PROCEEDINGS OF THE

27th ANNUAL
HORTICULTURE INDUSTRIES SHOW

TULSA COMMUNITY COLLEGE
NORTHEAST CAMPUS
3727 E. APACHE
TULSA, OK

OKLAHOMA & ARKANSAS HORTICULTURE INDUSTRIES SHOW

JANUARY 4 & 5, 2008

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Four Seasons of Success

Winery Sanitation: An Essential Tool for Preserving Wine Quality

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Introduction:

Consistent production of high-quality wines is a constant challenge for every winemaker. Of course wine quality is primarily a function of the quality of the grapes that go into a wine. The abilities of the winemaker are important as well. And there's no substitute for a bit of good fortune. Along with all the above, good winery sanitation is a critical, and sometimes overlooked, tool for maintaining wine quality during processing and storage.

Yeasts, molds, and bacteria that can spoil wine are ubiquitous in the environment and may be assumed to be present on grapes coming into the winery. Once present in the winery they may take up residence in hard-to-clean nooks and crannies such as hose connections, pumps, filters, bottlers, and so on. Winery personnel are often good carriers for moving microorganisms from one spot to another. Water is also a good carrier. Thus, even the act of washing can spread problems if proper cleaning and sanitizing practices are not followed.

Problems caused by different types of microbial contaminants:

Yeasts
Spoilage yeasts may generate a variety of compounds that produce off-flavors in wines including acetaldehyde, acetic acid, ethyl acetate, and others. Spoilage yeast may also cause various wine chemistry imbalances including loss of residual sugars and/or organic acids.

Bacteria
There are two main types of bacteria typically involved in quality issues: lactic acid bacteria and acetic acid bacteria. Quality issues connected with lactic acid bacteria include off-flavors and "ropy" mouthfeel defects. Quality issues connected with acetic acid bacteria include off-flavors, especially vinegary flavors, and may cause an increase in volatile acidity (VA) that puts wine in violation of legal limits.

Molds
Many species of mold may cause problems in the winery. These are typically different than mold found on incoming grapes. Note that mold will not actively grow in finished wine, but its presence in the winery can cause serious off-flavors in finished wine including very potent "cork taint" problems.

Controlling microorganisms:

Proper post-harvest handling of grapes is essential to avoiding problems with spoilage microorganisms as many of these will naturally be present on grapes in the field. Damaged fruit or lengthy storage at non-refrigeration temperatures may give these microorganisms a chance to do damage even before the fruit is crushed and destemmed.

Proper winemaking practices are also essential, but not always sufficient to control undesirable microorganisms. These include proper levels of nutrients in the must, control of must / wine chemistry, control of must / wine temperature, proper use of inhibitors e.g. sulfur dioxide (SO_2), and proper exclusion of oxygen.

In addition to the above, establishing a thorough cleaning and sanitation schedule for facilities and equipment is essential to maintaining wine quality. Among other things, this involves the proper use of appropriate cleaners and sanitizers.

Cleaning and Sanitizing:

Cleaning is always required before sanitizing in order to insure the effectiveness of the sanitizer. Dirty surfaces cannot be effectively sanitized. Proper sanitizing also requires matching a sanitizer to its intended use – some are more selective than others. Use the recommended concentrations for an effective kill. More sanitizer is not always better and too-high concentrations may be dangerous. Also, be sure to allow sufficient contact time for sanitizers to work. Be aware that water properties e.g. temperature and pH may profoundly affect sanitizer effectiveness and even safety.

Common Sanitizers and their Uses:

Following are some sanitizers commonly used in wineries, their proper uses, benefits, and limitations.

Hot Water / Steam
Pros: Environmentally friendly, non-toxic, and non-corrosive; Leaves no residues; Very effective against all microorganisms; Has good penetrating power.

Cons: Heat may damage seals, surfaces, and workers; May introduce excessive moisture into facility; Has no residual effectiveness; Generation equipment can be expensive to purchase.

Usage Tips: Hot water should be in excess of 180°F; 30 seconds at 180°F or greater is sufficient to kill all microorganisms of concern. ; Porous surfaces to be sanitized should be in contact with water at 180°F or greater for at least 20 minutes to allow heat penetration.; Be aware of temperature drop if using a stream of steam or hot water e.g. to clean a hose; Take time/temperature readings where hot water / condensate exits the unit being cleaned.

Ozone
Pros: Leaves no residues; Has no undesirable odor or flavor effects; Is very effective with rapid killing power; Its killing power is unaffected by pH or temperature; Generation equipment is relatively economical to operate.

Cons: Has limited residual effect; Ozone gas is irritating at low levels, toxic at higher levels, and explosive at very high levels; Generation equipment is relatively costly to buy; Training, maintenance, and monitoring costs may offset economical operation costs.

Usage Tips: Typical output of ozone generators is 2 – 5 parts per million (PPM) ozone at about 5 – 10 gallons per minute (GPM); Typical treatment times for 2 PPM – 1 to 5 minutes; for 5 PPM – 30 sec. to 2 minutes; Test kits are available to test ozone strength.

Note that ozone is a powerful oxidizer. Stainless steel, common plastics, including, PTFE (Teflon®), PVC (rigid, schedule 80 or 40), FPM (Viton®), and silicon are resistant to ozone. However, natural rubber is very susceptible to degradation.

Note too that ozone generators and ozonated water will produce ozone gas. OSHA limits for ozone exposure are: No more than 0.1 PPM for continuous eight-hour exposure. Short-term exposure limit (STEL) of 15 minutes at 0.3 PPM, not to be exceeded more than twice per eight-hour work day. Environmental ozone levels should be monitored; suppliers can assist with monitor selection and use.

Sulfur Dioxide (SO2)
Pros: Is very effective against many yeasts and bacteria; Is already used as an additive in wine making -- no concerns about residues; Has additional benefits e.g. stabilizing pigments and controlling oxidation.

Cons: Is not effective against all undesirable yeasts; Is not particularly effective against molds; Is mildly corrosive; Its effectiveness is very dependent upon pH; SO2 solutions emit an irritating gas.

Usage Tips: Recommended solution pH range: up to 3.3.; Recommended strength: 300 to 500 PPM free SO2; Recommended contact time: minimum 30 seconds.

Note that SO2 is particularly useful as a final sanitizing rinse for equipment where residues are likely to persist or where wine contact is likely to occur.

Chlorine
Chlorine is very commonly used as a sanitizer in the food industry. It may have some use for cleaning winery facilities or equipment, particularly outdoors, but it is generally not recommended for use in wineries due to its tendency to produce potent off-flavor and aroma compounds.

Sanitizer Storage Tips:

Cleaners and sanitizers must be stored separately from wine-contact items e.g. equipment, additives, fining agents, etc. Cleaners and sanitizers should be stored in a locked and labeled cabinet. It is best if possible to store cleaners and sanitizers in a separate room from wine-contact items. All containers, even temporary use containers, should be labeled with contents. Consider color coding containers such as buckets, etc. to limit chances of cross-contamination.

Conclusions:

Many wineries use sulfur dioxide as their primary sanitizing agent. Sulfur dioxide is an effective sanitizer, but it may not be enough by itself. A comprehensive cleaning and sanitizing program using other agents such as hot water, steam, and ozone will help to insure consistent production of high quality wines year in and year out.

