IOWA: VITICULTURE (GRAPE) 101
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ISU Extension
12-2-04 Integrated Crop Management Conference

IOWA HISTORY

Iowa has a rich and long history of grape production. Grapes were grown in the Council Bluffs area as early as 1857. In 1900 the US Agriculture Census showed that Iowa produced 7,403,900 pounds of grapes and 76,301 gallons of farm-processed wine. Iowa ranked sixth in grape production in 1919 in the United States with more that 12 million pounds. Iowa grape production peaked in 1929 with a yield of 15.8 million pounds. The 1997 Census of Agriculture listed only 56,536 pounds of grapes harvested.

Many agree that the downfall of the Iowa grape industry came about because of three major events. First was Prohibition from 1919 to 1933. Second and arguably the most important was the use of highly volatile 2,4-D on corn starting in 1944. By 1954, no vineyard in the state was free of 2,4-D injury. The final blow came on November 11th, 1940. The Armistice Day Blizzard killed most orchards and vineyards in the state. Then, during the winter of 1999/2000 Ron Mark of Summerset Winery in Indianola, Bill Brown of Timber Hill Winery in Leon, and Paul Tabor of Tabor Family Winery at Baldwin held three wine grape informational meetings across the state at three locations. These meetings planted the seed. There were only 2 native wineries and approximately five wine-grape vineyards in Iowa in 1999. Today there are 32 licensed wineries and 230+ wine grape vineyards in the state encompassing 500+ acres.

ISU Extension map displayed at 2004 Farm Progress show.
SIGNIFICANT EVENTS OVER THE PAST FOUR YEARS

1/2000 Iowa Grape Growers Association formed and have own website at: <http://www.iowawinegrowers.com>
2/2000 Iowa Wine & Grape Advisory Commission established by Iowa Dept. of Agriculture and Land Stewardship.
2/2001 First Iowa Grape Growers Annual meeting – approximately 200 in attendance.
4/2001 ISU establishes Viticulture homepage: <http://viticulture.hort.iastate.edu/home.html>
5/2001 Governor Vilsack signs enabling legislation to give up to $75,000/year for grape/wine promotion.
8/2001 Iowa Grape Growers reach 100th member level.
4/2002 Iowa Grape Growers reach 200th member level
5/2002 ISU Extension assigns Mike White as an 1/2 time viticulture specialist.
8/2002 Golden Hills RC&D in Oakland hires Eli Bergmeier as a Viticulture Technician.
11/20/03 "Two Rivers Grape & Wine Cooperative" registered with the state of Iowa.
7/2003 Approx. 2.9 mm gallons of wine purchased in Iowa. Approx. 76,000 gallons of this was produced by Iowa wineries - 2.4% market share.
1/2004 250 people attend 3rd annual Iowa Grape Growers Conference (IGGA).
1/2004 IGGA changes name to Iowa Wine Growers Association.

Of the 32 bonded wineries in Iowa, about 20 of these would be considered native wineries. Native wineries normally have a vineyard and/or orchard on their premise and/or use locally produced fruit for their wine. There are another dozen or so wineries in Iowa in the early planning and construction stages. Approximately 76,000 gallons of Iowa produced wine was sold in Iowa in 2003. Approximately 33,000 gallons were produced and sold through wineries outside of the Amana Colonies. It would take 73 acres of grapes yielding 3 tons per acre to provide enough juice for 33,000 gallons of wine.

NATIONAL GRAPE & WINE INDUSTRY

Since the 1970’s the U.S. adult per capita consumption of wine has grown from 1.3 gallons to 2.7 gallons. A core group of 10% of the U.S. adult population consumes 86% of the wine according to the Wine Market Research Council in 2002. This same study showed that a marginal group of 15% of the adult U.S. population is consuming the remaining 14% of the wine. The Wine Institute reported in April of 2004 that domestic wine sales grew 5% to a record 627 gallons in 2003. This represents $21.6 billion in sales. Of this 627 million gallons, table wine represents 558 million gallons (89%), dessert wine 41 million gallons (6.5%) and champagne/sparkling wine 28 million gallons (4.5%). Table wine sales in super markets grew 1.6% in value and 2.8% in volume in 2003 according to the AC Nielsen Beverage Alcohol Team which tracks laser scanning data in 3000 supermarkets and other large volume outlets. California controls 90% of the domestic wine market share and 67% of the all wines consumed in the U.S. California’s domination of the U.S. wine industry stands out in the following table.

