objectives of this study are to evaluate the performance of new *Vitis vinifera L.* wine grape cultivars and to use the information generated to develop production budgets for adapted cultivars. This study is being conducted at the U of A Fruit Substation at Clarksville, AR. Red and white cultivars are being evaluated in separate experiments. Vines are grafted on 1103 Paulsen rootstock and vineyard spacing is 2.4 m x 3.1 m (vine x row). The soil type is a Linkers fine sandy loam and vines are trained to a vertical-shoot-positioned trellis system. Vines are irrigated using a drip irrigation system. White cultivars included in the study are: Chardonnay, Chardonel, Viognier, Verdelho, Traminette, and Symphony. Cabernet Franc, Cabernet Sauvignon, Chambourcin, Malbec, Petite Verdot, Sangiovese, Syrah, and Tempranillo are the red cultivars in the study. Data being collected includes yield, components of yield, fruit composition, wine quality, and vegetative growth as indicated by dormant season pruning weight. Results have been obtained during the 2001, 2002 and 2003 seasons. Based on data collected to date, performance of Cabernet Franc, Cabernet Sauvignon, Chambourcin, Syrah, and Tempranillo has been promising for red cultivars while all white cultivars have performed well. It is important to note that extreme low temperatures have not yet occurred during this study so winter hardiness levels of the cultivars under evaluation have not been determined.

Evaluation of New York Advanced Selection Red Wine Grape Cultivars

(Keith Striegler, Project Leader)

The wine grape breeding program at Cornell University has produced several advanced selections which may be adapted to the Ozark Mountain Region and may provide winemakers with options for red wine production beyond the currently limited selection of adapted cultivars. These selections include: GR7 (Buffalo x Baco Noir), a very vigorous and highly productive selection that makes a dark red wine with a classical hybrid aroma; NY70.0809.10 (SV 18-307 x Steuben) a vigorous and productive selection that produces a vinifera type wine; and NY73.0136.17 (NY33277 x Chancelor x Steuben) a vigorous selection that produces a full-bodied wine with moderate tannin content. This experiment was established to evaluate the suitability of these advanced selections for red wine grape production and to compare them to standard red wine grape cultivars. The experiment is being conducted in an experimental vineyard at the Arkansas Agricultural Research and Extension Center, Fayetteville, AR that was planted in 2000. The vineyard is drip-irrigated and vineyard spacing is 2.4 m x 3.4 m (vine x row). Vines are trained to a

bilateral cordon and spur pruned. A vertical shoot-positioned trellis system with moveable catch wires has been used, and row orientation is north to south. The treatments are: NY70.0809.10 grafted on 3309 rootstock, NY70.0809.10 own rooted, NY73.0136.17 grafted on 3309 rootstock, NY73.0136.17 own rooted, GR7 own rooted, Chambourcin own rooted, and St. Vincent own rooted. Data were collected during the 2002 and 2003 seasons. To date, Chambourcin has proven to be the superior cultivar.

Evaluation of Muscadine Cultivars for Southwest Arkansas

(Keith Striegler, Project Leader)

Muscadines (*Vitis rotundifolia*) have been grown commercially in Arkansas since 1972 and are generally adapted to south and central Arkansas. However, cultivars can differ in winter hardiness and productivity. Several currently available processing and fresh market muscadine cultivars and two selections from North Carolina State University are being evaluated at the Southwest Research and Extension Center, Hope, AR. Evaluation began in 1999 and will continue through 2003. Preliminary data indicates cultivar differences in productivity, berry weight and fruit quality at this site. 'Carlos', 'Granny Val', 'Ison', 'Jumbo', 'Nesbitt', Southern Home', and 'Summit' were high yielding for all three years. 'Black Beauty' was very productive in 2001 (84 lb./vine). 'Black Beauty' and 'Sugargate' had the largest berry weight (10 g). 'Carlos', 'Ison', and 'Southern Home' had the smallest berries (≤ 5 g). Most cultivars had good fruit quality and those that rated highest overall included 'Black Beauty', 'Nesbitt', 'Supreme', 'Tara', 'Triumph' and the North Carolina selections. 'Ison', 'Jumbo' and 'Late Fry' had poor quality.