Cardiovascular Health Benefits of Grapes

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Cardiovascular disease (CVD) is a major public health concern with an associated health care cost of approximately $438.1 billion and is the leading cause of death in the United States each year.[1] Oklahoma ranks second in the nation in terms of death due to CVD with approximately 15,000 Oklahomans dying from CVD and an estimated associated cost of approximately $4 billion.[2] Diabetes and obesity are also prevalent in Oklahoma with approximately 30% and 8% of Oklahoma adults being classified as obese or diagnosed with diabetes, respectively.[3]

Atherosclerosis, the formation of fatty deposits in the artery, is the common cause of CVD. A series of inflammatory events plays a role in the initiation and progression of atherosclerosis.[4] Development of atherosclerosis or fatty deposits begins when damage to the lining of artery occurs and inflammatory cell (macrophages) start accumulating fat in the intima of the artery. Many other inflammatory molecules are also involved in this process. As fat deposits accumulate, the lumen of the artery decreases which can result to decrease in blood flow.

Diet plays an important role in the development and prevention of atherosclerosis. Numerous studies have consistently linked diets rich in fruits and vegetables to reduced CVD risk.[5] Micronutrients and phytochemicals found in fruits and vegetables may in part contribute to their health benefits. Grapes constitute one of the major sources of phenolic compounds among different fruits.[6-7] Grapes contain a wide variety of polyphenols including flavonoids, flavans, flavanols and anthocyanins which may in part contribute to its health benefits. Phenolic compounds that are abundant in grape products include resveratrol, quercetin, catechin, myrecitin, kaempfrol and tannic acid. Phenolic compounds are present in the whole grapes with the highest concentration in the seed, then the skin, and lowest in the pulp.

The phenolic compound in grapes, resveratrol, has been shown to prevent or delay the development of atherosclerosis.[8] Studies have shown that resveratrol acts in different ways to help prevent plaque formation. Resveratrol has been shown to delay or prevent the initial events of atherosclerotic development by scavenging free radicals, inhibiting enzymes that produce free radicals, inhibit uptake of fats by macrophages, and stimulate the production of molecules involved in the relaxation of blood vessels. Resveratrol has also been shown to block the production of inflammatory molecules which are extensively involved in the formation of plaque. In advanced atherosclerosis, resveratrol has been shown to be beneficial by inhibiting migration of the smooth muscle into the intima and decreasing platelet aggregation. Resveratrol also lowers the concentration of triglyceride and LDL-cholesterol, the ‘bad’ cholesterol.

Findings from human studies have shown that consumption of grapes is beneficial to the heart. Dietary supplementation with concentrated red grape juice has been shown to improve lipid profile and reduce plasma concentrations of inflammatory biomarkers and oxidized LDL in both healthy subjects and hemodialysis patients.[9] Purple grape juice was shown to improve endothelial functions in patients with coronary artery disease.[10] In healthy subjects, consumption of purple grape juice reduced platelet aggregation compared to orange and grapefruit juice.[11] Moreover, purple grape juice has similar anti-oxidant effects to vitamin E.[12] In summary, human studies show that grape juice exerts cardiovascular benefits by being a powerful antioxidant, strong inhibitors of LDL oxidation, inhibit platelet function, improve endothelial function and lipid profile, and reduce inflammation.

Despite the cardiovascular benefits of grape polyphenols, there are differences in the phenolic content of grapes. Phenolic content can be influenced by environmental factors,[13-15] maturity,[16] and the variety of grapes.[17] In terms of grape variety, anthocyanins are the main phenolics in red grapes and flavan-3-ols are the most abundant phenolics in white grapes.[17] In addition to variety, fruit maturity and environmental factors such as water status have been associated with differences in grape polyphenols.[13-15] Water status has been shown to affect fruit growth, the concentration of total phenolics, and wine sensory attributes.[13-15] Therefore, it is important to evaluate grape varieties grown in Oklahoma and determine the potential of each in preventing CVD.

Our research group is currently evaluating the anti-inflammatory properties of grape varieties grown in Oklahoma. The findings of our study will help Oklahoma grape growers better market their product and will benefit consumers by promoting products that can potentially reduce or prevent cardiovascular disease. Currently, the grape-growing and wine-making industry is a fast growing segment of the Oklahoma economy and a thriving market worldwide.[18] Research studies supporting the health benefits of products grown in Oklahoma will help support the growth of these industries.

The objective of this project is to examine the anti-inflammatory properties of juice from grape varieties grown in Oklahoma and disseminate our findings to Oklahoma grape growers and wine manufacturers as well as consumers. Our central hypothesis is that the juice from the grape variety with the highest total phenolic content will exhibit the most potent anti-inflammatory properties using an in vitro system and will be the most effective in preventing inflammatory-induced chronic diseases. Our specific aims are to: (1) determine total phenolic content of juice from grape varieties grown in Oklahoma; (2) assess the anti-inflammatory properties of juice from Oklahoma grapes and compare it with commercially available grape juice (i.e. Welch's) using a cell culture system; (3) utilize social marketing principles and focus group methodology to identify motivational factors for increased grape consumption on the part of consumers, and examine benefits and barriers of marketing nutritional benefits of grapes on the part of grape growers; and (4) disseminate our findings to Oklahoma grape growers and wine manufacturers as well as to consumers.

We have tested 33 varieties of Oklahoma grapes for their total phenolic content and antioxidant capacity as assessed by Folin assay and ferric reducing ability assay (FRA), respectively (Table 1). Grapes were either smashed or pureed and the juice was used for the analyses. Future studies will assess the anti-inflammatory properties of these grapes using cell culture system.

Table 1. Phenolic content and antioxidant capacity of Oklahoma grapes

Grape Variety	Pureed		Smashed	
	Phenolic Content (mg/mL)	Antioxidant Capacity (uM)	Phenolic Content (mg/mL)	Antioxidant Capacity (uM)
Cab Franc	74.1±10.3	6888.3±1368.2	26.0±10.3	2450.4±1368.2
Cabernet Sauvignon	63.6±10.3	3614.3±1368.2	28.8±10.3	2372.7±1368.2
Chambourcine	70.2±10.3	3378.3±1368.2	48.3±10.3	3221.5±1368.2
Chardonel	29.8±10.3	841.7±1368.2	66.6±10.3	2378.7±1368.2
Chardonnay	43.5±10.3	2984.2±1368.2	27.4±10.3	1912.2±1368.2
Cimmaron	82.4±10.3	5159.1±1368.2	56.1±10.3	4560.6±1368.2
Corot Noir	129.8±10.3	12250.0±1368.2	52.8±10.3	3317.0±1368.2
Cynthiana	65.5±10.3	3904.0±1368.2	67.1±10.3	3948.5±1368.2
Frontenac	62.3±10.3	9282.3±1368.2	63.8±10.3	
Gamay	73.7±10.3	4950.1±1368.2	41.7±10.3	2671.3±1368.2
GG 9318	74.7±10.3	3867.1±1368.2	34.8±10.3	2065.8±1368.2
GG 9330	82.7±10.3	3935.4±1368.2	32.7±10.3	2400.2±1368.2
GG 9336	65.4±10.3	2781.9±1368.2	24.1±10.3	2175.8±1368.2
GG 9356	72.1±10.3	2580.3±1368.	45.3±10.3	2414.1±1368.2
H1 #249	152.8±10.3	10082.6±1368.2	60.9±10.3	4004.6±1368.2
H2 #211	99.1±10.3	3245.4±1368.2	53.8±10.3	2637.9±1368.2
H5 #125	86.2±10.3	4016.3±1368.2	45.7±10.3	3001.7±1368.2
Merlot	89.5±10.3	5673.9±1368.2	46.5±10.3	2450.2±1368.2
Montepulciano	91.7±10.3	7408.7±1368.2	32.9±10.3	2780.2±1368.2
Petit Verdot	201.2±10.3	14820.9±1368.2	67.1±10.3	4106.2±1368.2
Pinot Gris	68.5±10.3	6726.8±1368.2	24.0±10.3	2697.4±1368.2

