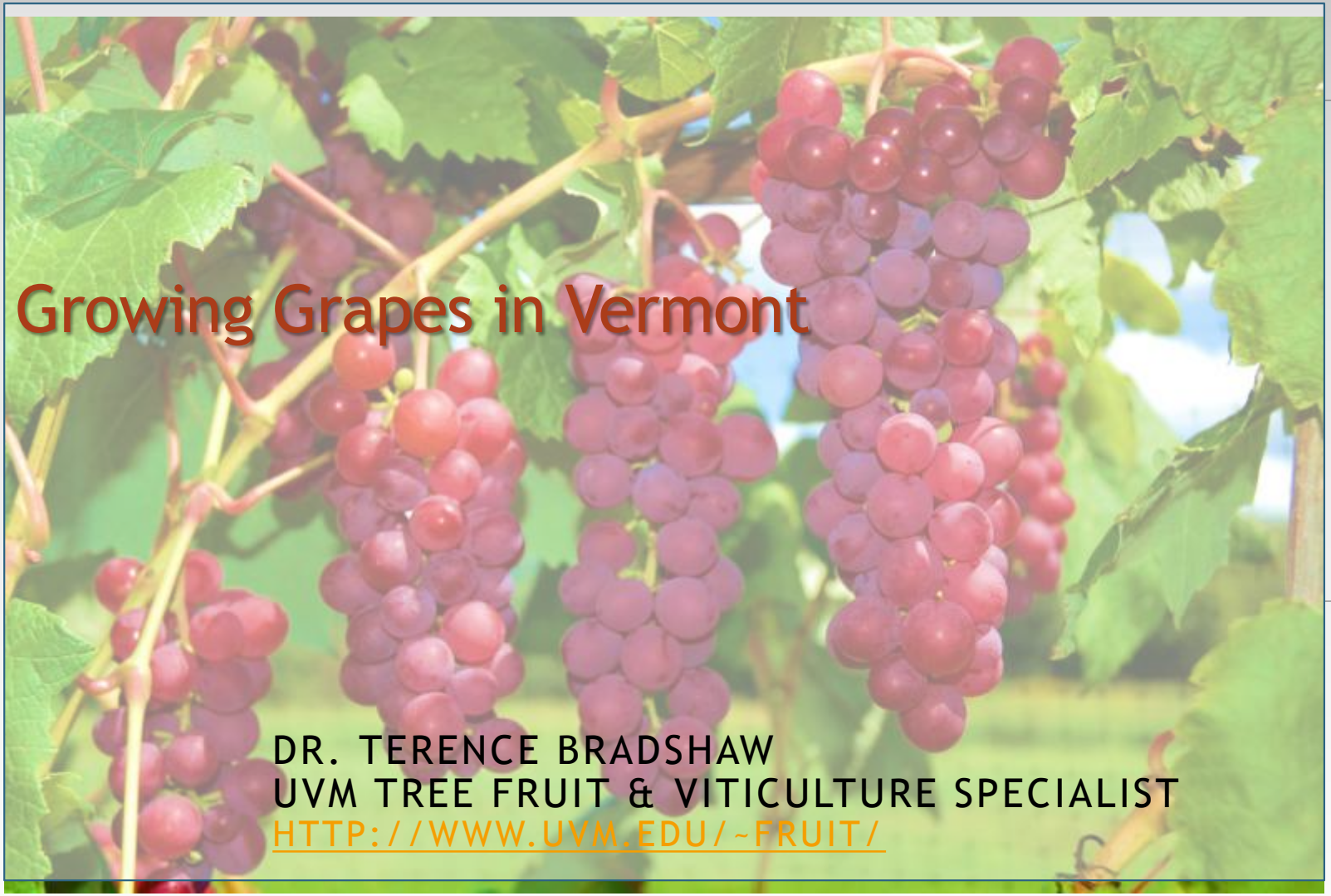


Growing Grapes in Vermont

DR. TERENCE BRADSHAW
UVM TREE FRUIT & VITICULTURE SPECIALIST
HTTP://WWW.UVM.EDU/~FRUIT/

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)

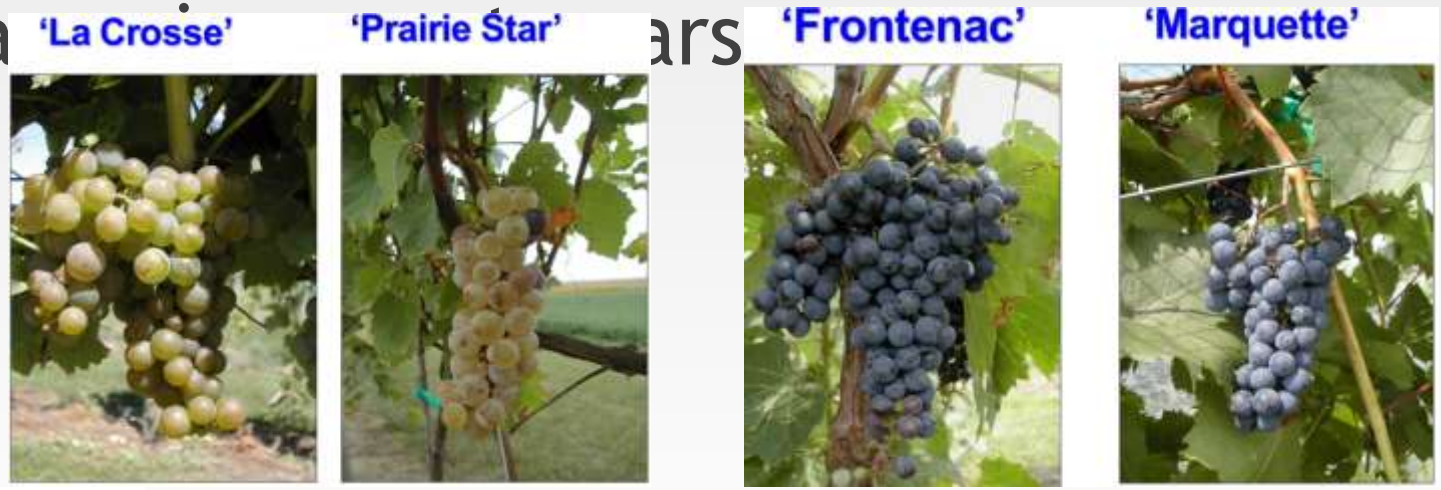
Kentucky: 50 wineries, 500 acres

Idaho: 40+ wineries, 1500 acres

Why is there a developing winegrape industry in Vermont now?

GLOBAL WARMING??

Breeding of cold-hardy, high quality wine gra ars



"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?

Climate	Topography	Soils
• **Winter Temperatures ***	• **Relative Elevation***	• **Drainage**
• Spring Frosts	• **Nearness to a large body of water***	• Moisture Holding Capacity
• Length of Growing Season	• Degree of Slope	• pH
• Growing Degree Days	• Direction of Slope	• Fertility
• Precipitation		• Organic Matter

* The most important consideration

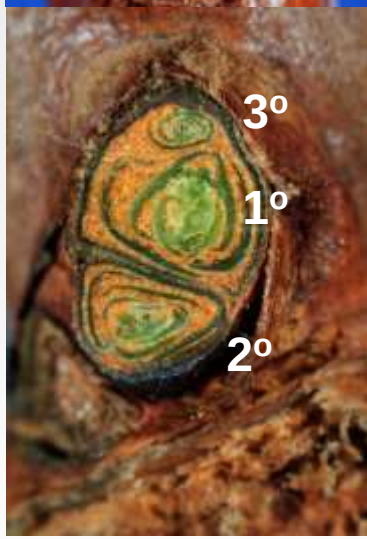
Winter Temperatures

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.