Influence of Cultural Practices on Yield, Fruit Composition and Growth of Cabernet Sauvignon Grapevines in Arkansas

(Keith Striegler, Project Leader)

Grapevine canopies are managed to manipulate vegetative growth and optimize vine physiology, improve vine productivity, reduce disease incidence, improve fruit composition, and increase wine quality. This experiment examined the response of Cabernet Sauvignon grapevines to selected canopy management practices applied individually or in combination. The experiment was conducted in a commercial vineyard that was established in 1996. Vines were grafted to 5BB Kober rootstock and planted in a Linkers fine sandy loam soil. The vineyard was drip-irrigated and vineyard spacing was 2.4 m x 3.4 m (vine x row). Vines were trained to a bilateral cordon and spur pruned. A vertical shoot-positioned trellis system with moveable catch wires was used, and row orientation was east to west. Canopy management treatments were shoot thinning, flower cluster thinning, and leaf removal. Treatments were imposed during the 2000 season. Initial results from the 2001 season are reported. Shoot thinning had little effect on canopy characteristics, yield or fruit composition. However, shoot thinning significantly reduced clusters per vine and yield. In addition, vines that were cluster-thinned had higher berry weight, cluster weight, berries per cluster, and pruning weight. Leaf removal reduced canopy density as indicated by point quadrant analysis. However, yield and fruit composition were not improved. The data are preliminary and further study is needed before equilibrium results are obtained.

TABLE GRAPE EVALUATION

Response of 'Jupiter' Grapevines to Shoot and Cluster Thinning

(Keith Striegler, Project Leader)

'Jupiter' is a seedless table grape cultivar that was released by the University of Arkansas in 1998. This cultivar has large non-slipskin berries that have a mild muscat flavor. Cultural practices such as shoot thinning and cluster thinning are used to regulate crop load and improve fruit quality in *Vitis vinifera L.* table grape cultivars. Little information is available on the impact of these practices on interspecific hybrid table grape cultivars such as 'Jupiter'. Information on the use of shoot and cluster thinning for 'Jupiter' would be beneficial for table grape growers in Arkansas. Consequently, the purpose of this study was to investigate the effects of shoot and cluster thinning on yield, harvest efficiency, fruit composition, and vegetative growth of 'Jupiter' table grapes. The research was conducted in a mature, own-rooted 'Jupiter' vineyard block with Captina silt loam soil. Vines were grown on a Hudson River Umbrella (high cordon) training system and were drip irrigated. Treatments included shoot thinning (removal of all non-count shoots when shoot length was 10 – 15 cm), cluster thinning (removal of clusters after berry set to retain one cluster per shoot), and shoot + cluster thinning. Data collected included packable and non-packable yield, yield distribution, shoots/vine, pruning weight, and fruit composition of packable and non-packable fruit. Data were collected at three harvest dates during the 1999 and 2000 seasons. Packable yield per vine was not significantly influenced by treatment. However, cluster thinning and shoot + cluster thinning reduced non-packable and total yield. Percentage packable fruit and harvest efficiency (% of packable fruit harvested on the first two picking dates) were increased by cluster thinning and shoot + cluster thinning. Pruning weight was reduced for control vines and vines which were shoot –thinned. Packable fruit was significantly more mature than non-packable fruit. These results indicate that use of cluster thinning or the combination of shoot and cluster thinning did not increase packable yield but did improve harvest efficiency as well as improve vine size which is critical for long term sustainable production.

Effect of Trellis/Training System on Performance of Mars Table Grapes

(Keith Striegler, Project Leader)

'Mars' is a slipskin seedless grape released by the University of Arkansas in 1984. The blue-black berries are large and borne in medium clusters on very vigorous plants. The vines are also very disease resistant and berries have good shipping characteristics making this a valuable and widely planted commercial cultivar in Arkansas. Information regarding appropriate trellis / training systems for this cultivar is lacking. Commercial experience with other cultivars on Geneva Double Curtain (GDC) and Hudson River Umbrella (HRU) has demonstrated increases in yield over the standard commercial trellis systems. The experiment was conducted in a commercial vineyard located near Searcy, AR. Own-rooted vines were planted in a Leadvale silt loam soil. The vineyard was drip-irrigated and vineyard spacing was 2.4 m x 3.1 m (vine x row). Vines were trained to a four-arm Kniffen trellis (control), a GDC trellis, and a HRU trellis. Treatments were imposed during the 2000 season. Results from the 2001 and 2002 season are reported. Vines trained to the GDC trellis system had increased yield. However, there were no consistent effects on fruit composition or vegetative growth.

ENOLOGY

Macerating Enzymes and Tannin for Color Extraction and Retention in Cynthiana Wine Production

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 from 220 to 640 nm was measured for 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). Tannin was applied prior to malolactic fermentation. 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. Total anthocyanin was slightly higher in wines treated with Vinozyme G than in the no enzyme treatment wines. Wines will continue to be evaluated to determine color retention.