Rubaiyat	121.4±10.3	7565.3±1368.2	60.8±10.3	6616.6±1368.2
Ruby Cabernet	53.4±10.3	4148.2±1368.2	27.3±10.3	3445.3±1368.2
Sangiovese	45.3±10.3	5206.8±1368.2	29.0±10.3	2108.3±1368.2
Sauvignon Blanc	33.7±10.3	2979.5±1368.2	24.2±10.3	2235.8±1368.2
Shiraz	30.5±10.3	4408.3±1368.2	28.7±10.3	2865.3±1368.2
Sun Belt	122.8±10.3	5662.6±1368.2	38.6±10.3	3851.5±1368.2
Traminette	44.4±10.3	2043.8±1368.2	23.5±10.3	2139.8±1368.2
Vignoles	75.3±10.3	4891.7±1368.2	53.2±10.3	5756.3±1368.2
Villard Blanc	49.4±10.3	3777.3±1368.2	23.0±10.3	3137.6±1368.2
Viognier	86.4±10.3	6169.4±1368.2	39.3±10.3	2674.5±1368.2
White Riesling	113.9±10.3	9924.1±1368.2	23.9±10.3	1089.4±1368.2
Zinfandel	143.4±10.3	10418.0±1368.2	31.2±10.3	3412.7±1368.2

Acknowledgements:

Collaborators for this project: Drs. Stephany Parker, Eric Stafne, Barbra Brown, Brenda Smith and graduate students Sandra Peterson and Wenjia Li. Funding for this research is provided by the Oklahoma Agricultural Experiment Station (Project # OKL 02653).

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Wine and Health

Moderation in Everything- David Tuggle MD FACS FCCM

"Eat the bread with joy and drink the wine with a merry heart." Ecclesiastes 9

Consuming wine in moderation daily will help people to die young as late as possible. ~ *Dr Philip Norrie*

Plato (427-347 BC) "Nothing more excellent or valuable than wine was ever granted by the Gods to man."

Galileo (1564-1642) "**Wine** is sunlight, held together by water."

Thomas Jefferson I think it is a great error to consider a heavy tax on wines as a tax on luxury. On the contrary, it is a tax on the health of our citizens.
I have lived temperately....I double the doctor's recommendation of a glass and a half of wine each day and even treble it with a friend.

Benjamin Franklin Good wine is a necessity of life for me. Wine is constant proof that God loves us and loves to see us happy.

Wine as a medicine (Hippocrates)
Wine was noted to be a medication as early as 3000 BC. This included wine alone, and as a solvent for herbs and minerals. Water impurity was rampant until the 1800's. Watered down wine was safer to drink than water itself due to the alcohol and acid normally found in the typical wine. In fact, it could be considered the first sports drink, since it contains calories, vitamins and minerals. In terms of calories, 1 gram of alcohol contains 7 calories, 1 gram of carbohydrate contains 4 cal, and 1 gram fat yields 9 cal. A glass of DRY wine has 80 cal. Sweet wine has more due calories due to increased sugar. So alcohol is a fuel that cannot be stored in the body. If you substitute Etoh for other foods you will have no weight gain, but when you add food to the alcohol you will gain weight.
In general, a 4 oz glass of wine=12 ounce beer (not 3.2)= shot (1.25 oz) whiskey in terms of alcohol calories. About 20% of Etoh is absorbed from the stomach, and 80% absorbed from the small intestine, with a small fraction absorbed through the lungs. Women metabolize alcohol slower than men due to reduced enzyme presence in stomach, compared to men. The average person will metabolize 1 drink per hour per 250 pounds of bodyweight. Wine is an excellent sanitizing liquid for household use.
Etoh- a rough formula for calculating blood alcohol is:

$$\text{Blood alcohol} = \frac{4 \times (\text{number of drinks})}{\text{weight (lbs)}}$$

Abraham Lincoln
"problems with alcohol relate not to the use of a bad thing, but to the abuse of a good thing."

The bad effects of too much ethanol have been well documented. Fetal alcohol syndrome, which takes 6 drinks a day to create the manifestations. Lead poisoning- do <u>not</u> store wine in crystal decanters, lead leaches out of the glass and has been found to cause lead toxicity, including death. Alcoholism- moderation is the key, and self control. Avoid alcohol with incompatible medications especially avoid TYLENOL (acetaminophen), this drug alone can cause liver damage. Aspirin and steroids plus alcohol may cause gastrointestinal bleeding. Don't wash down those medications with wine.

Wine Benefits-Politics

In the 1970s, the National Institutes of Health (i.e.-Federal Government) excluded and suppressed evidence from the Framingham Heart Study that showed moderate drinkers had 50 per cent fewer deaths from coronary disease than non-drinkers. More than 100 studies since 1991 have shown a decrease in death due to cardiovascular disease in light to moderate drinkers, especially wine. The French Paradox was featured on"60 minutes" in 1992. The French eat 30% more fat, ingest much more wine, and have 40% fewer deaths from heart attack, and this includes the fact that 40% of the French smoke vs. 28% of the US population that smokes. The downside of this study is that it ignored tea intake and water consumption, both of which are higher in France.

England, Denmark

Regular moderate consumption of wine has been associated with a lower mortality (55-78% lower) in these two countries. Binge or heavy drinkers had much higher heart disease. Abstainers had the highest incidence of heart disease.

The Kaiser Health Plan performed a 10 year study that looked at patients who had 1-2 drinks a day. Kaiser found a reduced death from cancer, heart disease, and lung disease in this group of patients

Alcohol or Chemicals?

Alcohol itself lowers LDL and increases HDL. Red wine has chemicals from skins that whites do not (catechin, quercetin, resveratrol) and thus are more likely to be of benefit. White wine does have protective benefits, most likely from modest ethanol ingestion. Antioxidants may be the protective chemical class in wine.

Whats the big deal?

There are more than 300 compounds in red wine, more than human plasma. The three that are most interest currently are catechin, quercetin, and resveratrol. These are also
polymeric flavenoids, polyphenols, and phytoestrogens. These are in reds because red wine is fermented with the skins. What are those chemicals doing? They are providing anti oxidants, an estrogen like effect, some anticoagulation (blood thinner), some Anti inflammatory effects, and if humans are like rats, perhaps some modest anti aging potential.

Resveratrol

This and similar chemicals are made in abundance in plants when they are stressed.
Production of this creates a survival mechanism for stressed plants to increase longevity, and increase anti-inflammatory mediators during times of drought or poor nutrition. Animals and plants share the same stress environment, thus they are protective in animals too. Resveratrol is specifically produced in the skins in response to fungal infections. The amount of resveratrol in wine depends on the grape, fungus level, and enological practices. The highest resveratrol levels are found in healthy grapes with low levels of Botrytis infection, not Botrytis infected grapes. In addition, maceration on the skins produced higher resveratrol levels in wine, especially pinot noir. Norton (Cynthiana) has also been found to have high levels of resveratrol in the skins.