- **1º bud: The most productive.**
- **2º bud: Less productive; varies with type & cultivar.**
  - **American types 50% or less productive**
  - **French hybrids 60-80% as productive.**
- **3º 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-

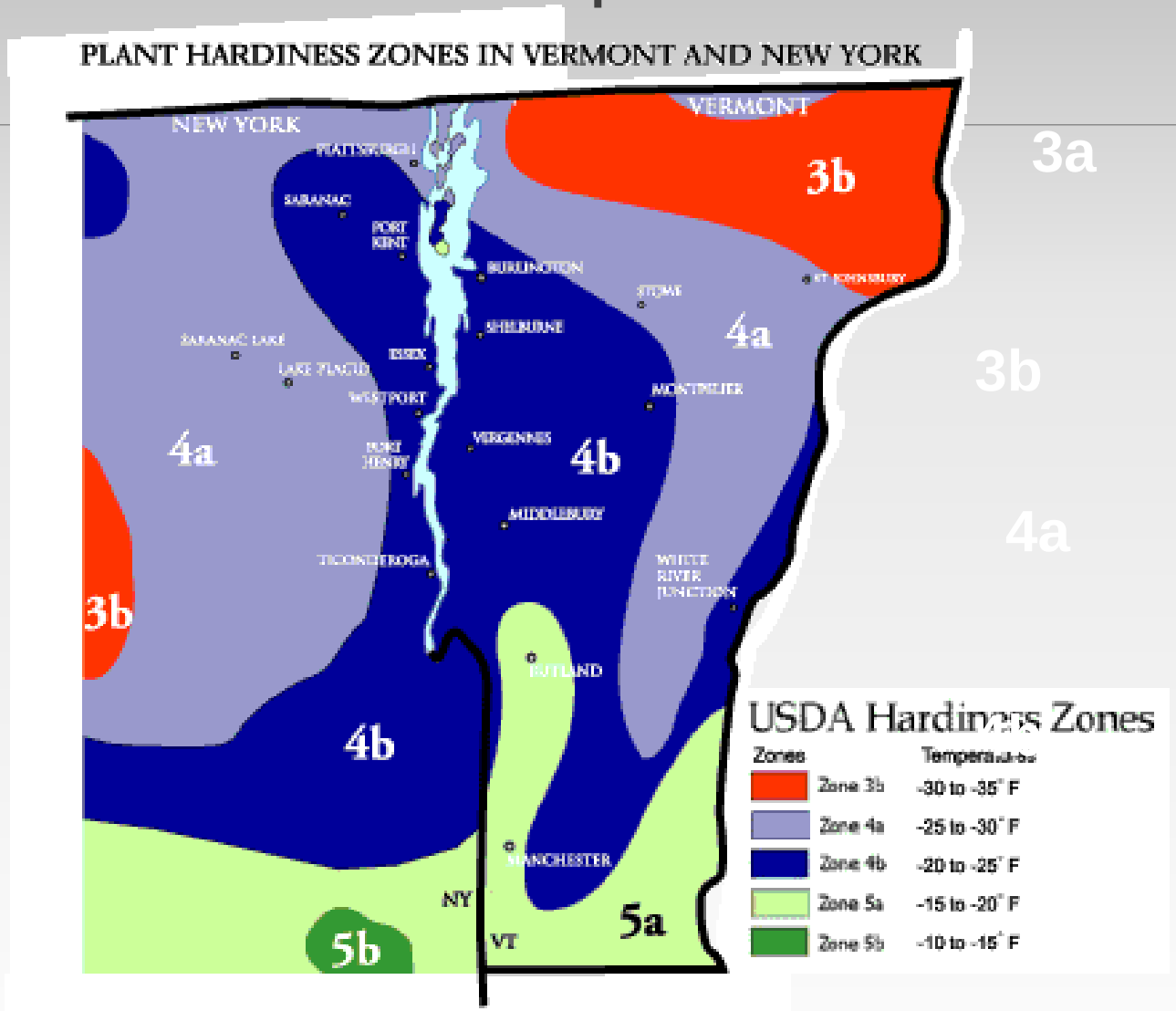
- Protect vines from cold at the most critical stages
  - Variety selection (genetic hardiness)
  - Site selection (meso/micro climate)
  - Winter protection (training/protection)
  - Vegetative management (healthy tissue, retard bud break)

Classification of Vine Hardiness

Based on the temperature at which injury begins to occur

Temp. (F°)	Category	Suitable Type
≥ 0	**Very cold tender**	Almost any.
- 5	**Cold tender**	Most northern *vinifera*.
- 10	**Moderately Hardy**	Hardy *vinifera*, moderately hardy French hybrids.
- 15	**Hardy**	Hardy French hybrids, most *labrusca*.
≤ - 20	**Very hardy**	Hardy *labrusca*, most *riparia* hybrids.

USDA Hardiness Zone Map



Length of the Growing Season

Frost-Free Days	Suitability for Grapes
< 150	**Unacceptable ?**
150 to 160	**Marginal:** Only early season maturing varieties.
160 to 170	**Satisfactory:** Early & most mid-season maturing varieties.
170 to 180	**Good:** Early, mid-season & some late-season varieties.
> 180	**Excellent:** Most varieties.

Is often very site specific.