### U.S. Wine Production by State

(US Census Bureau & National Agricultural Statistics 2003 Data)

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Wineries</th>
<th>State Production in Gallons</th>
<th>State</th>
<th>Number of Wineries</th>
<th>State Production in Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>900/63%</td>
<td>466 mm</td>
<td>CO</td>
<td>48/2.0%</td>
<td>133 m</td>
</tr>
<tr>
<td>WA</td>
<td>250/11%</td>
<td>12 mm</td>
<td>MO</td>
<td>47/1.9%</td>
<td>775 m</td>
</tr>
</tbody>
</table>
Wine consumption varies greatly by state and region. A strong trend line exists between wine consumption, age, education and income in the U.S. The core group of wine consumers mentioned above are typically 40-59 years old, highly educated and have an annual income of $78,000. The marginal group is slightly younger, 30-49 years old, highly educated and have an average annual income of $63,800 per year. Both the core and marginal groups are poised to grow. Most predict U.S. wine consumption to increase.

Midwest Wine Consumption Comparison
(The U.S. Census Bureau and the Wine Institute)

<table>
<thead>
<tr>
<th>Top Wine Consuming States</th>
<th>Midwest Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>Total Volume</td>
</tr>
<tr>
<td>CA</td>
<td>90.6 mm gal.</td>
</tr>
<tr>
<td>NY</td>
<td>42.8 mm gal.</td>
</tr>
<tr>
<td>FL</td>
<td>37.2 mm gal.</td>
</tr>
<tr>
<td>TX</td>
<td>27.4 mm gal.</td>
</tr>
<tr>
<td>NJ</td>
<td>23.6 mm gal.</td>
</tr>
<tr>
<td>WA</td>
<td>15.4 mm gal.</td>
</tr>
</tbody>
</table>

WORLD GRAPE & WINE INDUSTRY

In an April 2003 report, The Wine Council showed U.S. wine exports up in 2003 to a all time high of 95.9 million gallons ($643mm). A 23% volume increase over the 77.7 million gallons exported in 2000. U.S. wine exports amounted to only 7.3 mm gallons in 1986. According to the Wine Institute, total worldwide grape acreage increased 2.5% from 1997 to 2001 to 19.6 million acres. Worldwide wine production from 1997 to 2001 increased 2% to 5.87 billion gallons. The U.S. is ranked within the top six wine producing countries as shown below.

2001 Top Six Wine Producing Countries
(The Wine Institute 2001 Data)

1. France  1.23 billion gallons  4. U.S.  485 million gallons
2. Italy   1.17 billion gallons  5. Argentina  366 “  “

The U.S. does not rank nearly as high when it comes to wine consumption among our population. The U.S. ranked 35th at 1.93 gallons of wine consumed per capita in 2001. Here are the top eight wine consuming countries.
### 2001 Top Eight Wine Consuming Countries
(The Wine Institute 2001 Data – Per Capita Consumption/Year)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Consumption/Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Luxembourg</td>
<td>13.02 gallons</td>
</tr>
<tr>
<td>2.</td>
<td>France</td>
<td>12.58 “</td>
</tr>
<tr>
<td>3.</td>
<td>Italy</td>
<td>11.64 “</td>
</tr>
<tr>
<td>4.</td>
<td>Portugal</td>
<td>10.91 “</td>
</tr>
<tr>
<td>5.</td>
<td>Croatia</td>
<td>10.39 gallons</td>
</tr>
<tr>
<td>6.</td>
<td>Switzerland</td>
<td>8.97 “</td>
</tr>
<tr>
<td>7.</td>
<td>Spain</td>
<td>7.6 “</td>
</tr>
<tr>
<td>8.</td>
<td>Argentina</td>
<td>7.17 “</td>
</tr>
</tbody>
</table>

### ECONOMIC IMPACT OF THE NATIVE WINE INDUSTRY

A 2003 Federal State Marketing Improvement Project (FSMIP) study completed for the Missouri Wine Industry, “Missouri Wineries: Present Status and Future Scenarios” clearly pointed out the benefits of having a strong rural native winery industry. At the time of the study, Missouri’s 47 wineries created the following economic impact.

- a. 259+ Missouri jobs with over $7 million wages.
- b. $25+ million in economic output.
- c. 0.66 jobs created elsewhere for each person employed in wine industry.
- d. Each $1 spent at a winery stimulates another 82¢ in local economic activity.
- e. Every $1 of income earned at a winery stimulates another 79¢ of income earned in another industry.