Benefits?
Large population studies have shown a decrease in cardiac disease and lower peripheral vascular complications. A lower BP, decreased rates of cancer (gastric, esoph, colon, skin) have also been demonstrated. Other studies have shown that platelets are less sticky (like taking aspirin), and there are reductions in common cold symptoms.
Other less well documented benefits include less Alzheimer's, less dementia, fewer strokes, and possibly increased longevity. There may be a decrease in diabetes, reduced scarring from radiation therapy, and decreased gallstones.

Who should not?
The single group exception, whose members should ***not*** consume ***any*** alcohol, is pre-menopausal women with a family history of breast cancer. Also, if you do consume moderate wine amounts, make sure you get 600 mcg/day folic acid per day.

Conclusions-Harvard Public Health
For a pregnant woman and her unborn child, a recovering alcoholic, a person with liver disease, and people taking one or more medications that interact with alcohol, moderate drinking offers little benefit and potential risks.

For a 30-year-old man, the increased risk of alcohol-related accidents outweighs the possible heart-related benefits of moderate alcohol consumption.

For a 60-year-old man, a drink a day may offer protection against heart disease that is likely to outweigh potential harm (assuming he isn't prone to alcoholism).

For a 60-year-old woman, the benefit/risk calculations are trickier. More than ten times as many women die each year from heart disease than breast cancer - more than 500,000 women a year from cardiovascular disease compared with 41,000 a year from breast cancer.
Conclusions
More than 400 studies show benefits from wine drinking.
More than 100 studies show cardiovascular benefits from wine drinking.
There is some data that modest alcohol ingestion does provide some of the beneficial effects.
Fermentation on skins provides some beneficial effect. Beer may be as beneficial but is far and away the greatest cause of drunk driving deaths. Wine and beer are likely better than spirits for your health.

Grape Phylloxera, Green June Beetle and Grape Root Borer Studies

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Grape Phylloxera:
The grape phylloxera (GP) is native to North America and native grapes have resistance to them; however, European-American hybrid wine grape varieties being grown in North America are susceptible to both foliar and root forms of GP. On these susceptible varieties, the root feeding wounds of the phylloxera let pathogenic fungi into the roots causing root death and eventually vine death (Granett et al. 2001). The magnitude of this problem was first seen in the 1860's in France where the insect nearly wiped out the wine industry of the entire country. The eventual solution to the declining vineyards of Europe was to graft the susceptible vines onto resistant rootstock (Ordish 1987). This is still the most effective form of control for the root form of grape phylloxera. For the foliar form some insecticides such as Danitol (fenpropathrin), Admire (imidacloprid), Actara (thiamethoxam), and Assail (acetamiprid) are available.

In a typical year for AR, by mid-April, over wintered GP eggs hatch, crawlers walk to terminal leaves and begin to feed on expanding leaves causing gall formation. By late-April, vines of susceptible cultivars will have several shoots per vine with one or two leaves each with one or two galls. In 2006, these early crawlers matured into fundatrix females (stem mothers) that produce second generation crawlers with peak emergence on 11 May (600 DD). These crawlers matured and produced third generation crawlers with peak emergence on 30 June (1600 DD). At that time, untreated vines averaged 10 and 15 GP-galled shoots per vine on 16 June and 24 July, respectively. In comparison, 2007 was an atypical year due to freezes on 7-8 April. By mid-June 2007 we found less than one GP-galled shoot per vine in 'Vignoles' vineyards in Altus, AR and Purdy, MO. This was, therefore, a great season to study GP biology.

In 2007 several types of sticky traps were used to monitor weekly changes in the number of crawlers on the canes and trunk, emerging from the soil from roots and flight of winged adults. Galled leaves usually appear by late April but in 2007 we did not find GP galls until early July. The very low season total trap catches were attributed to low grape phylloxera population densities after the freeze on 7-8 April (Table 1). Sticky tapes on canes in Altus, AR captured a mean of 5.1 crawlers per cm of tape all season (Table 1) with first crawlers by 18 June or 1553 DD (base 50° F) and the next generation peaked by 2 August or 2831 DD (Fig. 1). In Purdy, MO tapes on canes caught a mean of 6.9 crawlers per cm of tape all season (Table 1) with first catch by 26 June or 1600 DD and the next generation peaked by 31 July or 2526 DD (Fig. 2). The trunk sticky tape traps caught a mean of 11.4 crawlers per cm tape (Table 1) and mirrored the cane tapes in timing of crawler catches from 13 June to 22 August at Altus, AR (Fig. 3). In comparison, a mean of 0.1 crawlers per cm of tape (Table 1) were captured on the trunk tapes from 14 August to 19 September in Purdy, MO (Fig. 4). The ground emergence sticky traps near grapevines had a large catch of crawlers from the soil by 12 July (2223 DD) in Altus from before 5 July and on 9 August and 26 October (Fig. 3) and by 4 September (3522 DD) in Purdy, MO on 26 August (Fig. 4). The cane traps and aerial traps (Fig. 1 and 2) captured winged adults on 16 August and from 4 September to 8 October, peaking in late September, in Altus, AR and from 7 August to 4 October, peaking on 4 September, in Purdy, MO.

These preliminary studies indicate that: sticky tape traps on canes and tape traps on trunks could be used to monitor crawler activity to aid timing of bloom insecticide sprays or late September sprays against GP laying overwintering eggs to reduce next season population. Ground emergence traps detected crawlers emerging from the soil from mid-July through August. Cane tapes and aerial traps did well in detecting flight of winged adults from early-August to October. Trunk sticky tapes captured crawlers but not winged adults.

Green June Beetle:
The green June beetle (GJB) is a native of North America. It is large, about 1 to 1-½ " long. The grubs feed on decaying organic matter until pupation, form a soil cell, and then emerge shortly after a soil moistening rain in late June or July. Adults prefer to feed on ripening fruit.

Various odor mixtures were tested as trap baits for relative attractiveness to GJB adults. We collaborated on studies of bait mixtures and insecticide efficacy with Dr. Maciej Pszczolkowski (Missouri State University, State Fruit Experiment Station, Mt. Grove, MO). In Purdy, MO we set out modified Japanese beetle yellow traps to funnel GJB adults into a clear 3-gal. plastic storage box. Traps were hung at 3 ft height, spaced 60 ft apart in transect parallel to but 100 ft to the west of a 'Seyval' grape block infested with GJB. Mix-M and 91% isopropyl alcohol baits attracted 1,090 and 1,069 GJB, respectively, compared to only 691 GJB attracted to 50% isopropyl alcohol. These same 12 traps captured a season total of 41,669 GJB adults in Purdy, MO. In Fayetteville, AR we were trying a number of bait mixtures and captured a total of 9,122 GJB from 16 traps. These bait mixtures require further field testing to determine the potential of each for mass trapping GJB adults and preventing fruit damage.