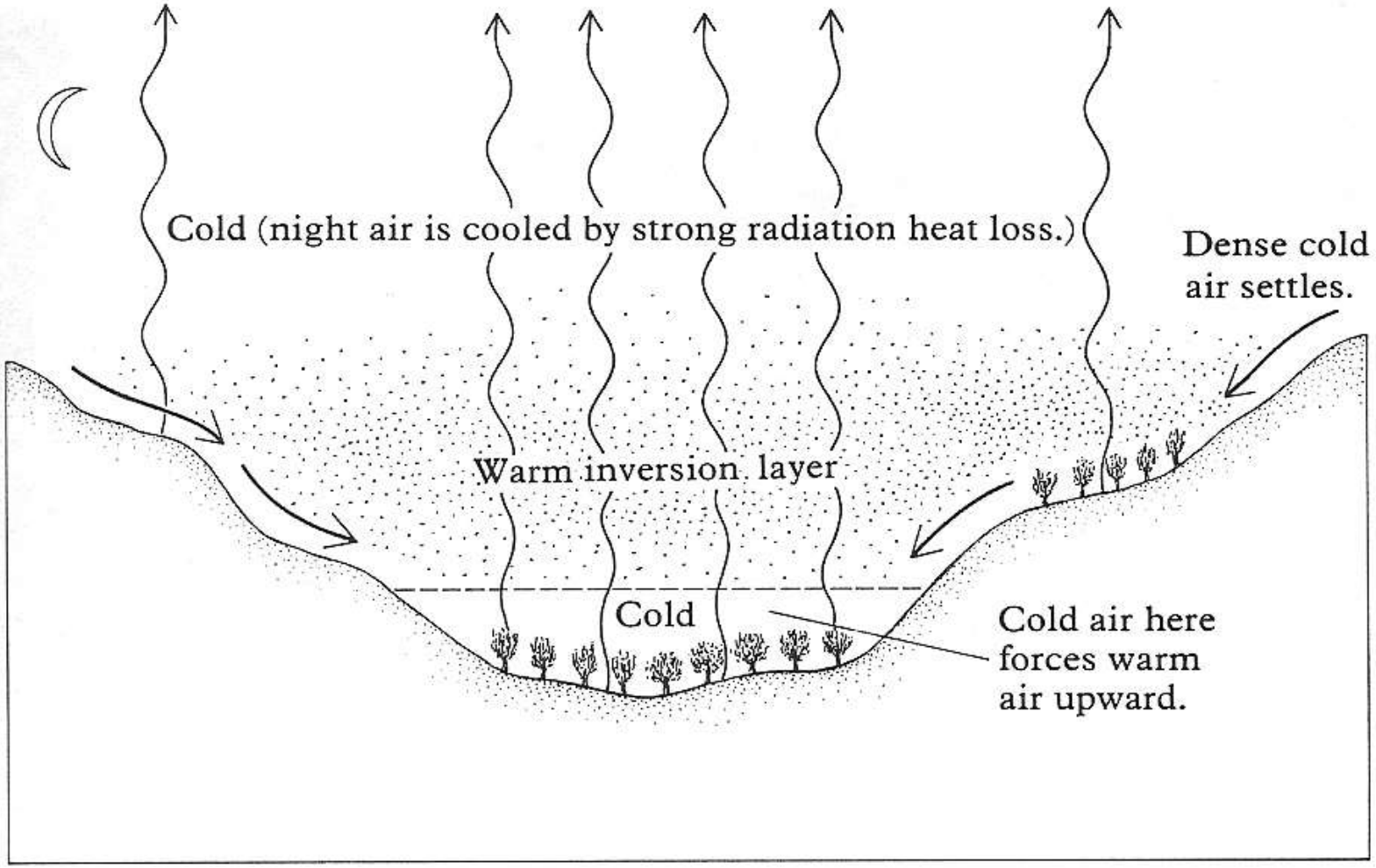
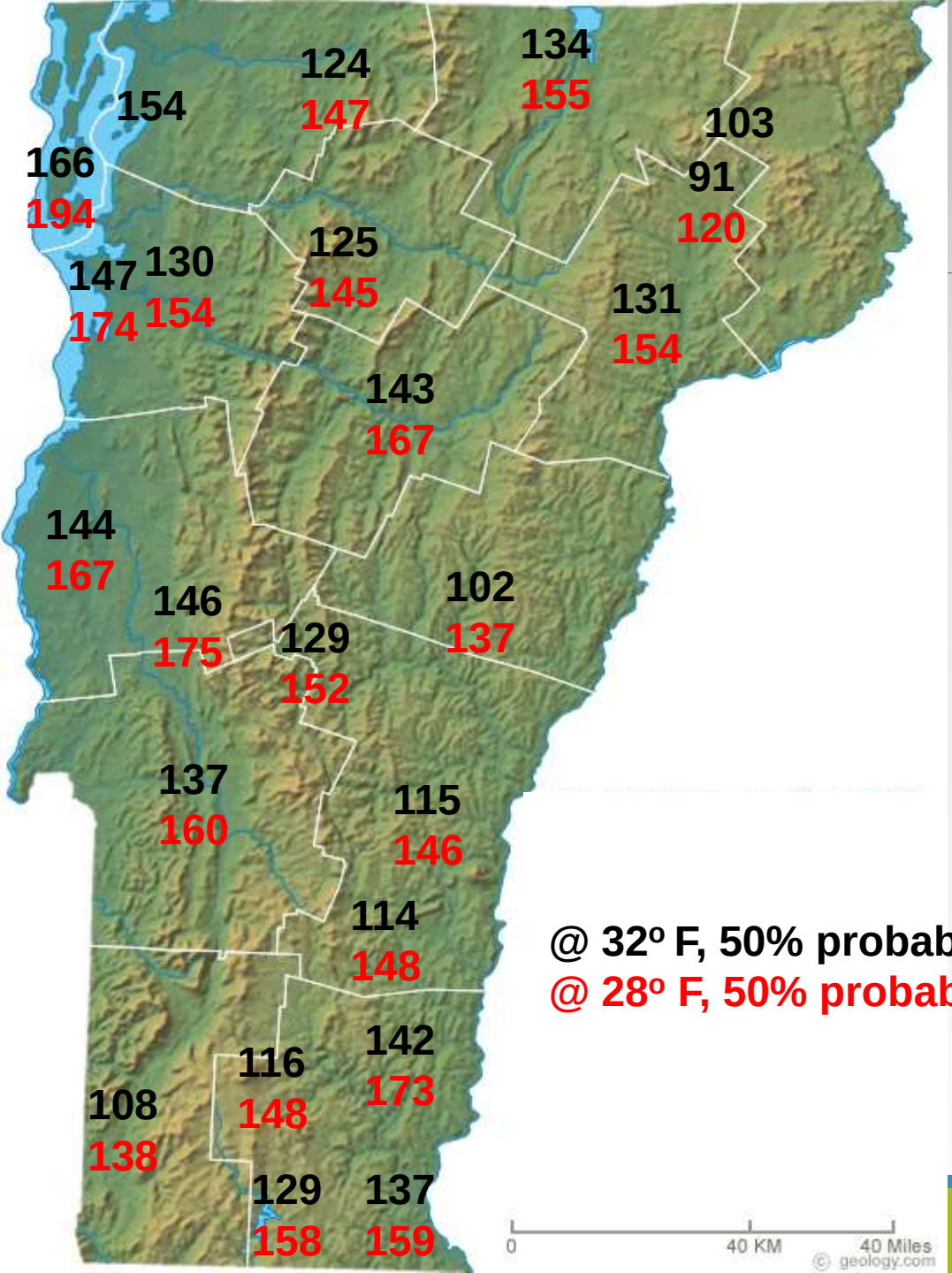


Figure 15-17 A schematic view of a valley with trees planted on the floor and up a slope. On clear, still nights, strong radiation heat loss at the earth's surface cools the air. The dense cold air that is formed settles at the bottom of the valley, forcing warmer air up to a higher level—thus producing 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)

	Last<29	First<29	FFD (29F)	GDDb50
Burlington	**24-Apr**	**16-Oct**	**175**	**2373**
Berlin	**29-Apr**	**11-Oct**	**165**	**1865**
Cornwall	**25-Apr**	**10-Oct**	**168**	**2331**
East Haven	**16-May**	**5-Sep**	**112**	**1046**

Soil Selection Factors

- Internal Drainage
- Moisture Holding Capacity
  - Texture
  - Depth
- pH
- Fertility

Reasons for Poor Soil Drainage

Poor surface runoff

- Slope
- Depressions

Lateral seepage

- On slopes
- Textural change

Texture

- High clay content

Impervious layer in substrata

- Clay layer
- Compacted layer
- Abrupt textural change

High water 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 of poorly drained soils (distance between tile lines & cost become a factor).

