Growing Grapes in Vermont

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Grape Origins

*Vitis vinifera*: Middle East into Mediterranean Europe

- Evidence of winemaking traced to at least 6000 B.C.
- Domestication occurred ~3200 B.C.
- Shiraz known by 800’s AD

Romans spread winemaking across Europe

- By 100 AD, Rhine valley (Germany) had extensive plantations

Spanish initially brought wines and vines to America during exploration and settlement

- East coast vines died
- West (Califonia, NM) flourished
Modern Advances in Viticulture

Late 1800’s, *Phylloxera* spread to France & other parts of Europe
- Rootstocks from North American vines were (are) used to confer resistance
- ‘French American’ hybrids developed to breed resistance

Fungal diseases from New World (Downy Mildew)
- Bordeaux mixture, 1880’s

Commodification of grapes and wine
- Research on trellis design, cultivars, clones

2000: Spread to non-traditional sites
- North: Idaho, Iowa, VT
- South: Florida, TX
Grapes in Vermont (and other crazy cold places)

Vermont: 22 bonded (grape) wineries; ~200 acres grapes?

Minnesota: 30 wineries, 700 acre (2009)
Iowa: 85 wineries, 1200 acres (2010)

Kentucky: 50 wineries, 500 acres
Idaho: 40+ wineries, 1500 acres
Why is there a developing winegrape industry in Vermont now?

GLOBAL WARMING??

Breeding of cold-hardy, high quality wine grapes in recent years.
“New” Cold-Hardy Wine Grape Cultivars

La Crescent  

Frontenac  

St. Croix
Grape growing limitations

**COLD!!**

Majority of grapes (table, wine) are **vinifera**
- -15°F at best

Native grape industry includes Concord (#1), Delaware, Himrod, Catawba
- -20 to -30°F BUT
- Require long growing season and...
- Commodity markets in major growing areas depress prices for marginal sites
Is your site suitable for grapes?

<table>
<thead>
<tr>
<th>Climate</th>
<th>Topography</th>
<th>Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Winter Temperatures *</td>
<td>• Relative Elevation*</td>
<td>• Drainage</td>
</tr>
<tr>
<td>• Spring Frosts</td>
<td>• Nearness to a large body of water*</td>
<td>• Moisture Holding Capacity</td>
</tr>
<tr>
<td>• Length of Growing Season</td>
<td>• Degree of Slope</td>
<td>• pH</td>
</tr>
<tr>
<td>• Growing Degree Days</td>
<td>• Direction of Slope</td>
<td>• Fertility</td>
</tr>
<tr>
<td>• Precipitation</td>
<td></td>
<td>• Organic Matter</td>
</tr>
</tbody>
</table>

* The most important consideration
Winter Temperatures
Determine what cultivars can be grown & how productive they will be.

**Cane buds** are the most tender portion of a grape vine.
A compound bud with the potential to produce 3 or more shoots.
- **1° bud:** The most productive.
- **2° bud:** Less productive; varies with type & cultivar.
  - American types 50% or less productive
  - French hybrids 60-80% as productive.
- **3° bud:** Very un-productive
Challenges with Growing Grapes in Vermont

Bud injury occurs between -10 and -25 degrees F.

Select cultivars which mature within your growing season (frost free period).

Success depends upon selected cultural management practices

KEY-

- Protect vines from cold at the most critical stages
- Variety selection (genetic hardiness)
- Site selection (meso/micro climate)
- Winter protection (training/protection)
- Vegetative management (healthy tissue, retard bud break)
## Classification of Vine Hardiness

Based on the temperature at which injury begins to occur

<table>
<thead>
<tr>
<th>Temp. (${\text{F}^\circ}$)</th>
<th>Category</th>
<th>Suitable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\geq 0$</td>
<td>Very cold tender</td>
<td>Almost any.</td>
</tr>
<tr>
<td>$-5$</td>
<td>Cold tender</td>
<td>Most northern <em>vinifera</em>.</td>
</tr>
<tr>
<td>$-10$</td>
<td>Moderately Hardy</td>
<td>Hardy <em>vinifera</em>, moderately hardy French hybrids.</td>
</tr>
<tr>
<td>$-15$</td>
<td>Hardy</td>
<td>Hardy French hybrids, most <em>labrusca</em>.</td>
</tr>
<tr>
<td>$\leq -20$</td>
<td>Very hardy</td>
<td>Hardy <em>labrusca</em>, most <em>riparia</em> hybrids.</td>
</tr>
</tbody>
</table>
USDA Hardiness Zone Map
Length of the Growing Season