There are few insecticides known to work well against GJB on grapes. Sevin (carbaryl) is the only compound registered for GJB on grape and was used as a standard for the following efficacy experiment. The efficacy of four synthetic insecticides, Actara (thiamethoxam), Assail (acetamiprid), Danitol (fenpropathrin), and Sevin (carbaryl) were compared to that of four organic insecticides, Beetle Beater (*Bt* susp. *tenebrionis*), Rotenone + Pyrethrin, Aza-Direct (azadirachtin), and Pyrethrin + piperonyl butoxide (PB). Ten GJBs fed insecticide treated grapes or untreated grapes (check). For the synthetic insecticides, Danitol worked the best with 100 % mortality in 72 hrs. Assail and Actara were the next best with 85 % control in 72 hrs. Sevin was the least effective of the synthetic insecticides with 47.5 % control in 72 hrs. For the organic insecticides *Bt* subsp. *tenebrionis* had 45 % control and rotenone + pyrethrin had 40 % control in 72 hrs. Aza-Direct and pyrethrin + PBO were not significantly different from the untreated check. When GJB adults were dipped in insecticide solution, >95% of GJB adults were killed with ¼ the recommended rate of Danitol, ½ the recommended rate of Sevin, and 4 times the recommended rate of Actara.

Grape Root Borer:
The grape root borer (GRB) has a 2 year life cycle. Root feeding slowly reduces vine vigor and may kill vine. The larvae feed inside the main roots and then pupate in the soil near the surface. During the day, adults emerge from mid June to late August, mate and lay 40 eggs individually on grape leaves.

Before grape root borer flight began in June 2007, we set out a GRB mass trapping experiment in four vineyards (Crown Valley and Stone Hill, MO; Hindsville and Bethel Heights, AR). We tied one GRB sex pheromone green bucket trap to the top trellis wire per acre in each of four 15 to 16 acre blocks. We placed inside each trap a Vaportape dichlorvos insecticidal strip (Hercon Environmental) to cause rapid insect knockdown, prevent escape and make GRB identification and counting easier. The Trece

GRB sex pheromone lures were replaced in late July. Trap counts and GRB pupal skin counts (600 vines per treated block or 100 vines per check block in St. James) were recorded in July and August or early September. Some of the season total trap counts in 2007 were fairly high but overall < 6% of the grapevines were infested with GRB as noted by the low number of GRB pupal skins counted. This study will be continued for several more years.

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Table 1. Season catch of grape phylloxera crawlers (GP) or winged adults in Altus, AR and Purdy, MO in 2007

Vineyard location or Sticky trap type	No. crawlers per cm tape	No. winged adults
Altus, AR		
Ground*	21.3	--
Trunk	11.4	0.8
Cane	5.1	0.8
Aerial	0	7.1
Purdy, MO		
Ground*	3.6	--
Trunk	0.7	0.1
Cane	6.9	0.8
Aerial	3.4	14.3

* Number of crawlers on 4” x 8” sticky board

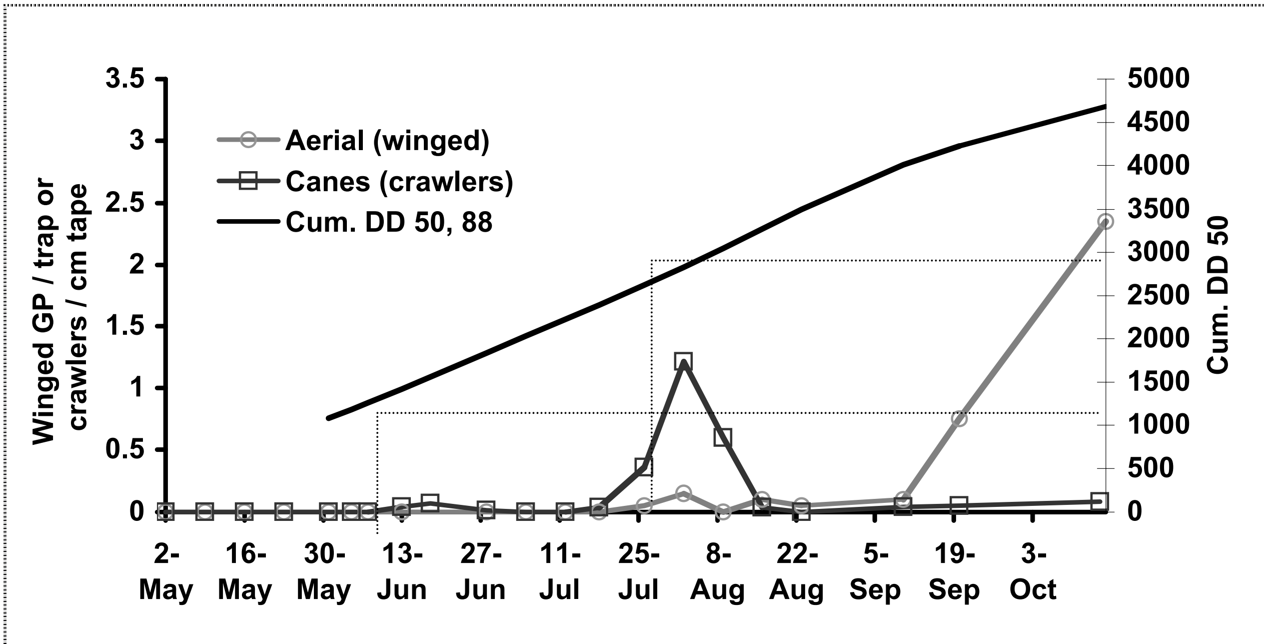

Figure 1. Seasonal counts of grape phylloxera (GP) crawlers on grape cane tape traps and winged adults on aerial sticky traps relative to daily degree-days accumulated since 21 March (DD, base 50° F) in Altus, AR (2007)

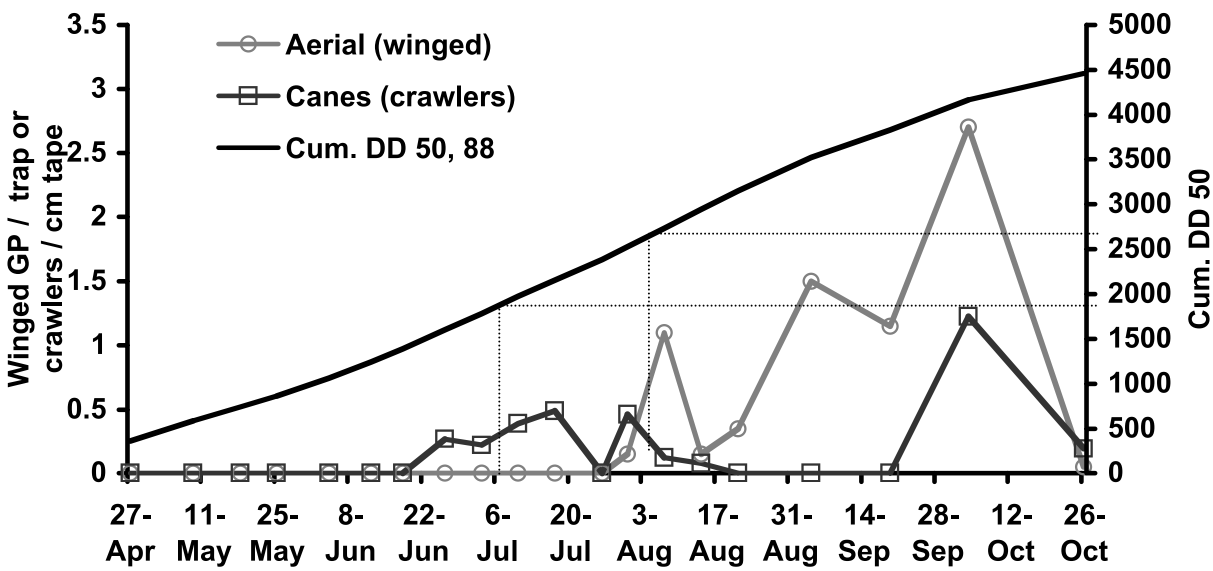

Figure 2. Seasonal counts of grape phylloxera (GP) crawlers on grape cane tape traps and winged adults on aerial sticky traps relative to daily degree-days accumulated since 21 March (DD, base 50° F) in Purdy, MO (2007)