Soil pH for Grapes

Desired range: 5.5 to 6.5

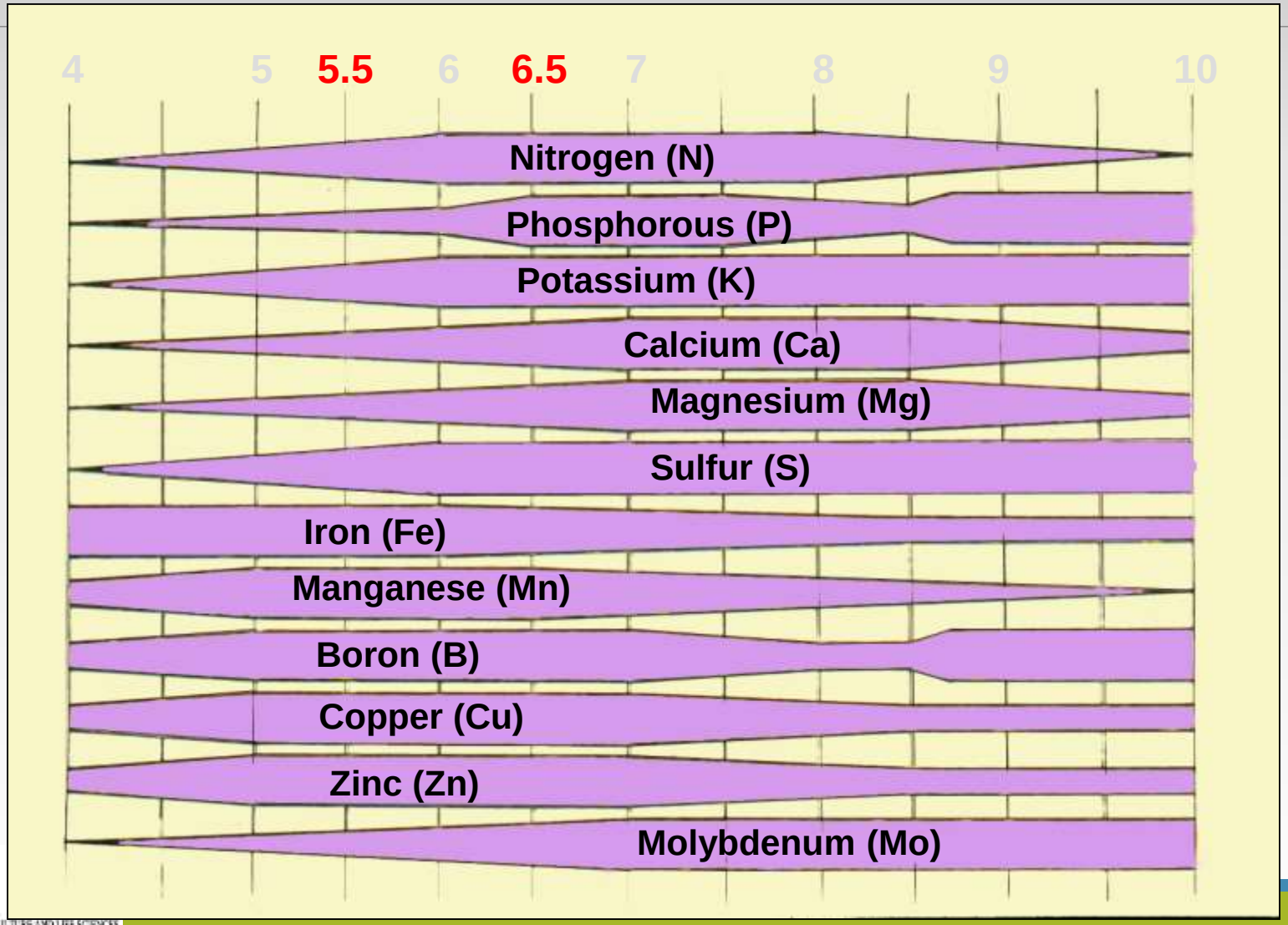
- American: 5.0 to 6.5 (~ 6.0 optimum)
- French Hybrid: 5.5 to 6.5; (6.0 to 6.5 optimum)
  - **Will tolerate a pH up to ~ 7.0**