<table>
<thead>
<tr>
<th>Frost-Free Days</th>
<th>Suitability for Grapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 150</td>
<td>Unacceptable ?</td>
</tr>
<tr>
<td>150 to 160</td>
<td><strong>Marginal:</strong> Only early season maturing varieties.</td>
</tr>
<tr>
<td>160 to 170</td>
<td><strong>Satisfactory:</strong> Early &amp; most mid-season maturing varieties.</td>
</tr>
<tr>
<td>170 to 180</td>
<td><strong>Good:</strong> Early, mid-season &amp; some late-season varieties.</td>
</tr>
<tr>
<td>&gt; 180</td>
<td><strong>Excellent:</strong> Most varieties.</td>
</tr>
</tbody>
</table>

Is often very site specific.
Figure 15-17  A schematic view of a valley with trees planted on the floor and up a slope. On clear, still nights, strong radiation heat loss at the earth’s surface cools the air. The dense cold air that is formed settles at the bottom of the valley, forcing warmer air up to a higher level—thus producing a temperature inversion, which is advantageous to the trees on the slope on frosty nights.
Lake effects
Lake effects
Frost Free Days

@ 32° F, 50% probability
@ 28° F, 50% probability
Sample Weather Data

**Climate Variables for VT Locations, 1971-2000 (NOAA)**

<table>
<thead>
<tr>
<th>Location</th>
<th>Last&lt;29</th>
<th>First&lt;29</th>
<th>FFD (29F)</th>
<th>GDDb50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burlington</td>
<td>24-Apr</td>
<td>16-Oct</td>
<td>175</td>
<td>2373</td>
</tr>
<tr>
<td>Berlin</td>
<td>29-Apr</td>
<td>11-Oct</td>
<td>165</td>
<td>1865</td>
</tr>
<tr>
<td>Cornwall</td>
<td>25-Apr</td>
<td>10-Oct</td>
<td>168</td>
<td>2331</td>
</tr>
<tr>
<td>East Haven</td>
<td>16-May</td>
<td>5-Sep</td>
<td>112</td>
<td>1046</td>
</tr>
</tbody>
</table>
Soil Selection Factors
Internal Drainage
Moisture Holding Capacity
Texture
Depth
pH
Fertility
# Reasons for Poor Soil Drainage

<table>
<thead>
<tr>
<th>Poor surface runoff</th>
<th>Impervious layer in substrata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope</td>
<td>Clay layer</td>
</tr>
<tr>
<td>Depressions</td>
<td>Compacted layer</td>
</tr>
<tr>
<td>Lateral seepage</td>
<td>Abrupt textural change</td>
</tr>
<tr>
<td>On slopes</td>
<td>High water table</td>
</tr>
<tr>
<td>Textural change</td>
<td></td>
</tr>
<tr>
<td>Texture</td>
<td></td>
</tr>
<tr>
<td>High clay content</td>
<td></td>
</tr>
</tbody>
</table>
What Can be Done to Improve Soil Drainage

Sub-soil before planting
- Effective for compacted soils if there is good soil below.

Plant on raised beds
- Suitable on moderately well drained soils.
- Maybe okay for somewhat poorly drained soils.

Install drainage tile
- Suitable for somewhat poorly drained soils.
- Maybe okay for poorly drained soils (distance between tile lines & cost become a factor).
Soil pH for Grapes

**Desired range:** 5.5 to 6.5

- American: 5.0 to 6.5 (~ 6.0 optimum)
- French Hybrid: 5.5 to 6.5; (6.0 to 6.5 optimum)
  ◦ Will tolerate a pH up to ~ 7.0

**Adjust Soil pH:**

- Below 6.0: bring up to 6.0 or 6.5 with lime.
- Above 6.8 or 7.0: consider lowering to 6.5 or 6.0 with sulfur, or using acid forming fertilizers (ammonium sulfate).
Soil pH

Nutrient Availability as Influenced by Soil pH

Nitrogen (N)
Phosphorous (P)
Potassium (K)
Calcium (Ca)
Magnesium (Mg)
Sulfur (S)
Iron (Fe)
Manganese (Mn)
Boron (B)
Copper (Cu)
Zinc (Zn)
Molybdenum (Mo)
Soil Fertility

Least concern when selecting a site.

- Can amend the soil.