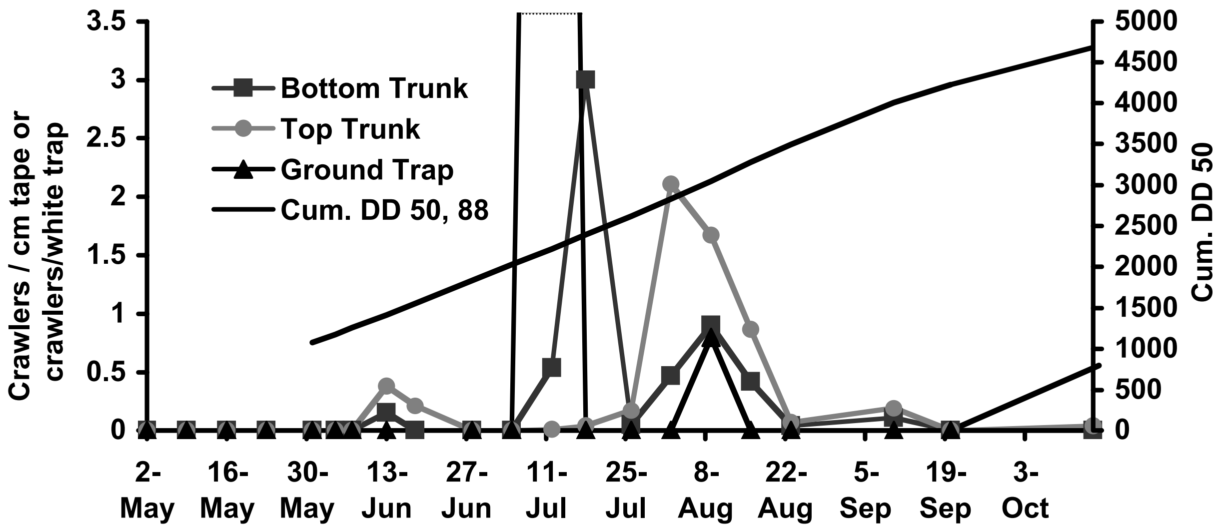

Figure 3. Seasonal counts of grape phylloxera (GP) crawlers on grape trunk tape traps and ground sticky traps relative to daily degree-days accumulated since 21 March (DD, base 50° F) in Altus, AR (2007)

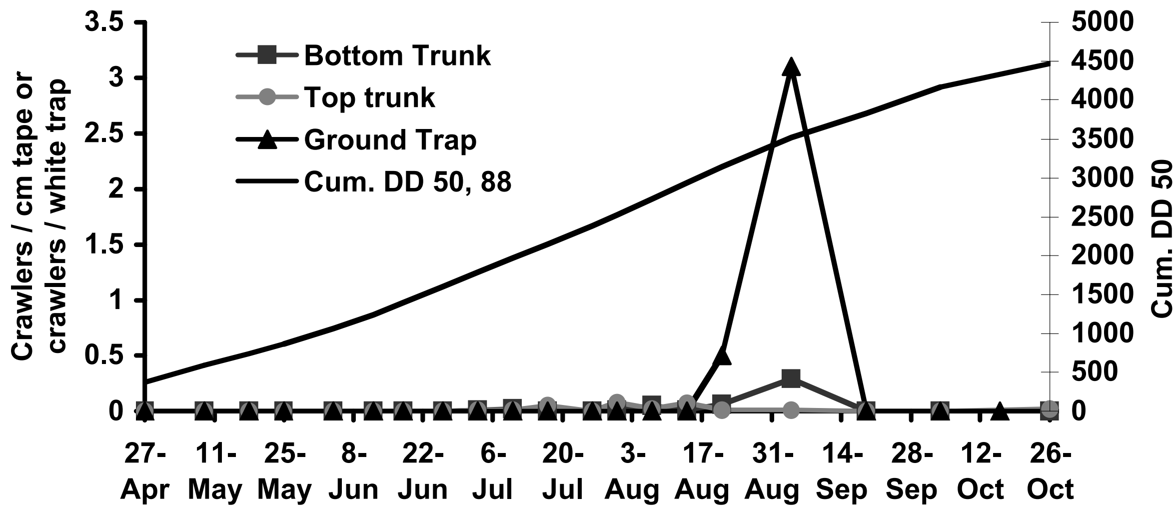

Figure 4. Seasonal counts of grape phylloxera (GP) crawlers on grape trunk tape traps and ground sticky traps relative to daily degree-days accumulated since 21 March (DD, base 50° F) in Purdy, MO (2007)

Management of Grape Diseases in Oklahoma: Considering the Plants, Pathogens, and Environment

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Damon is a native of Western New York and was raised in the heart of the Finger Lakes Region. Throughout his high school career he was actively involved in the Boy Scouts of America and achieved the Rank of Eagle Scout. After graduating from high school he attended the State University of New York at Geneseo (SUNY Geneseo). At SUNY Geneseo Damon concentrated his efforts in the study of plant sciences while he conducted undergraduate research entitled “Effects of Light Emitting Diodes (LED) on Plant Growth.” In May of 2001 he graduated with a Bachelor of Science Degree in Biology. In August of 2001 he accepted a graduate research assistantship from the Department of Plant Pathology at North Carolina State University under the direction of Dr. Barbara Shew. Damon obtained his Master of Science degree in Plant Pathology in the spring of 2004. The title of his thesis was “Biology and Epidemiology of *Sclerotinia minor* on Peanut (*Arachis hypogaea* L.). He began his Doctoral degree program at NC State University in August of 2004 under the direction of Dr. Barbara Shew and Dr. Turner Sutton. His research was focused on improving the management of Sclerotinia blight of peanut by the development of regression-based disease advisories, fungicide spray programs, and pathogen detection methods. He completed his Doctoral research program in August of 2007. Damon is currently an assistant professor and state extension specialist of plant pathology in the Department of Entomology and Plant Pathology at Oklahoma State University. He has extension and research responsibilities for turf, ornamental, and horticultural crops. His extension efforts focus on generating, evaluating, and disseminating solutions to many of the disease problems associated with those commodities, while his research efforts focus on the biology, epidemiology, and management of diseases of turfgrass, grape, pecan and ornamental crops.

In the State of Oklahoma grape production has become a lucrative alternative to conventional row crop farms. In 2001, only four wineries were licensed in Oklahoma. In 2007, this number has approached 50. There are over 500 acres of grapes grown in Oklahoma, however, the demand for Oklahoma-grown grapes by wineries in Oklahoma is greater than the vineyards can supply. The expansion of vineyards in Oklahoma is currently limited by the lack of information about cultivars that perform well in the state and by insects and disease pressure. Currently, nearly 80% of Oklahoma’s grape crop is comprised of well known European cultivars and hybrids derived from *Vitis vinifera* including ‘Chardonnay’, ‘Cabernet Sauvignon’, ‘Merlot’, ‘Zinfandel’, ‘Vignoles’, and ‘Chambourcin’. Most of these cultivars are also highly susceptible to Black rot (a foliar and fruit disease caused by the fungus *Guignardia bidwellii*) the most serious grape disease in Oklahoma and the Southern United States. Other diseases such as crown gall, powdery mildew, downy mildew, Botrytis bunch rot, and Phomopsis leaf and cane spot can also be of concern in Oklahoma.