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



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

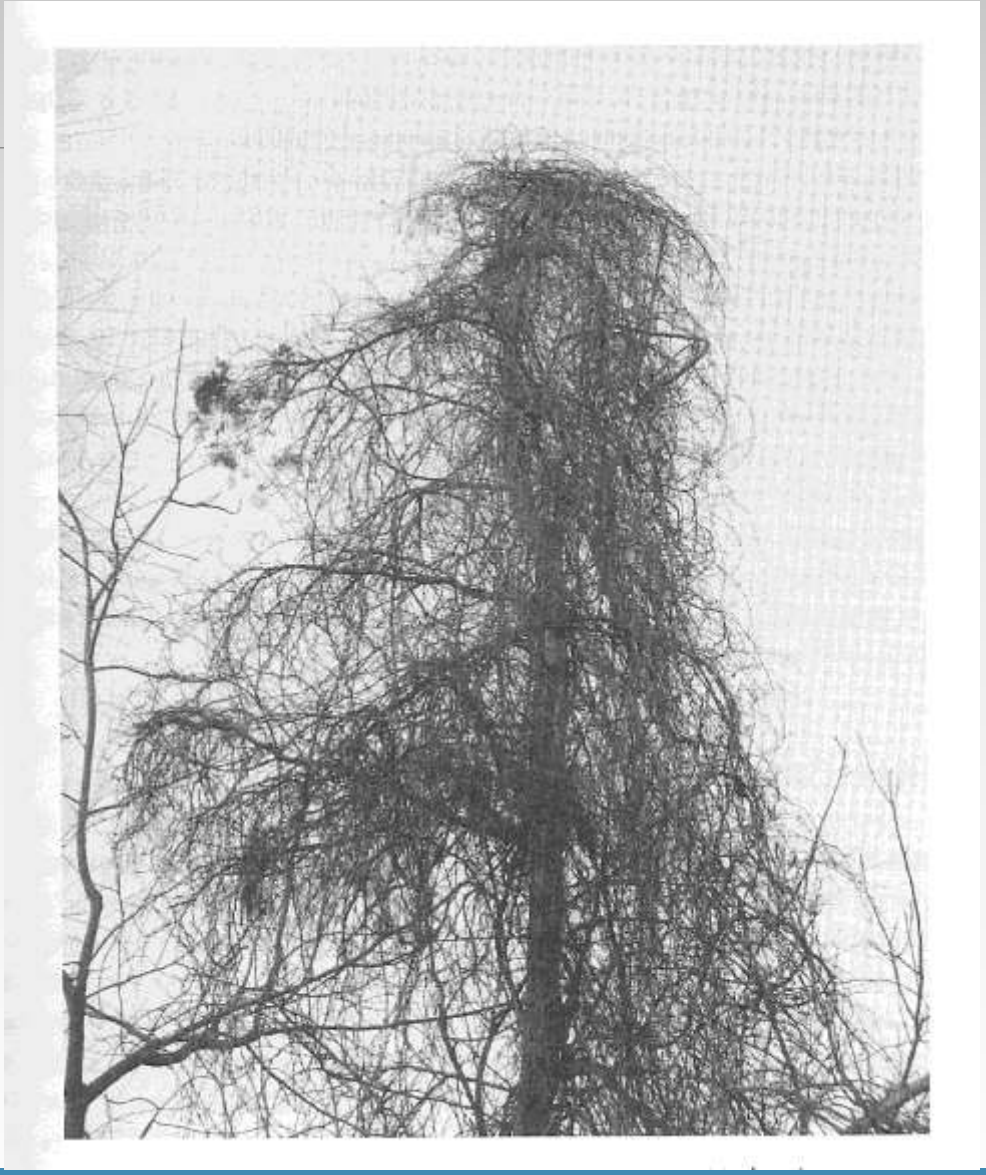
Grapes are a *liana:* a climbing vine

- 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

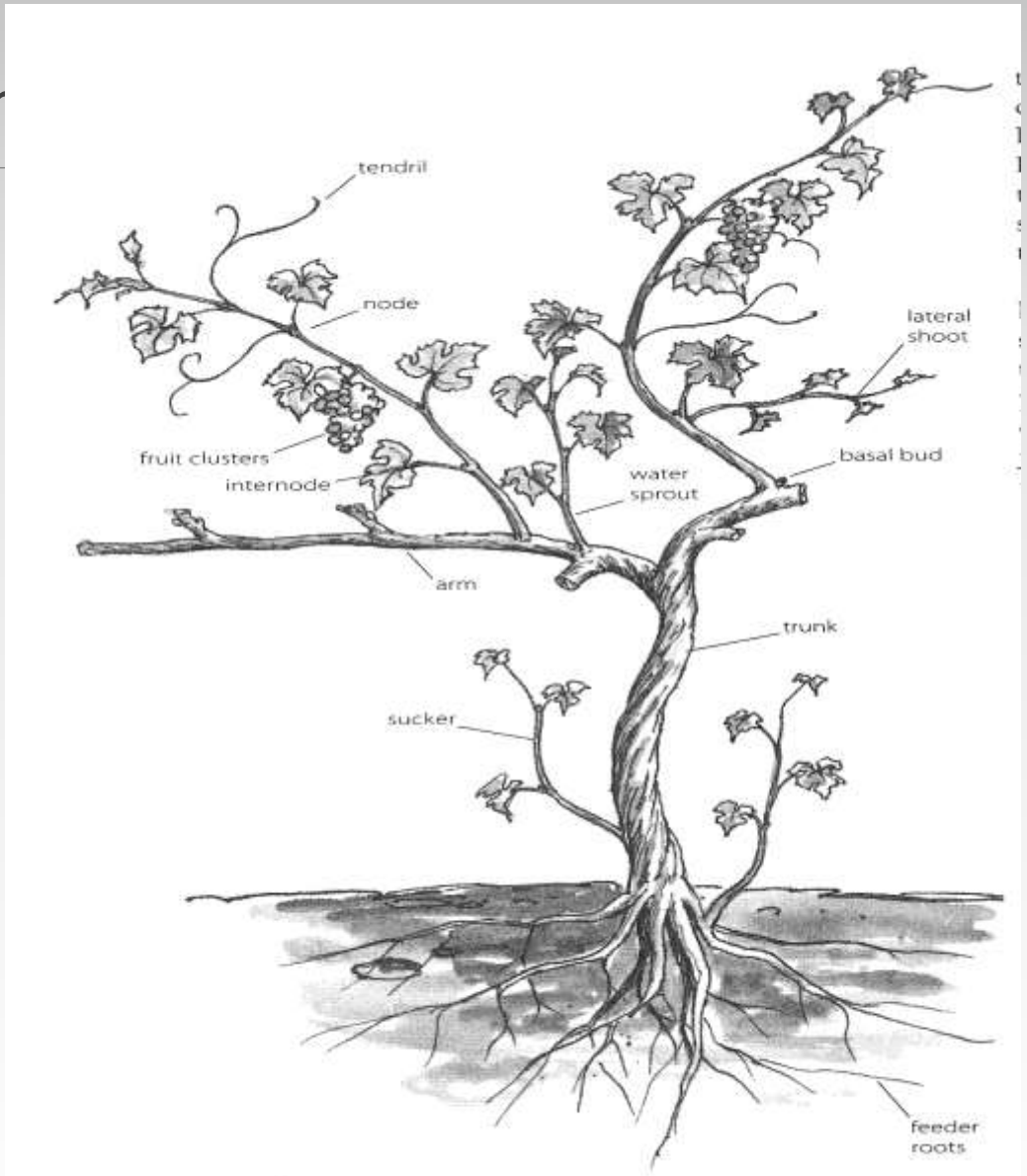
Apical dominance encourages growth vertically to exploit solar reception



Source: Creasy & Creasy, *Grapes*

Grape Plant Structur

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



Structural components of a grape vine.

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 vinyard 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.

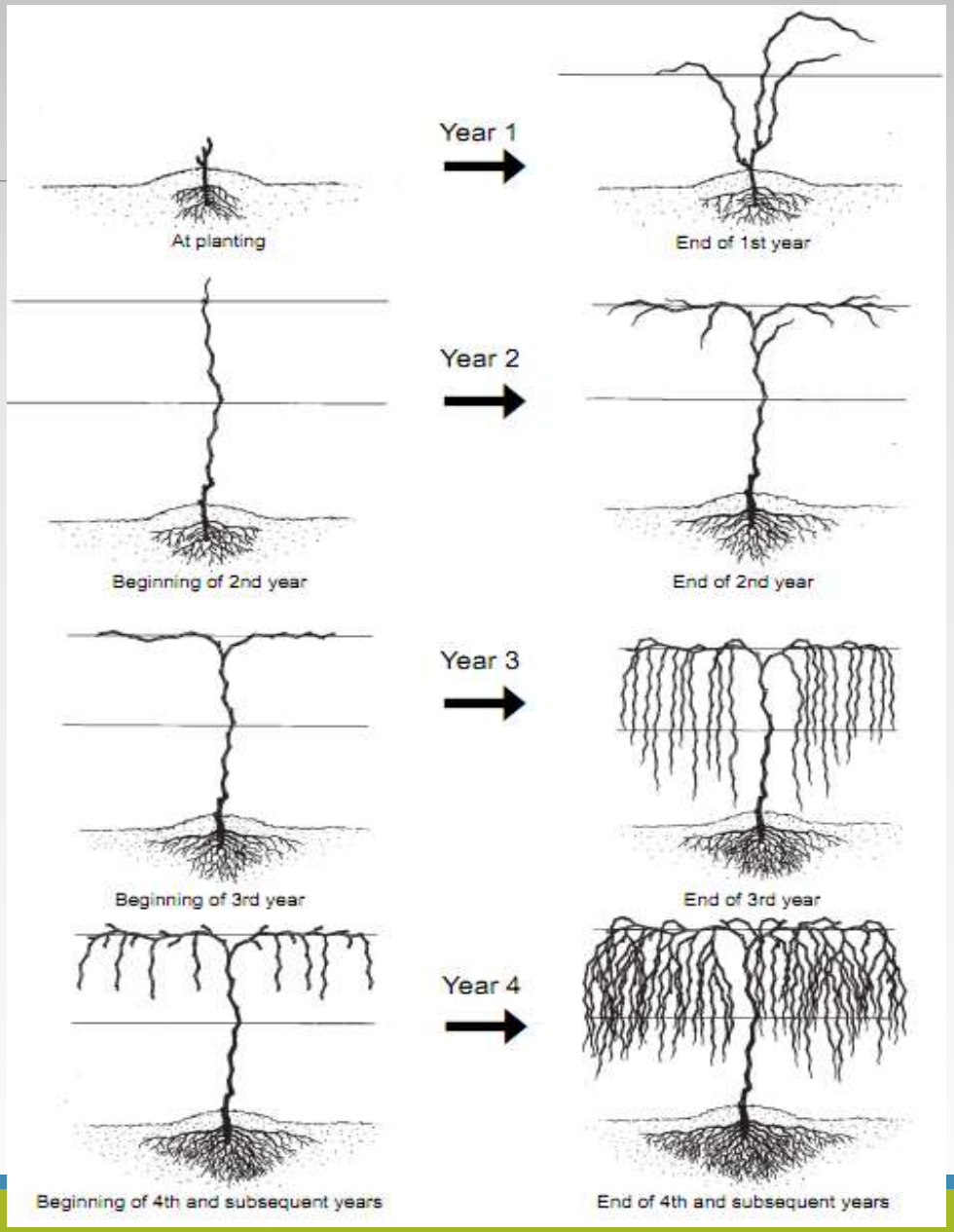
During the first year, the vines are normally tied to a stake to keep them off the ground.