**Concerns:**

- **P** Immobile in the soil.
  - Pre-plant application is the only economical chance to correct a shortage.
  - Often high where manure has been applied.
- **K** Grapes have a high requirement for K.
  - Can stratify where cultivation is not practiced as in a vineyard.
  - Excessive soil Mg can inhibit the uptake of K.
- **Mg** Can be low in many eastern soils, particularly on sandier soils.
  - Uptake of Mg can be inhibited where K has been over-applied.
- **Zn** Grapes have a relatively high requirement for Zn.
Grape growth habit

Grapes are a *liana*: a climbing vine

- Generally require support
- Ecological niche: canopy climbers
  - Strong apical dominance
  - ‘Plastic’ growth habit, malleable to grower’s training systems
    - Allows Growers to manipulate the plant for commercial needs
      - Yield
      - Mechanization
      - Cold Hardiness
      - Ripening
Grape Habit

Wild vine growth uses existing structures (trees) for support

Apical dominance encourages growth vertically to exploit solar reception

Source: Creasy & Creasy, Grapes
Grape Plant Structure

- Trunk
- Arm/Cordon
- Buds
- Suckers
- Lateral Shoots
- Tendrils

Source: Lon Rombough, The Grape Grower
Grape Flowers

Wild grapes typically are dioecious

Most grape *cultivated* varieties have hermaphroditic, self-fertile flowers
Getting Started with your home vineyard

Site Selection - full sun

Sources of vines - propagation

- Northeast Vine Supply
- Double A Vineyards

Spacing 6-8 ft x 10 ft

Build the trellis before planting?

Plan training system
Planning the vineyard

Expect 10-20 pounds of grapes per mature vine

Expect 1-2 gallons wine from those grapes *if hardy and well-managed*

Vines require 50-100 sq feet of space

SO:

- A vineyard to support a 25 gallon annual home winery would require:
  - 25 vines
  - 6 x 10 ft spacing = 60 sq ft each
  - =1500 sq feet of vineyard
Planting Vines

Early spring is the best time to plant grapevines. Fall planting is not recommended because plants are likely to be lost to heaving and cold damage.

During the first year, the vines are normally tied to a stake to keep them off the ground.

**Season 1:** Tie all growth to a vertical stake and control weeds

**Season 2:** Train a single trunk plus one renewal spur to the wire, remove all else

**Season 3:** Develop fruiting arms (cordons) or vine head
Early vine training
Training System  
4-Cane Kniffin
Training System
Single Curtain
Training System
Single Curtain
Training System
Open Fan
Fan System
(with mulch potential)
Winter Mulch

Snow

Bury in Soil

Use organic mulch (hay, straw, etc...mice can be a problem.)

Uncover and trellis before spring growth begins.
Spur and Cane Training
Cane Pruning Systems
Seasonal Pruning
(About 40 buds per plant)
Pruning

Annual pruning is important in maintaining a uniform yearly production of quality fruit.

The best time to prune grapevines is in the dormant season after the danger of severe cold weather has past.

When ‘Lay-down’ management is used, prune mildly in fall and complete pruning at spring trellising.
Pruning

Mature vines:
- Prune to a determined number of buds
- Rule of thumb, 6 buds/foot of canopy
  - Remove some if no cold damage
- Cold-damaged vines, leave more buds BUT
  - If too much fruit sets (>4 clusters/foot of canopy), remove fruit clusters just after set
Pruning
Pruning
Pruning
Training System
Lazy ‘J’ for Horizontal Lay-down

FIGURE 3. Parts Of The Vine
Planting for Training System

Upright Training  Horizontal Training

FIGURE 2. Setting Transplants
Before Spring Pruning
Save canes from last season's growth...contains fruiting buds
Spring Pruned
Training a New Trunk
(Used to replace old/damaged)
Summer Growth
Summer Growth
Summer Maintenance

Shoot thinning @ 6” growth
- 4-6 shoots per ft of canopy

Shoot positioning (combing)
- Direct shoots down (high wire)
- or up (low wire)
- or tie to wires (fan, kniffin)

Cluster thinning
- 1-2 clusters per shoot

Hedging
- Trim shoots when on ground or coming up over top wire
Shoot combing
Shoot combing
Cluster thinning
Fertilizing

Grapes perform best where the soil pH is between 5.5 and 6.5. Apply 8 ounces of 10-0-10 fertilizer per plant seven days after planting.

An equivalent of 30 lbs N per acre (or about 0.05 lb actual N per vine) in the first three years about just as new growth begins in the spring.

An equivalent of 50lbs N per acre (or about 0.08 lb actual K per vine) after fruiting commences in year four and later. Potassium fertilizers should be applied in June or July. Adequate soil moisture is critical to transport potassium into the plant.