Plant disease management strategies should be based on sound plant pathological principles. The plant disease triangle concept is one of the most fundamental principles of plant pathology and can be a useful tool for any disease management practitioner when developing a control strategy. The disease triangle concept states that plant disease will occur if and only if the three components of the triangle are fulfilled at the same time. The three components of the triangle are as follows: the presence of a susceptible host plant; a pathogen (e.g. fungus) able to contact the host; and environmental conditions that favor disease development either by being favorable for growth of the pathogen and/or by inducing stress in the host. If any one of these components are missing, plant disease will not occur. Therefore, by focusing efforts on one or several components of the triangle, a practitioner can develop a simple and sound disease management plan.

Efforts focused on the host component of the triangle include selecting resistant cultivars, preventing stress in the host by carefully choosing the planting site, and developing a stress management plan that includes careful attention to nutrient and water requirements of the host. Efforts to modify the environmental component have focused on proper planting site, and adequate canopy management. By promoting good airflow in the canopy and increased sun exposure, disease causing canopy humidity and moisture can be reduced. Pathogen directed efforts can include exclusion, sanitation, or protection of the host from the pathogen. The latter management strategy involves the application of pesticides (usually fungicides).

Fungicides come in two types, protectants or systemics. Protectants will simply provide protection against new infections, while systemic fungicides can slow or stop infections in their very early stages, in addition to their protectant activity. Typically protectant fungicides will have residual mobility, meaning that the fungicides will adhere only to the parts they are applied and stay only on those parts. This type of fungicide will not be translocated to other parts of the plant or to new parts of the plant. Protectants can be washed from plant tissue if substantial rain events occur. New plant growth after the application of the protectant fungicide will also be unprotected. Systemic fungicides have the capability to be translocated to other parts of the plant. If given adequate time for absorption into plant tissue, systemic fungicides are resistant from washing off plant tissue. Depending on the fungicide type and mobility, the time of use can be classified as prophylactic or eradicant. Because of the diversity of modern fungicides available to grape growers, care should be taken in choosing the proper compound. The target pathogen, the disease cycle and the prevailing weather conditions should be considered before a fungicide is chosen.

Regardless of the type or mobility of a fungicide, no pesticide will ‘heal’ existing lesions. Practitioners should always strive to develop a proactive fungicide application plan for several reasons. Lesion development is continuous for many pathogens when environmental conditions are favorable for disease. While symptoms my not be visibly present, the pathogen may have already infected resulting in an incubating lesion. In this situation, protectant fungicides will be rendered useless. Furthermore, if infections have already occurred, the window of opportunity for systemic fungicide applications can be small (3-4 days) or nonexistent for many fungicides. Application of fungicide within the window of opportunity may not be possible due to weather conditions that are not conducive for spraying over extended periods of time.

Black rot or grape is caused by the fungus *Guignardia bidwellii*. The disease manifests itself on leaves initially, followed by secondary infections of fruit. Most loss is a result of direct destruction of the fruit by the fungus. Genetic resistance is the easiest and most economical method of disease management for this disease. Most *Vitis vinifera* grapes are highly susceptible to *G. bidwellii.* However, fungicides are available for managing the disease. Fungicides should be used when weather is, or predicted to be, favorable for the pathogen. The most critical time for application of fungicides is just prior to bloom until at least 4-to-6 weeks post-bloom. Once veraison is initiated, natural ontogenic resistance in the fruit exists and fungicides are not required. Proper canopy management and sanitation, including removal of mummies from the canopy and cultivation or burial of debris can limit damage caused by the black rot fungus.

Uncinula necator is the fungus that causes powdery mildew of grape. Periods of no rain and high relative humidity, combined with moderate temperatures are most favorable for growth of the fungus. Genetic host resistance is the easiest and most economical method of managing this disease. As with *G. bidwellii,* most *V. vinifera* grapes are susceptible to *U. necator.* Fungicides are available for managing the disease. Programs should be initiated at bud break and continue to harvest. Growers should be especially diligent about maintaining a sound powdery mildew fungicide program during periods when weather is favorable for growth of the pathogen.

Crown gall of grape is caused by several species of *Agrobacterium*. *A. vitis* is the bacterium most associated with crown gall of grape. However, *A. tumefaciens* has also been isolated from galls on grape. Vines that are wounded by mechanical injury or freeze damage are most prone to infection. Most *V. vinifera* cultivars are susceptible to infection by *A. vitis.* Many American cultivars and hybrids have some genetic resistance to the pathogen. Cultural practices that result in limiting mechanical and freeze injury have proven useful for managing this disease. No chemical or biological control methods have resulted in adequate control of grape crown gall.

Pruning and Thinning for Crop Control in Oklahoma Vineyards

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Chris Lake is the viticulturist for Stone Bluff Cellars. Stone Bluff Cellars is one of Oklahoma's oldest and largest wineries. Established in 2000, the winery produces award winning wine from premium quality, regionally grown fruit. The winery's estate vineyards are comprised of *Vitis vinifera* L., hybrid and American wine grape cultivars. The oldest block of vines was planted in 1997 and the youngest vines were planted in 2003. Sustainable yields of high quality fruit have been maintained through a combination of factors including: site selection, appropriate cultivars, adequate nutrition, supplemental irrigation and use of pruning and thinning for crop control.

Pruning and thinning are important management tools that are useful in achieving and maintaining vineyard productivity. Pruning grapevines is an ancient practice. There is some evidence of vineyard management contracts dictating methods and timing of pruning that date back to the beginning of the Christian era. Traditional pruning regimes remove 85-95% of the previous season's growth and retain only a limited number of fruitful nodes that will produce an average size crop capable of ripening during a normal growing season. Appropriate pruning practices can vary from vine to vine, within and between vineyard blocks and even from one region to another. While experience seems to be the best teacher of pruning technique (the evidence of a good pruning job is presented at the end of the growing season), there are fundamental principals of pruning to guide growers in evaluating and improving their current pruning practices.

A review of pruning and thinning terms and purposes is appropriate to this discussion. Pruning removes and vegetative part of a vine. The primary purposes are to control crop load, arrange fruit bearing units and maintain the form of a plant. It is the least expensive method of crop control. Thinning is the removal of flower clusters, immature clusters or cluster bearing shoots. Thinning allows for a delay in setting ultimate crop load and makes possible the maximization of crop without reduction in fruit quality. Physiologically, pruning depresses vine growth while thinning allows the vine attain maximum vegetative and reproductive growth (Winkler, 1931).

For wine grape growers in Oklahoma, timing and methods of pruning and/or thinning will vary by cultivar, location, training system and winery requirements. Timing of pruning can occur anytime between leaf fall and advanced budburst. Small acreages can delay pruning until late winter thereby providing some protection from pruning wound pathogens. Scheduling can be flexible and the labor requirement can be minimized by starting early with fewer workers. Thinning must occur within a short time frame and at a specific growth stage. Labor requirements are high, involve skilled workers and are of short duration. Thinning is commonly performed as cluster thinning and accomplished at or just after fruit set. Pruning and thinning are commonly accomplished by hand but both have been successfully mechanized. Mechanized pruning and thinning may provide options for crop control on acreages large enough to justify the capital investment.