Control of Cynthiana Wine Attributes Using Ion Exchange on Different Pre-Fermentation Treatments

Wine produced from Cynthiana grapes can have both high pH (3.5 to 3.9) and high titratable acidity (8.5 to 12 g/L tartaric acid). Pre-fermentation treatments (control, ion exchange, tartaric acid addition, sulfuric acid addition) were used in conjunction with post fermentation ion exchange systems (no treatment, membrane, resin) to adjust the pH. Although pH was reduced using the different pre-fermentation treatments, ion exchange of the wine was necessary to lower the pH to an optimum range. Wine pH was lowered from 3.98 to 3.44 using ion exchange in combination with pre-fermentation treatments. Color and phenolic parameters were measured using absorption spectrophotometry. Ion exchange increased the color density in all pre-fermentation treatments. Phenolics and red pigment color were not greatly affected by ion exchange and pre-fermentation treatments. These pre-fermentation treatments and ion exchange applications have commercial potential.

pH Modification in Cynthiana Wine Using Cationic Membranes, Resins and Other Methods

Membrane and resin ion exchange technology was used for pH reduction and production of Cynthiana wine, which can have high pH and high titratable acidity. Wine attributes were monitored during storage for 6 months at 21 and 38 °C. Non-adjusted Cynthiana wine (pH 4.1) was compared to ion-exchange-adjusted wine (pH 3.5). Ion exchange lowered the pH and potassium content and increased the titratable acidity of wine without having detrimental effects on color and phenolics. No trends were found to indicate differences between manufacturers of membranes and resins on pH-adjusted Cynthiana wine. Wine treated with membrane ion exchange was higher in color density and phenolics than resin treated wine. During storage at both temperatures, the quality of the wine decreased, with greater degradation at 38 °C. Ion exchange decreased the pH of Cynthiana wine without negatively affecting wine quality attributes. A panel familiar with

characteristics of Cynthiana wine found that the color and flavor of the pH-adjusted wine was improved.

Comparison Between Ion Exchange Systems with Tartaric Acid Addition for pH Reduction of Syrah Wine

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 analyzed initially and after six months at 21°C. The wine's pH was lowered from 4.26 to 3.5, and it had improved color attributes and higher titratable acidity, but lower total phenolics and potassium levels. Color attributes improved, while phenolics decreased after storage. 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 the Syrah wine. Analytical color attributes corresponded with sensory evaluation. The panel noticed more differences between the control and the pH reduction treatments than within the pH reduction treatments. pH reduction using ion exchange had a similar impact on the wine as compared to the tartaric acid addition treatment.

Minimizing Color Degradation in Blush Wines

Minimization of color degradation in blush wines was investigated. Cabernet Sauvignon wines produced with sulfur dioxide (SO_2) added at crush (0, 30, 60, and 120 mg/L) and again at bottling were evaluated during 12 months of storage at 16°C. Addition of SO_2 at crush did not affect browning (absorbance at 420 nm) but increased red color (absorbance at 520 nm). As SO_2 levels at bottling increased, browning and red color decreased. Pre-fermentation treatments (hyperoxidation, nitrogen sparging, and SO_2 addition) and tannic acid addition at bottling in Cabernet Sauvignon, Delaware, and Noble blush wines stored at 16 and 37°C were evaluated. Pre-fermentation treatments did not affect red color. Browning differences were observed in Cabernet Sauvignon but not in Delaware and Noble wines. In blush wines from all cultivars, as tannic acid levels increased, browning and red color increased in blush wines. The pre-fermentation treatments can be used to minimize color degradation in the cultivars evaluated.

Yield, Quality and Nutraceutical Evaluation of Sunbelt and Muscadine Grapes

Heated and unheated pressing methods were evaluated on Sunbelt and different muscadine grape cultivars (Carlos, Nesbit and Black Beauty). Sunbelt produces Concord-type juice and is adapted to warm climatic conditions of the southern United States. Muscadine grapes (*Vitis rotundifolia*), native to the southeastern United States, have a unique flavor and aroma for juice production. For the unheated treatment, pectolytic enzyme was added at crush and the grapes were held four hours and pressed. For the heated treatment, grapes were crushed, heated to 60°C, pectolytic enzyme was added, held for 20 minutes, cooled to 40°C, and pressed. Juice yield data was obtained at pressing. Heating the must prior to pressing increased the juice yield in all cultivars. Hot press juice yields for Black Beauty, Carlos, Nesbit and Sunbelt were 606, 602, 578, and 773 liters/metric ton (145, 144, 139 and 185 gallons/ton), respectively. Unheated must press yields for Black Beauty, Carlos, Nesbit and Sunbelt were 522, 499, 520 and 699 liters/metric ton (125, 120, 125 and 168 gallons/ton), respectively. The remaining seeds and skins were dried in a commercial food dehydrator. Sugar, pH, acidity and color quality of the juice were evaluated. Oxygen radical absorbance capacity (ORAC), anthocyanins,