Do not concentrate fertilizer at the base of the trunk. Keep fertilizer 6 to 12 inches from the trunk and spread evenly under the spread of the vine.
Weed Management/Mulch

For best vine performance, avoid using thick organic mulches...heat is needed for growth.

Use tillage, herbicides or black plastic mulch to control weeds.
Summer growth, year 2
Herbicide Injury
Diseases

Common grape diseases are **black rot, downy mildew, powdery mildew, anthracnose, phomopsis cane and leaf spot**, and botrytis bunch rot or gray rot.

Proper spacing for air circulation, inoculum removal

Spray program:

http://ohioline.osu.edu/b780/b780.pdf
http://www.uvm.edu/~fruit/grapes/gr_ipm/AnInitialIPMStrategy.pdf
Insects

Major insects and mites on grapes are grape berry moth, Japanese beetle, grape flea beetle, European red mite, grape root borer, and grape phylloxera.
Summary of Cultural Practices

Select cultivars to match your climate
Train vines for winter and summer
Weed control, black plastic
Fertilize before spring growth begins
Prune annually

Winter care: hardy cultivars, otherwise lay-down and rely on snow mulch or bury.
<table>
<thead>
<tr>
<th>Valiant</th>
<th>Other Swenson cvs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta (Alpha)</td>
<td>Worden</td>
</tr>
<tr>
<td>King of the North</td>
<td>Fredonia</td>
</tr>
<tr>
<td>Bluebell</td>
<td>Concord</td>
</tr>
<tr>
<td>Swenson Red</td>
<td>Somerset Seedless</td>
</tr>
<tr>
<td>Eidelweiss</td>
<td>Trollhaugen</td>
</tr>
<tr>
<td>Table Grapes - <em>Maturity</em></td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td></td>
</tr>
<tr>
<td>Valiant (late Aug.)</td>
<td></td>
</tr>
<tr>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>Swenson Red (early Sept.)</td>
<td></td>
</tr>
<tr>
<td>Bluebelle (mid to late Sept.)</td>
<td></td>
</tr>
<tr>
<td>Eidelweiss</td>
<td></td>
</tr>
<tr>
<td>Suelter (late Sept.)</td>
<td></td>
</tr>
<tr>
<td>King of the North</td>
<td></td>
</tr>
<tr>
<td>Worden</td>
<td></td>
</tr>
<tr>
<td>Somerset Seedless</td>
<td></td>
</tr>
<tr>
<td>Trollhaugen</td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td></td>
</tr>
<tr>
<td>Vanessa</td>
<td></td>
</tr>
<tr>
<td>Wine Grapes</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>----------</td>
</tr>
<tr>
<td>St Croix</td>
<td>Swenson White</td>
</tr>
<tr>
<td>St. Pepin</td>
<td>Corot Noir (Tender)</td>
</tr>
<tr>
<td>Lacrosse</td>
<td>Leon Millot</td>
</tr>
<tr>
<td>Kay Gray</td>
<td>Marquette</td>
</tr>
<tr>
<td>Petite Pearl</td>
<td></td>
</tr>
<tr>
<td>Frontenac</td>
<td></td>
</tr>
<tr>
<td>Prairie Star</td>
<td></td>
</tr>
<tr>
<td>Louise Swenson</td>
<td></td>
</tr>
</tbody>
</table>
Traminette: 1996 Cornell release

- Greatest winter injury in two of three years
- Lowest cordon length 2010
- Among lowest pre-thinning cluster count each year
- Among lowest crop yield each year: mean 1.7 tons/acid (3.8 MT/ha)
- Lowest juice pH in two of three years
- Disease resistance relatively good under low pressure/good coverage
- Removed from planting after 2011
Vignoles: 1949 French-hybrid release

- Cold hardiness questionable: among lowest % live buds that pushed shoots in each year
- Lowest pruning weight in each year
- Lowest pre-thinning cluster count in one of two years
- Crop yield among lowest in all years: mean 0.8 tons/ ac (1.8 MT/ha)
- Very susceptible to Downy Mildew
- Removed from planting after 2011
Foliar Disease Incidence 2009-2012
‘Typical’ 4-5 Fungicide Program

Foliar Disease Incidence 2014-2015
‘Typical’ 4-5 Fungicide Program

Powdery Mildew: % Foliar incidence

- Corot Noir
- Frontenac
- La Crescent
- Marquette
- Prairie Star
- St. Croix

Unpublished data
Fruit Disease Incidence 2014-2015
‘Typical’ 4-5 Fungicide Program

Powdery Mildew: % Fruit incidence

Unpublished data
Foliar Disease Incidence 2009-2012
‘Typical’ 4-5 Fungicide Program