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

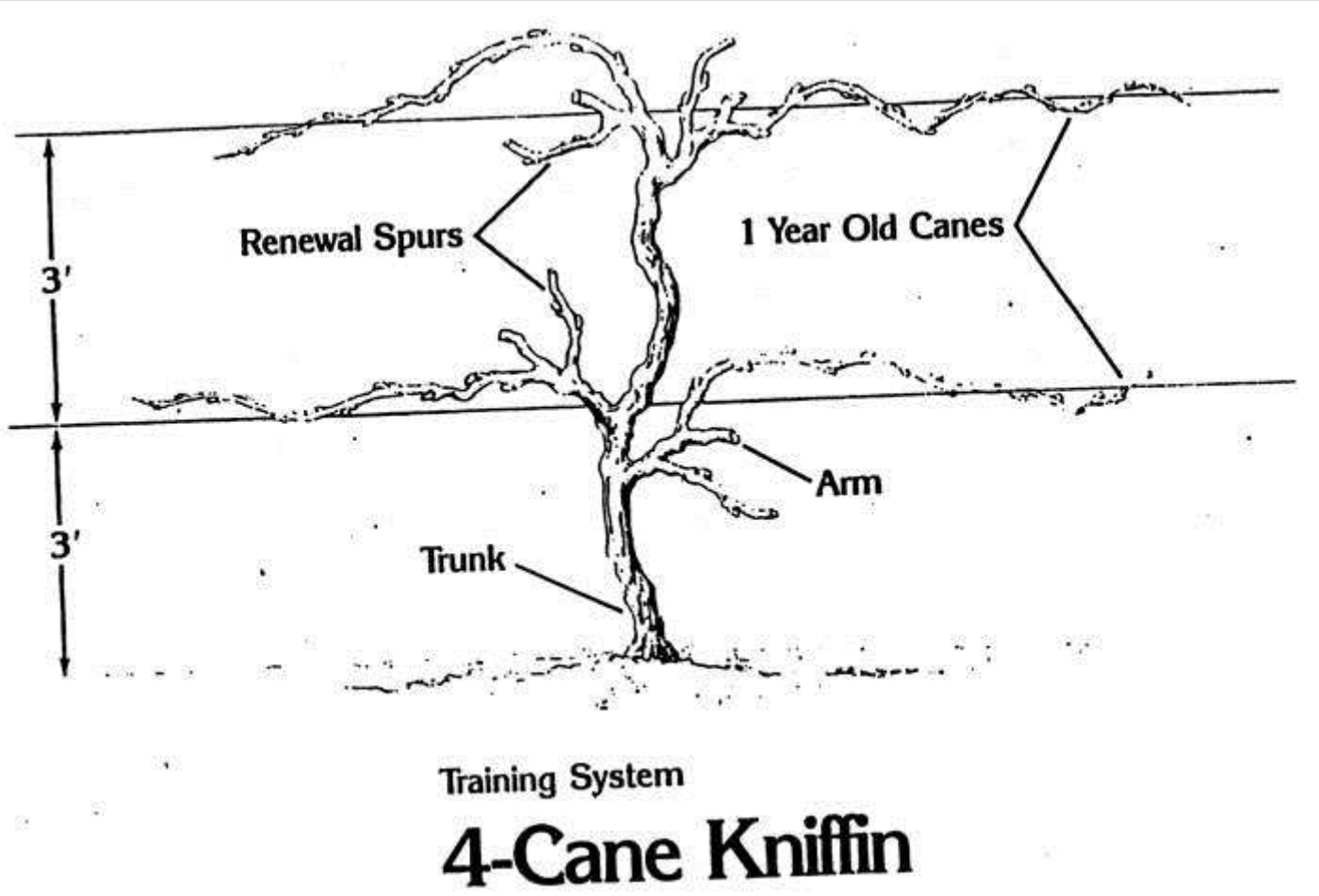
Season 2: Train a single trunk plus one renewal spur to the wire, remove all else