and total phenolic levels were determined from the grapes, juice, seeds, skins, and seeds + skins. Heating the must before pressing increased the soluble solids of Sunbelt but not that of the muscadines. Hot pressing increased the color density, the ORAC levels and the anthocyanin levels. ORAC and anthyocyanin levels of juice from hot pressed Sunbelt grapes were higher than the levels in the juice from the muscadine cultivars.

Analysis of Wine Components in Cynthiana and Syrah Wine

Red wine is composed of a complex matrix of compounds that can interfere with analysis. A high-performance liquid chromatography (HPLC) procedure was developed to efficiently analyze organic acids, sugars, glycerol and ethanol in Cynthiana (*Vitis aestivalis*) wine. Standard laboratory procedures (pH, titratable acidity and color attributes) and HPLC were found reproducible for Cynthiana wine. HPLC recovery efficiency was determined by analysis of spiked and unspiked samples (model, Cynthiana and Syrah (*Vitis vinifera*) wines. Although recovery of components was greater in the model wine, recovery in Cynthiana and Syrah wine was comparable. The HPLC procedure was further compared to commercial rapid enzyme analysis tests using model, Cynthiana, and Syrah wines. HPLC analyses were more accurate than enzymatic tests for determining components in the model, Cynthiana and Syrah wines. Considering the complexity of the wines analyzed, reproducibility and recovery of the HPLC procedure was demonstrated, and showed improvement and precision when compared to existing methods.

Yeast Supplements to Enhance Fermentation Rates in Wine Production under Normal and Stress Conditions

The ability of yeast supplements (GO-FERM® and Fermaid K) to enhance the fermentation rate of wine were evaluated. GO-FERM® (recommended level of 0.3 g/L) is an inactive yeast containing vitamins, minerals and amino acids used during rehydration. Fermaid K (recommended level of 0.24 g/L) is a nutrient containing nitrogen, sterols, fatty acids, yeast hulls, vitamins and magnesium added to the juice before or during fermentation. Sterile Chardonel juice was used for micro-fermentations. Fermentation rate was monitored daily by weight changes (g/day) due to carbon dioxide (CO_2) loss. Nitrogen, minerals, organic acids, sugars, and ethanol levels were evaluated before and after fermentation. The experiments were (1) GO-FERM® addition (0, 0.15, 0.3, and 0.6 g/L) fermented at 21°C, (2) GO-FERM® (0, 0.3, and 0.6 g/L), Fermaid (0 and 0.24 g/L), and fermentation temperatures of 15 and 25°C, (3) GO-FERM® (0, 0.3, and 0.6 g/L), Fermaid (0 and 0.24 g/L), and nitrogen levels (control and semi-model juice) fermented at 15°C, and (4) pH levels (3, 3.5, and 4), GO-FERM® (0 and 0.6 g/L), and Fermaid (0 and 0.24 g/L) fermented at 15°C. The addition of Fermaid increased nitrogen and the addition of GO-FERM® increased the sodium of the juice prior to fermentation. Fermentation at an increased temperature was faster but had more CO_2 loss/day during early fermentation. The juice with 0.6 g/L GO-FERM® only and with 0.6 g/L GO-FERM® + Fermaid performed similarly. 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.

RESEARCH PUBLICATIONS Since 2000:

1. Morris, J.R. 2000. Vineyard Mechanization for New York. Proc. Vitic. 2000. New York. pp. 28-30.
2. Morris, J.R. 2000. Past, Present and Future of Vineyard Mechanization. Proc. Am. Soc. Enol. & Vitic. Mtg. Seattle, WA. Am. J. Enol. Vitic. 51(5):155-163.
3. Main, G., M. Faupel, J.R. Morris and R. McNew. 2001. Quality and stability of blueberry juice blended with apple, grape and cranberry juice. J. Food Qual. 24:111-125.
4. Morris, J.R. 2001. Precision viticulture – A mechanized systems approach. Proc. Am. Soc. Enol. Vitic./Eastern Section Symposium, Cool Climate Oenology and Viticulture Institute, St. Catherines, Ontario, Canada; pp. 103-110.
5. Walker, T.L., J.R. Morris, R.T. Threlfall, and G. Main. 2001. Density separation, storage shelf life, and sensory evaluation of 'Fry' muscadine grapes. HortSci. 36(5):941-945.
6. Bates, T., J.R. Morris, R. Dunst, G. Main, B. Shaffer, T. Oldridge, B. Betts, D. Betts, and D. Vercant. 2001. Evaluation of mechanical thinning on the yield and quality of mechanical and hand-pruned 'Concord' grapevines.
7. Morris, J.R. 2001. Progress report for project total vineyard mechanization to optimize yield and quality of Concord, Vitis labruscana, grape production. Viticulture Consortium NYSAES Report of 2001 Proposals Received and Awards Made. pp 138-140.
8. Buescher, W.A., C.E. Siler, J.R. Morris, G.L. Main and R.T. Threlfall. 2001. High alcohol production from grape juice concentrate. Am. J. Enol. Vitic. 52(4):345-351.
9. Morris, J.R. and J.M. Blevins. 2001. Harvesting and handling. IN: Muscadine Grapes, Basiouny, F.M. and Himelrick, D.G. (Eds.), ASHS Press, Alexandria, VA. Pp. 259-272.
10. Main, G.L., J.R. Morris, and K. Striegler. 2002. Rootstock effects on Chardonel productivity, fruit, and wine composition. Am. J. Enol. Vitic. 53(1):37-40.
11. Morris, J.R. 2002. A systems approach to vineyard mechanization. 2002 Ohio Grape-Wine Short Course. Hort. & Crop Sci. Dept. Series 726. pp 41-51.
12. Threlfall, R.T. and J.R. Morris. 2002. Using Dimethyldicarbonate to minimize sulfur dioxide for prevention of fermentation from excessive yeast contamination in juice and semi-sweet wine. J. Food Sci. 67(7):2758-2762.
13. Striegler, R.K., J.R. Morris, R.T. Threlfall, G.L. Main, C.B. Lake, and S.G. Graves. 2002. Minimal input production systems affect yield and juice quality of 'Sunbelt' grapes in California's San Joaquin. HortSci. 37(6):867-870.
14. Walker, T., J. Morris, R. Threlfall, and G. Main. 2002. pH modification of Cynthiana wine using cationic exchange. J. Agric. Food Chem. 50: 6346-6352.
15. Berg, G.T. and R.K. Striegler, 2002. Natural sun-dried raisin production systems. In: V.E. Petrucci and C. Clary (eds.). A Treatise on Raisin Production, Processing and Marketing. Malcolm Media Press, Clovis, CA.
16. Carter, M, R.K. Striegler, J.R. Clark, and M. Phillips. 2002. Muscadine cultivar evaluation in southwest Arkansas. Horticultural Studies 2001: 13-14, U of A, Division of Ag. Res. Ser. 494.
17. Walker, T.L., J.R. Morris, R.T. Threlfall and G.L. Main. 2003. Control of Cynthiana wine attributes using ion exchange on different pre-fermentation treatments. Am. J. Eno. Vitic. 54(1):67-71.
18. Walker, T., J.R. Morris, R.T. Threlfall and G.L. Main. 2003. Analysis of wine components in Cynthiana and Syrah wine. J. Ag. Food Chem. 51: 1543-1547.
19. Walker, T.L., J.R. Morris, R.T. Threlfall and G.L. Main. 2003. Comparison between ion exchange systems with tartaric acid addition for pH reduction of Syrah wine. J. Food Quality. In review.

POPULAR ARTICLES FOR THE PAST 5 YEARS:

1. Morris, J.R. 2000. Past, present and future of vineyard mechanization. Wine East 2000 Buyer's Guide. pp. 6-23.
2. Striegler, R.K., D. Trowbridge, S.G. Graves, G.T. Berg, and C.B. Lake 2000. Mechanized production systems and Syrah grapevines: Impact on yield and quality in the San Joaquin Valley. American Vineyard 9(2): 26-28.
3. Morris, J.R. 2002. Vineyard mechanization – a system approach. Western Fruit Grower. 122(2):1-2.
4. Striegler, R.K., J.R. Morris, R.T. Threlfall, G.L. Main, C.B. Lake, and S.G. Graves. 2002 Growing Sunbelt Grapes in the San Joaquin Valley: A Potential New Market for Grape Growers. American Vineyard 11(5):4,6-7,30 (May 2002).