The largest influence on choice of pruning and/or thinning practices is economics. Pruning as the sole means of crop control requires the least amount of labor. Recent cost estimates for a professional crew is $750/ac to prune with a speed of 2 acres per day (Chris Lake, personal communication). Pruning and thinning combined will greatly increase the cost of crop control. Thinning operations are estimated to cost $125/ac and proceed at 0.5 ac per day (Noguera et al., 2005). Justification for the added expense comes from the added protection against crop loss from late spring frost and the potential increase in fruit quality associated with fruit thinning. As growers in this region develop management techniques to minimize the effects of unpredictable seasonal variations the combination of pruning and thinning should be considered as a useful tool for maximizing production in a sustainable manner

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Origins of Interspecific Hybrid Winegrapes

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Introduction to Grapes

Grapes are in the Vitaceae family which consists of 11 genera and 600 species, including the most commercially important genus, *Vitis*. *Vitis* is the only food-bearing genus in the family and has two subgenera: Euvitis and Muscadinia. All bunch grapes are in the Euvitis subgenus of which *Vitis vinifera* is the most important species. *V. vinifera* originated in the Caspian Sea region and there have been more than 5000 named cultivars. The range in which *V. vinifera* can be successfully cultivated is limited by climatic factors. This species requires a long growing season, relatively high summer temperatures, low humidity, a rain-free harvest period, and mild winter temperatures. It is most often used for wine, but these grapes can also be used to produce juice, raisins, canned good, rootstocks, or for fresh consumption.

Other Important Grape Species

There are also other important grape species that have been utilized in the creation of interspecific hybrids. These species are from North America, and the most well-known is *V. labrusca*. *V. labrusca* (also called *V. labruscana*) is commonly called the Fox Grape. The most famous cultivars from this species are 'Concord', 'Niagara', and 'Isabella'. It has large berries, small clusters, fair pest resistance, and a distinctive and strong flavor. The Riverbank Grape is *V. riparia*. Several cultivars have this species in their lineage, such as 'Beta', 'Clinton', 'Baco Noir', 'Marechal Foch', and rootstocks 3309C, 5BBK, and SO4. It has small berries and small clusters with wide variation in ripening time and cold hardiness levels. It is vigorous, roots easily (which makes it attractive to use as a rootstock), and has fair to good pest resistance. The Summer Grape is *V. aestivalis*, which is mainly known for the cultivar Cynthiana (also called Norton). It has small to medium berries with medium to large, open clusters, and fair pest resistance. One of the issues with this grape is its tendency toward high sugar and high acid, thus rendering wine-making a challenge. *V. rupestris* is commonly known as the Sand Grape. Cultivars using this species are 'St. George' and the rootstock AxR1. It has small berries, small to medium clusters, and has a very "wild" taste. The plant is vigorous and roots easily while having good pest resistance. Another important species is *V. lincecumii*, the Post Oak Grape. This species is native to Oklahoma and surrounding states. Many cultivars have this species in their background, including 'Bailey', 'Beacon', 'Ellen Scott', 'Marguerite', and 'Rubaiyat'. It has medium to large berries with small to medium clusters and a distinctive "wild" taste, but different from *V. labrusca*. It also has fair pest resistance. This species was hailed by T.V. Munson as being especially important for creating hybrid grape cultivars.

Hybrid Grape Origins

The creation of interspecific hybrid grapes primarily came about because of problems encountered in France in the 1860s. A devastating phylloxera outbreak began there in 1860 and in the next 20 years about 90% of French vineyards were destroyed. To combat this epidemic, cultivars derived from American species were planted. At one time over 25,000 acres of 'Noah' was planted in France. 'Clinton', 'Othello', 'Lenoir', 'Isabella', and 'Herbemont' were also planted. 'Concord', 'Catawba', and 'Delaware' were tried but had low resistance to phylloxera. These species also brought with them new disease problems like downy mildew and black rot. In 1876, it was found that *V. vinifera* cultivars could be grafted onto American grapes successfully. The discovery helped transition back to *V. vinifera* grapes, but diseases were also a problem. In 1885, Bordeaux mixture was discovered as a broad spectrum fungicide to help alleviate the disease problems.

French hyrids originally started as breeding for rootstocks on which to place *V. vinifera* grapes. Amateur grape breeders pushed the breeding process forward to look for vines with roots resistant to phylloxera, foliage resistant to fungal pathogens, and fruit that could produce wines more similar to *V. vinifera* types. The first stage of breeding for hybrids used crosses of American cultivars or rootstock with *V. vinifera* cultivars. This stage of breeding produced some cultivars such as 'Baco noir' and 'Baco blanc'. Some of the important American types used in the breeding process were 'Noah' and Jaeger 70. The *V. vinifera* cultivars used included 'Folle Blanche', 'Aramon', 'Clairette', and 'Cinsaut'. The second wave of breeding for interspecific hybrids used crosses between hybrids gained from the first stage. Some of the influential breeders of this time period were Seibel, Bertille Seyve, Joanes Seyve, Galibert, and Landot. The third stage of hybrid breeding led to the modern hyrid grapes commonly grown today. These were usually crosses of hybrids from the second stage with *V. vinifera* grapes to gain superior wine quality. However, with the elevation of wine quality came the dilution of pest resistance. There are several breeding programs now involved around the world in creating high quality hybrid grapes. Some of the programs in the United States are in New York, Arkansas, California, Florida, Mississippi, Georgia, North Carolina, and Missouri.

Commercial Hybrid Grapes
There are many high quality hybrid grape cultivars available. Some examples follow:

'Chambourcin' (true parentage unknown), high yielding, moderately cold hardy, vigorous, disease resistant, also grown in France and Australia.

'Chardonel' (Seyval Blanc x Chardonnay), highly productive, moderately cold hardy, makes a wine very similar to 'Chardonnay', patented.

'Frontenac' (*V. riparia* x Landot 4511), vigorous and productive, very cold hardy, very resistant to diseases, must limit skin exposure in wine making, needs malolactic fermentation.

'Marechal Foch' (includes *V. riparia*, V. rupestris, and V. vinifera), a sibling of 'Leon Millot', vigorous, early ripening, good winter hardiness, early budbreak, fruitful secondary buds.

'Rubaiyat' (Seibel 5437 x Bailey), developed at Oklahoma State University, medium vigor, medium cluster size, large berry size, disease resistant, cold hardy, useful as a teinturier (add color in blends).

'Traminette' (J.S. 23.416 x Gewurztraminer), similar wine character to 'Gewurztraminer', good disease resistance, decent winter hardiness, large clusters, good yields.

'Vignoles' (unknown), cold hardy, moderate vigor and productivity, compact clusters, susceptible to bunch rots, makes a fruity, sweet wine.

Final Comments

Hybrid grapes make good substitutes in areas where *V. vinifera* grapes are marginally adapted or not adapted. The modern hybrid grapes produce high quality wines that do not include “off” flavors that are characteristic of some older hybrids. Rombough (2002) stated that hybrid grapes can be as successful as *V. vinifera* grapes. He wrote:

> “The question is one of marketing, and nothing else. Most wineries make their money from the walk-in trade. And each and every walker-in is amenable to hand-selling…it doesn’t matter what name is on the label, so long as there is quality in the bottle.”

Quality is an important aspect to consider. Adaptation is very important when deciding what type of grapes to grow. Just because *V. vinifera* cultivars like ‘Pinot noir’ or ‘Zinfandel’ make exceptional wines elsewhere does not necessarily mean they will make good wines in Oklahoma.

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