Season 3: Develop fruiting arms (cordons) or vine head

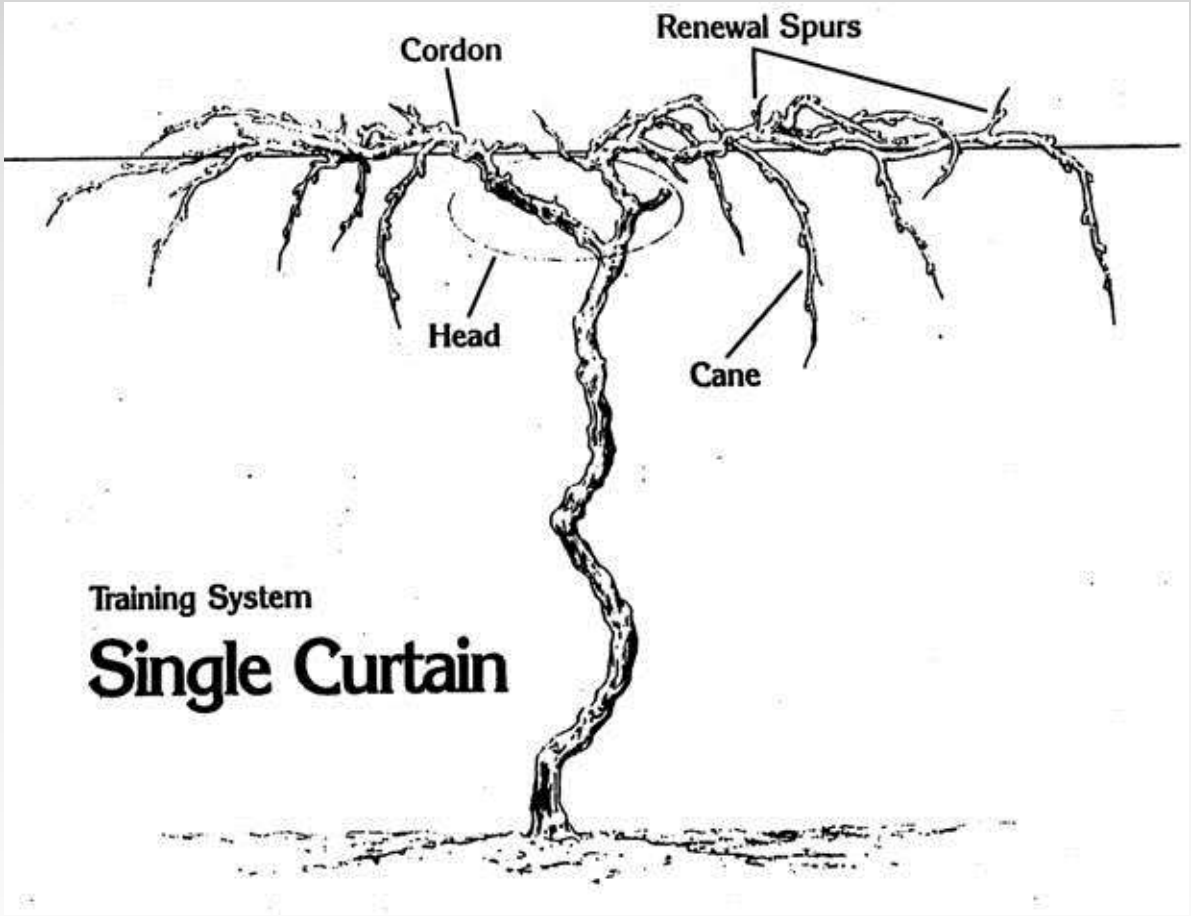
Early vine training



Training System
4-Cane Kniffin

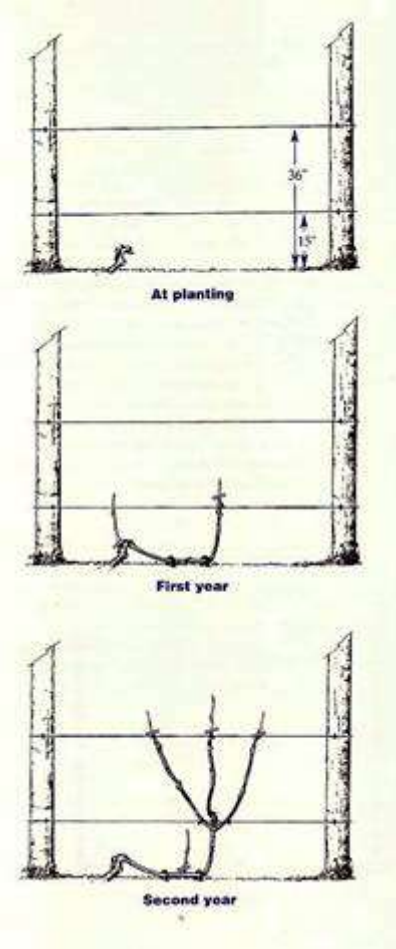


Training System
Single Curtain

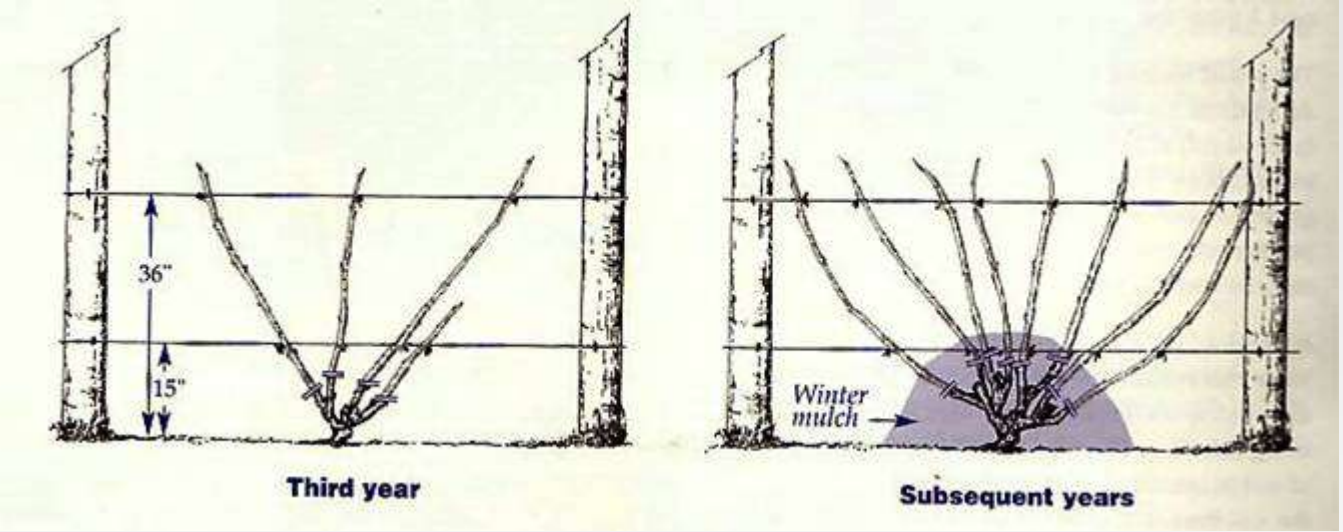


Training System
Single Curtain

Training System
Open Fan



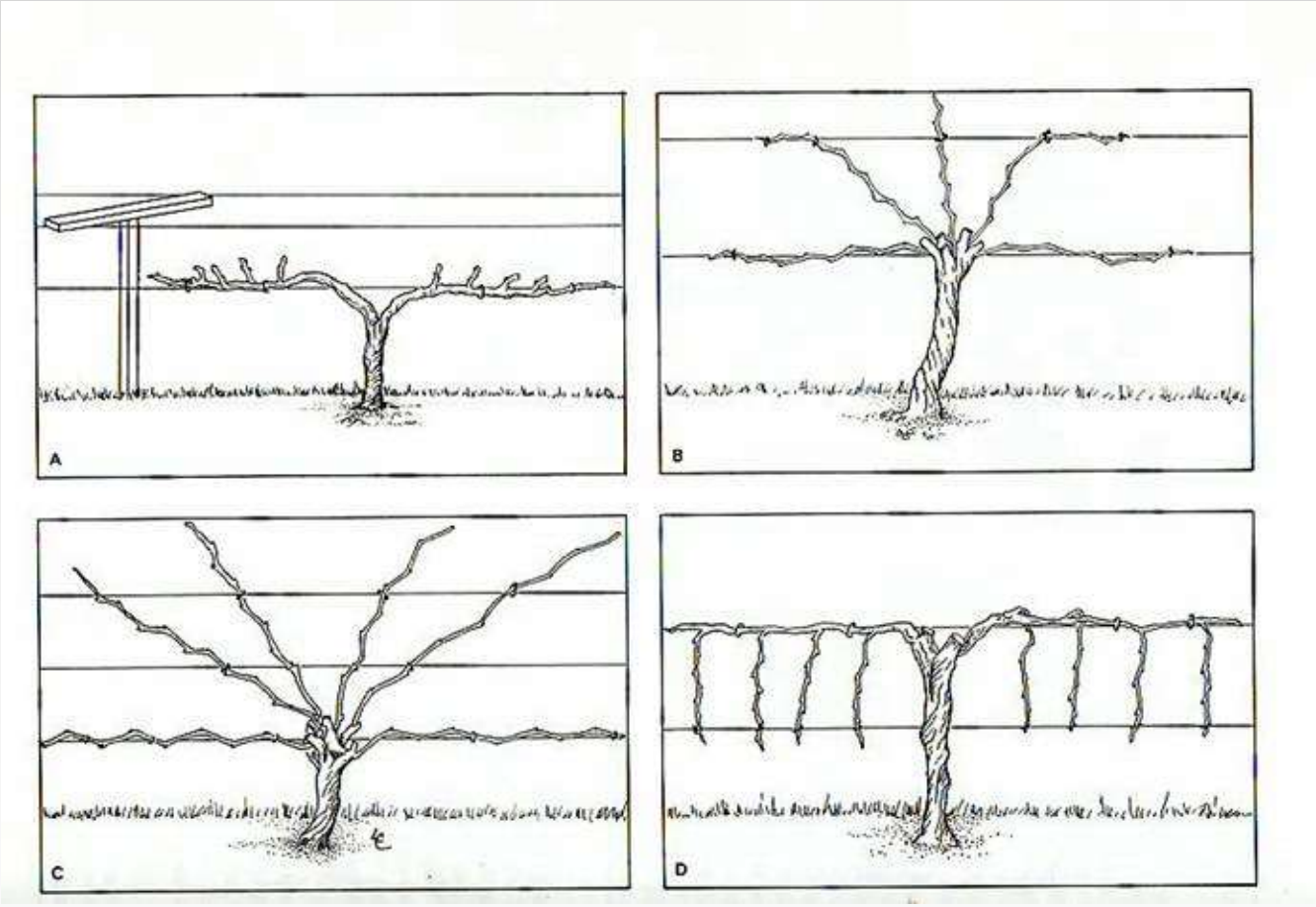
Fan System
(with mulch potential)