Two major trends relating to Missouri’s wine industry was the development of local restaurants and agri-tourism in rural areas.

“An Analysis of the Economic Impact of Virginia’s Wine Industry” was conducted by Virginia’s Commonwealth University’s Center for Public Policy in 2002. This study emphasized the impact of a strong native wine industry to a state:

- a. 80 wineries with $69 million sales.
- b. $26 million in tourism sales.
- c. $95 million in total economic impact.
- d. 1,030 in total employment
- e. $8 million in state taxes.

The Illinois grape and wine industry started in the mid-80’s with 4 wineries. It now has 33 wineries. The Illinois Grape & Wine Council and four other organizations partnered to complete a recent economic impact study of their industry. This study can be found at this WWW site: <http://www.Illinoiswine.org>. Some of the key impacts they found included:

- a. For every $3 spent in a winery a tourist will spend $1 locally.
- b. Vineyards annually produce $2,400 to $8,000 in gross value per acre.
- c. One grape/wine industry job supports 1.5 other Illinois jobs.
- d. A typical Illinois winery with $500,000 in sales pays 9% in local, state and federal taxes.

The Pennsylvania Wine Association completed an economic impact study of their industry in May of 2003. This report can be found here: <http://www.pennsylvaniawine.com>. Pennsylvania has the 5th largest number of wineries in the U.S. and is the 4th largest producer of grapes. Their 82 wineries currently boast:

- a. $21 million in sales.
b. $190 million in total economic impact.

c. A typical farm winery attracts 10,000 visitors per year.

d. One full-time employee per 1,500 to 2,000 gallons of wine produced.

e. A winery tourist will spend twice as much locally than the typical tourist.

Iowa presently taxes all wholesale wine sales at $1.75 per gallon. There is a federal excise tax of $1.07 per gallon produced in a winery. A 5% state sales tax applies to all retail sales of wine. Iowa’s fledgling winery industry produced 76,000 gallons of wine in 2003 and paid $4.3 million in state wine taxes. Iowa’s winery industry has a huge potential to provide a VERY positive economic impact to rural Iowa and state and federal tax coffers. USDA subsidies to Iowa from 1995 to 2002 amounted to over $10 billion, (see chart below).

**USDA Subsidies to Iowa from 1995 to 2002:**

<table>
<thead>
<tr>
<th>Year</th>
<th>Subsidies ($)</th>
<th>Top 10 Commodities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>$784,960,746</td>
<td>1. Corn $6,699,709,084</td>
</tr>
<tr>
<td>1996</td>
<td>$501,667,940</td>
<td>2. Soybeans $1,917,531,425</td>
</tr>
<tr>
<td>1997</td>
<td>$709,573,633</td>
<td>3. CRP $1,352,539,797</td>
</tr>
<tr>
<td>1998</td>
<td>$1,167,255,301</td>
<td>4. Dairy $64,314,058</td>
</tr>
<tr>
<td>1999</td>
<td>$2,062,392,787</td>
<td>5. Livestock $58,990,535</td>
</tr>
<tr>
<td>2000</td>
<td>$2,305,750,067</td>
<td>6. Wheat $17,975,414</td>
</tr>
<tr>
<td>2001</td>
<td>$1,972,708,312</td>
<td>7. EQIP $15,948,956</td>
</tr>
<tr>
<td>2002</td>
<td>$739,968,117</td>
<td>8. Oat $13,824,853</td>
</tr>
<tr>
<td></td>
<td>$10,244,276,904</td>
<td>9. Wool $3,590,075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Sheep Meat $2,769,541</td>
</tr>
</tbody>
</table>

Source - Environmental Working Group: <http://www.ewg.org/farm/>

In comparison, there are no federal subsidies for Midwest wine grapes or wineries. The overall impact to Iowa’s rural economy by building up a strong vineyard and native wine industry could be immense.