‘Typical’ 4-5 Fungicide Program

Downy Mildew: % Foliar incidence

Corot Noir  | Frontenac  | La Crescent | Marquette | Prairie Star | St. Croix
---|---|---|---|---|---
| 0 | 0 | 10 | 0 | 0 | 10

Unpublished data
Disease Incidence
‘Typical’ 4-5 Fungicide Program

Downy Mildew: % Fruit incidence

Consistent with 2009-2012

Unpublished data
Foliar Disease Incidence: 2009-2012
‘Typical’ 4-5 Fungicide Program

‘Typical’ 4-5 Fungicide Program

Black Rot: % Foliar incidence

- Corot Noir
- Frontenac
- La Crescent
- Marquette
- Prairie Star
- St. Croix

Data unpublished
‘Typical’ 4-5 Fungicide Program

Black Rot: % Fruit incidence

Corot Noir  Frontenac  La Crescent  Marquette  Prairie Star  St. Croix

Data unpublished
‘Typical’ 4-5 Fungicide Program

Anthracnose: % Foliar incidence

Data unpublished
Fruit Disease Incidence: 2014-2015
‘Typical’ 4-5 Fungicide Program

Anthracnose: % Fruit incidence

Data unpublished
Cultivar Yields of Six Winegrapes
UVM Horticulture Research Center, South Burlington, VT

- Corot Noir
- Frontenac
- LaCrescent
- Marquette
- St. Croix
- Prairie Star
### Percent primary bud survival
UVM NE1020 Vineyard, S. Burlington, VT

<table>
<thead>
<tr>
<th>Vine Name</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corot Noir</td>
<td>77b</td>
<td>80b</td>
<td>50c</td>
<td>35b</td>
</tr>
<tr>
<td>Frontenac</td>
<td>95a</td>
<td>88ab</td>
<td>92a</td>
<td>90a</td>
</tr>
<tr>
<td>La Crescent</td>
<td>86ab</td>
<td>97a</td>
<td>90ab</td>
<td>84a</td>
</tr>
<tr>
<td>Marquette</td>
<td>91a</td>
<td>93a</td>
<td>87ab</td>
<td>83a</td>
</tr>
<tr>
<td>Prairie Star</td>
<td>92a</td>
<td>87ab</td>
<td>77b</td>
<td>45b</td>
</tr>
<tr>
<td>St Croix</td>
<td>93a</td>
<td>95a</td>
<td>90ab</td>
<td>78a</td>
</tr>
</tbody>
</table>
Corot Noir: 2006 Cornell release

Brix, pH, TA and Yield for Corot Noir
UVM Horticulture Center, South Burlington, Vermont

- Brix (%SS)
- pH
- TA (g/100ml)
- Yield (Ton/Acre)
Frontenac: 1996 University of Minnesota release

Brix, pH, TA, and Yield for Frontenac
UVM Horticulture Center, South Burlington, Vermont

- Brix (%SS)
- pH
- TA (g/100ml)
- Yield (Ton/Acre)

Graph showing the comparison of Brix, pH, TA, and Yield from 2009 to 2015.
LaCrescent: 2002 University of Minnesota release

Brix, pH, TA, and Yield for LaCrescent
UVM Horticulture Center, South Burlington, Vermont

Brix, Yield

25
20
15
10
5
0

pH, TA

3.5
3
2.5
2
1.5
1
0.5
0

Brix (%SS)
pH
TA (g/100ml)
Yield (Ton/Acre)
Marquette: 2006 University of Minnesota release

Brix, pH, TA, and Yield for Marquette
UVM Horticulture Center, South Burlington, Vermont

- Brix (%SS)
- pH
- TA (g/100ml)
- Yield (Ton/Acre)

Graph showing the changes in Brix, pH, TA, and Yield from 2009 to 2015.
Prairie Star: 2000 Elmer Swenson release

Brix, pH, TA, Ravaz Index, and Yield for Prairie Star
UVM Horticulture Center, South Burlington, Vermont

Axis Title

Brix, yield


Axis Title

Yield (Tons/Acre)

pH, TA

Brix (%SS)

TA (g/100ml)
Brix, pH, TA, Ravaz Index, and Yield for Marquette
UVM Horticulture Center, South Burlington, Vermont

- Brix (%SS)
- pH
- TA (g/100 ml)
- Yield (Ton/Acre)
‘La Crosse’

‘Prairie Star’
Grape Cultivar Information

- Iowa State University Viticulture:
  http://viticulture.hort.iastate.edu/cultivars/cultivars.html