**VINEYARD SITE SELECTION**

Initial site selection and preparation are key in the success of a commercial vineyard. Decisions and actions made during the first year will affect the productivity, quality, production efficiency and profitability of a commercial vineyard for many years. Here are some key site considerations:

a. A southeast to south facing slope or ridge top would be ideal. These sites offer the opportunity of early morning sunshine and wind drying morning dew off of the leaves. Shortening the time of leaf wetness decreases the potential of fungus diseases.

b. Grapes do not like wet soils. Keep them off of river bottoms and hillside seeps. Suggest digging a hole 3’ deep and fill it with water. Ideally you would want the water to be gone in 24-48 hours. Planting grapes on ridges and/or tile drainage can be used to offset moderate drainage problems. Surface or subsurface irrigation can be used during dry periods to compensate the lack of a deep root system.

c. Seasonal high water table should be 4’ or deeper.

d. Do not plant grapes on lowland creek or river bottoms due to frost damage potential. Avoid frost pockets. Consider sites with good airflow.
e. A pH range of 5.5 to 6.5 is considered ideal for grapes. More specifically, American varieties (*Vitis lambrusca*) tend to favor a lower 5.0 to 6.5 pH and French (*Vitis vinifera*) varieties tend to favor a higher pH of 5.5 to 7.0.

f. Perennial vine crops like grapes with deep root systems do not show obvious cause and effect yield and quality relationships to exact soil fertility levels like annual crops such as corn or soybeans. This is one area where much more research is needed in the Midwest. A general consensus among viticulture/horticulture specialists would consider these fertility levels as adequate for grapes in the Midwest:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorous (P)</td>
<td>20 – 25 ppm</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>125 - 150 ppm</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>2 - 4 ppm</td>
</tr>
<tr>
<td>OM%</td>
<td>2 - 3%</td>
</tr>
</tbody>
</table>

**PLANTING AND VARIETY SELECTION**

Wine grape vineyards in Iowa are normally planted in late April and May. The typical row spacing ranges between 8-12 feet wide. Plant spacing ranges between 6-8 feet apart. Approximately 550 plants are needed per acre with the most commonly used vineyard design of 10 feet between rows and 8 feet between plants. Most vineyards are started with 1-2 year old plants that normally cost between $1.50 and $4.50 each. Planting methods vary. Augers, shovels, and tree planting bars are the three most common planting methods used. A few people have started their vineyards from 4-bud vine cuttings acquired during pruning or purchased from a nursery. Though cuttings are cheaper, typically the 1st year harvest will be delayed until the 4th year after planting instead of the typical 3rd year first harvest. Grow tubes are often used during the first year of production to protect the plant from herbicide overspray damage. Glyphosate is the most common herbicide used in Iowa vineyards. The grow tubes also deter browse damage from deer and rabbits. Most people install the trellis system right after planting. The first year goal is to get the grape vines up to the top trellis wire during the 1st year. All of the grapes are pulled from vines early in the season the first two years after planting. Physically removing all the fruit enhances root and cane growth.

There are presently around 25-30 wine grape varieties now being planted in Iowa. Approximately 1/3 of these are native American varieties. The remainder consists primarily of French (*Vitis vinifera*) x American (*Vitis lambrusca*) hybrids. The French varieties are used for their quality taste characteristics. Along with taste, the American varieties provide the cold and disease tolerance characteristics needed in the Midwest. Specific details about these varieties can be found in the publication “Grape Cultivars for Consideration in Iowa” available on the ISU Extension Viticulture homepage: <http://viticulture.hort.iastate.edu/>.

**COST OF PRODUCTION**

It will cost approximately $3000 to $5000 per acre the first year to establish a vineyard. Accrued expenses of $8 - $10,000 per acre can be expected by the end of the 3rd year/1st harvest season. One should start to produce approximately one ton/acre on the 3rd year after establishment. Full production of approximately 3-4 tons/acre will start around the 5th year. Typical prices for a ton of wine grapes delivered to the winery now range from $800 to $1,200 per ton in Iowa and neighboring states. Prices will vary based on variety and quality. It takes about 9 years to pay the start-up costs and begin to net a return of $1500 to $2000/ac./yr. ISU Extension has an excellent
The real money is in the wine! A $1,000 ton of wine grapes should produce around 150 gallons or 750 bottles of wine at an average price of $10 per bottle = $7,500. A small 5-10,000 gallon winery will cost approximately $250,000 for land, equipment and building to establish. Gross returns for a native winery and vineyard in Iowa will run approximately $30,000/ac/yr. from the wine. Net returns from a native winery will normally run between 5% to 15% of the gross sales. These startup costs and net returns are estimates only and will vary greatly between individual wineries.

VINEYARD MANAGEMENT PRACTICES

Many people do not realize that grapes are very MANAGEMENT INTENSIVE. Labor estimates will vary depending on the equipment used, type of trellis system, seasonal pest pressure and age of the vineyard. A typical commercial vineyard in Iowa today will probably require 100-200 hours of labor per acre per year. Approximately half of this time would be involved with harvest. Here is an example of what a typical commercial vineyard seasonal work schedule would look like:

<table>
<thead>
<tr>
<th>Feb/March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prune</td>
<td>- Lime Sulfur application</td>
<td>- 1x spray insecticide</td>
<td>- canopy management</td>
<td>- 1x spray fungicide</td>
</tr>
<tr>
<td></td>
<td>- 1x mow</td>
<td>- 2x spray fungicide</td>
<td>- 1x foliar fertilizer</td>
<td>- 1x spray fungicide</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 2x mow</td>
<td>- 1x spray herbicide</td>
<td>- 1x spray fungicide</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 1x foliar fertilizer</td>
<td>- foliar leaf thinning around grape bunches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- petiole testing for fertilizer requirements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- begin harvest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Brix/TA/pH testing of grapes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oct.</td>
<td></td>
<td>- continue harvest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- finish up harvest</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- continue Brix/TA/pH testing of grapes</td>
</tr>
</tbody>
</table>

ORGANIC GRAPES

There are several people in Iowa trying to grow organic grapes. This is VERY MANAGEMENT INTENSIVE! ISU Extension is currently working with several organic vineyards in the state. Variety and site selection are the two most important factors when considering an organic vineyard. Viable disease prevention and control options are very limited. More research is needed in this area. There are many viable organic options for fertility management and insect and weed control. More information on organic viticulture can be found at these WWW sites:

a. ISU Extension Organic Ag: <http://extension.agron.iastate.edu/organicag/>
b. Organic Agriculture Homepage Iowa Department of Agriculture & Land Stewardship: <http://www.agriculture.state.ia.us/organicAg.htm>
e. Organic Viticulture Homepage Cornell University, NY: <http://www.nysaes.cornell.edu/hort/faculty/pool/organicvitwkshp/tabofcontents.html>
PHENOXY HERBICIDE DRIFT

2,4-D and dicamba are the two primary types of "phenoxy herbicides" that have the highest potential to damage grapes. These two products have the ability to volatize after application when temperatures typically exceed 80°F within two days of the application. The higher the temperature and the more leaf surface the product was applied to, the higher risk of vapors arising by volatilization. 2,4-D LVE (low volatile ester) are more volatile than 2,4-D amine formulations.

2,4-D can be found in many brush and lawn weed control products. Crossbow, Grazon P&D, Brush Killer, Weed Master, Tri-Mec, Mecamine-D, and Weed-B-Gone are just a few of the many products that can contain 2,4-D. Dicamba, typically called "Banvel" can be found in many corn/brush/lawn products. Banvel, Clarity, Distinct, Marksman, Northstar, Brush Killer, Weed Master, Tri-Mec, Mecamine-D, Weed-B-Gone, are just some of the most common products on the market today.

2,4-D and dicamba drift damages grape plants by entering through the leaves. The characteristic fan shaped leaves, epinasty (downward bending of leaves), leaf strapping with deep sinuses, leaf puckering, and leaf cupping are typical symptoms of phenoxy drift. The rate, timing, and grape variety will determine the level of the phenoxy drift injury. Early season drift prior and during bloom can reduce berry set. Mid to late season drift can reduce yield and delay ripening. Repeated drift occurrences over several years can severely reduce production and increase the potential of winterkill. These products can be applied after the first killing frost in October and prior to bud-break in May without damaging grapes. In fact, some forms of 2,4-D are labeled to be applied to the grassed area between the vineyard rows for broadleaf control during this dormant period.

The damage potential to grapes from phenoxy herbicides is greatest during the blooming and early fruit forming stages, ie..late May and June. This is the same time many farmers are spraying corn with dicamba products and spraying fence lines or pastures for brush control. There are many other non-volatile herbicide products that can be used for weed control in corn and brush control in pastures and fence lines. Farmers need to discuss these options with their Certified Crop Advisor and/or local ag dealer to determine their options.

Opinions vary, but if dicamba is to be used, I would recommend not spraying within 1 mile of grapes, and follow all application practices that would reduce the likelihood of vapor and/or physical drift. If 2,4-D is to be used, I would suggest the less volatile amine formulation and not applying it within 1/2 mile of grapes. Temperatures below 80F for two days after application will also significantly reduce the potential of vapor drift from volatilization.

We all know that it is AGAINST THE LAW to drift pesticides onto adjacent land and sensitive crops. It does not matter if the trespass occurred from direct physical drift or vapor drift from volatilization. Still,… much of the responsibility of reducing the potential of herbicide drift falls upon the vineyard owner. Here are the actions I advise vineyard owners to follow:

a. Put a "No Spray Drift - Grapes" signs on fence.

b. Mark out boundaries of vineyard on FSA (Farm Service Agency) black & white aerial photo. Include your complete contact information. Pass out copies to local ag-chem/fertilizer dealers and applicators.

c. Stop by, visit and pass out copies of aerial photo to neighboring farmers. Discuss
dicamba/2,4-D issue and suggest they work with their local Certified Crop Advisor for alternative herbicide or timing options.

e. Planting a windbreak of evergreen trees or shrubs around the vineyard will buffer some of the affect of any herbicide drift that might occur.

f. Suggest lawn applicators apply broadleaf herbicides without 2,4-D or dicamba, or apply herbicides after Oct 15th, and before April 20th.

g. Use some common sense. If possible, avoid placing a vineyard next to corn/soybean fields, golf courses or other hazardous areas.

h. Consider planting less sensitive grape varieties. Some grape varieties seem/are less susceptible to 2,4-D/dicamba drift than others. American (Vitis lambrusca) varieties are more susceptible than French (Vitis vinifera) varieties. Cayuga White, Traminette, Vignoles, Brianna, and La Crescent are several French-American grape varieties that show a good tolerance to 2,4-D/dicama drift.

Prior Communication is Key. No responsible pesticide applicator would knowingly drift a pesticide onto a adjacent sensitive crop he/she was aware of. The legal and financial ramifications are just too great! Further information about herbicide drift injury to grapes can be found in the following WWW publications:

a. Grapes--Grapes are sensitive to herbicide drift, 8-20-99:  
   <http://eesc.orst.edu/agcomwebfile/garden/Fruit/grapes.html>

b. "2,4-D Drift Injury to Grape in Missouri. page 6 of Vineyard and Vintage View Newsletter:  
   <http://eesc.orst.edu/agcomwebfile/garden/Fruit/grapes.html>

c. Questions & Answers About Herbicide Injury to Grapes, MF-2588, K-State:  

d. Preventing Hormonal-Type Herbicide Damage to Kansas Grapes" S-142, K-State:  

e. Preventing Herbicide Drift and Injury to Grapes, Oregon State Univ.:  
   <http://eesc.oregonstate.edu/agcomwebfile/edmat/em8860.pdf>

f. Herbicide Drift and Injury to Grapes, 6 p. Southern IL Univ. publication. $3 Hardcopy only:  
   <https://webstore.aces.uiuc.edu/shopsite/C1382.html>

SUMMARY

This paper was intended as a primer to introduce the reader to Iowa’s re-emerging grape and wine industry. The following selected WWW sites are suggested for those wanting to do further research into viticulture or enology (wine making).

Selected Viticulture & Enology WWW Sites:

1. Iowa Wine Growers Association homepage: http://www.iowawinegrowers.com/
3. ISU Viticulture homepage: http://viticulture.hort.iastate.edu/home.html
4. Univ. of NE Viticulture homepage: http://agronomy.unl.edu/viticulture/
5. Mid American Viticulture & Enology Center, SMSU, Mountain Grove, MO:  
   <http://mtngrv.smsu.edu/mvec/index.htm>
8. The 2004 Iowa Small Fruit and Grape Spray guide is a companion publication to 861: <http://www.extension.iastate.edu/Publications/PM1375.pdf>
12. “Grape: Cultivars, Training and Pruning” G82-168A, Univ. of Nebraska: <http://www.ianr.unl.edu/pubs/horticulture/g618.htm>
13. “Home Fruit Production: Grape Training Systems” GO90H, 1/93, Univ. of Missouri: <http://muextension.missouri.edu/xplor/agguides/hort/g06090.htm>
15. ”Trellis Systems for Your Vineyard” Univ. of NE: <http://agronomy.unl.edu/viticulture/trellis_systems_for_your_vineyard.htm>
16. UC Davis Enology Center: <http://wineserver.ucdavis.edu/>
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