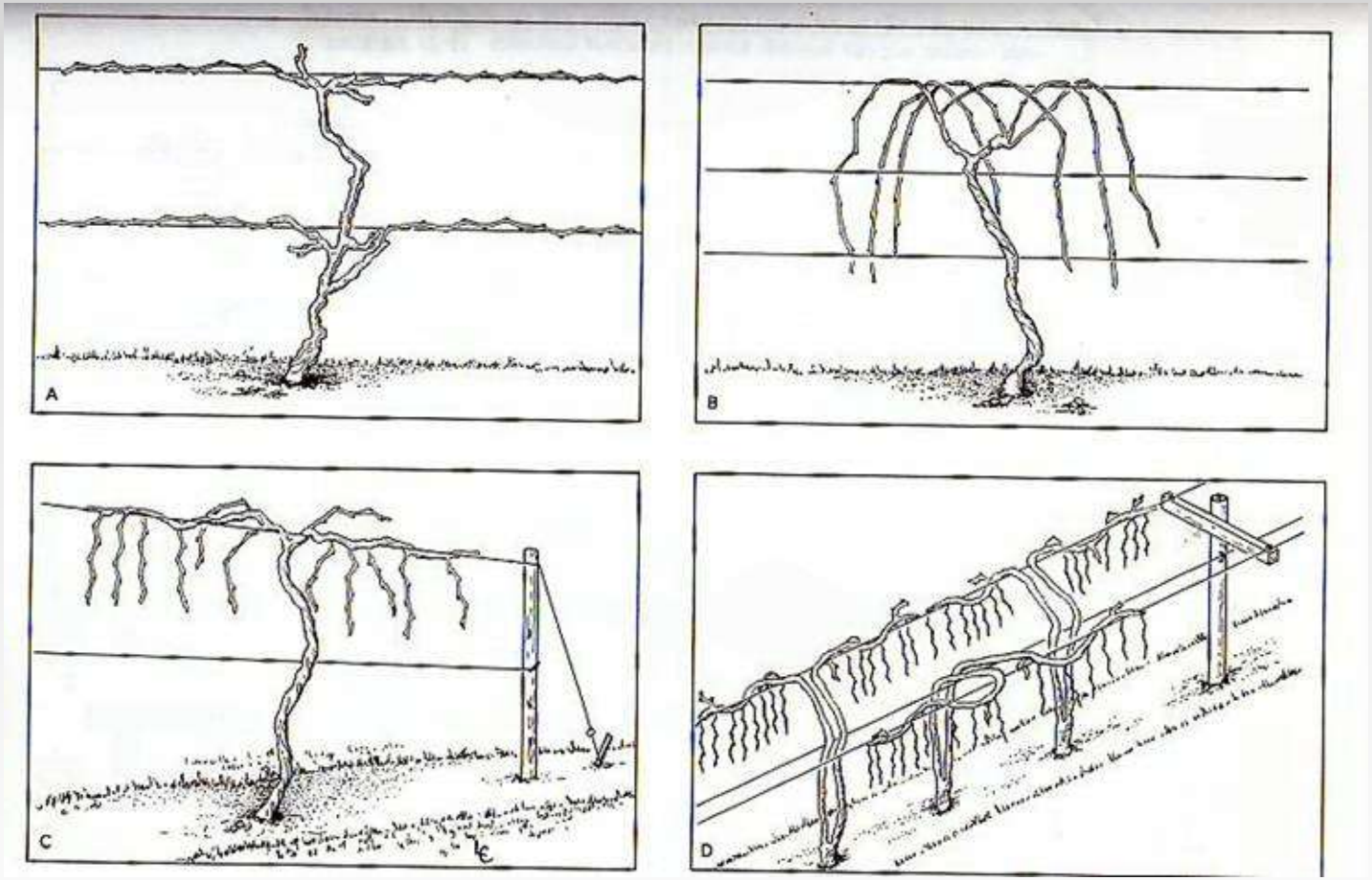
Winter Mulch

- Snow
- Bury in Soil
- Use organic mulch (hay, straw, etc…mice can be a problem.)
- Uncover and trellis before spring growth begins.

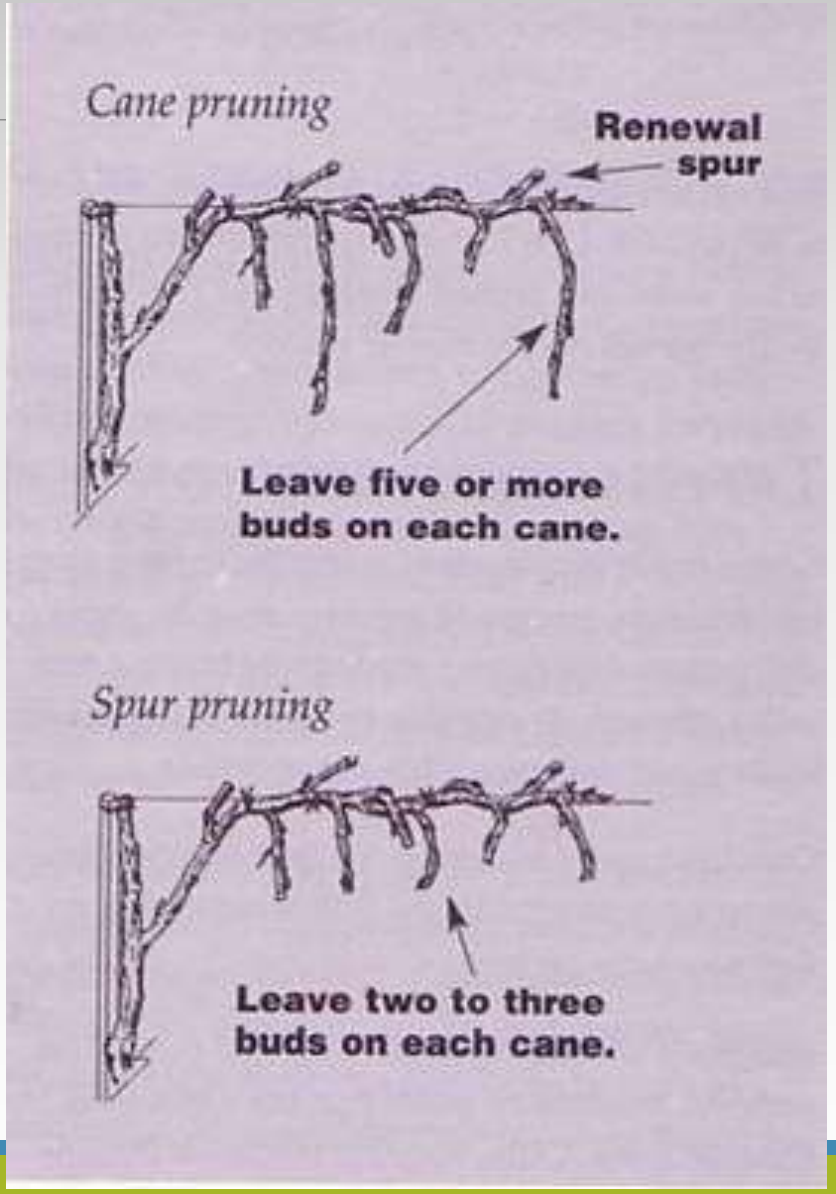
Spur and Cane Training



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 # 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

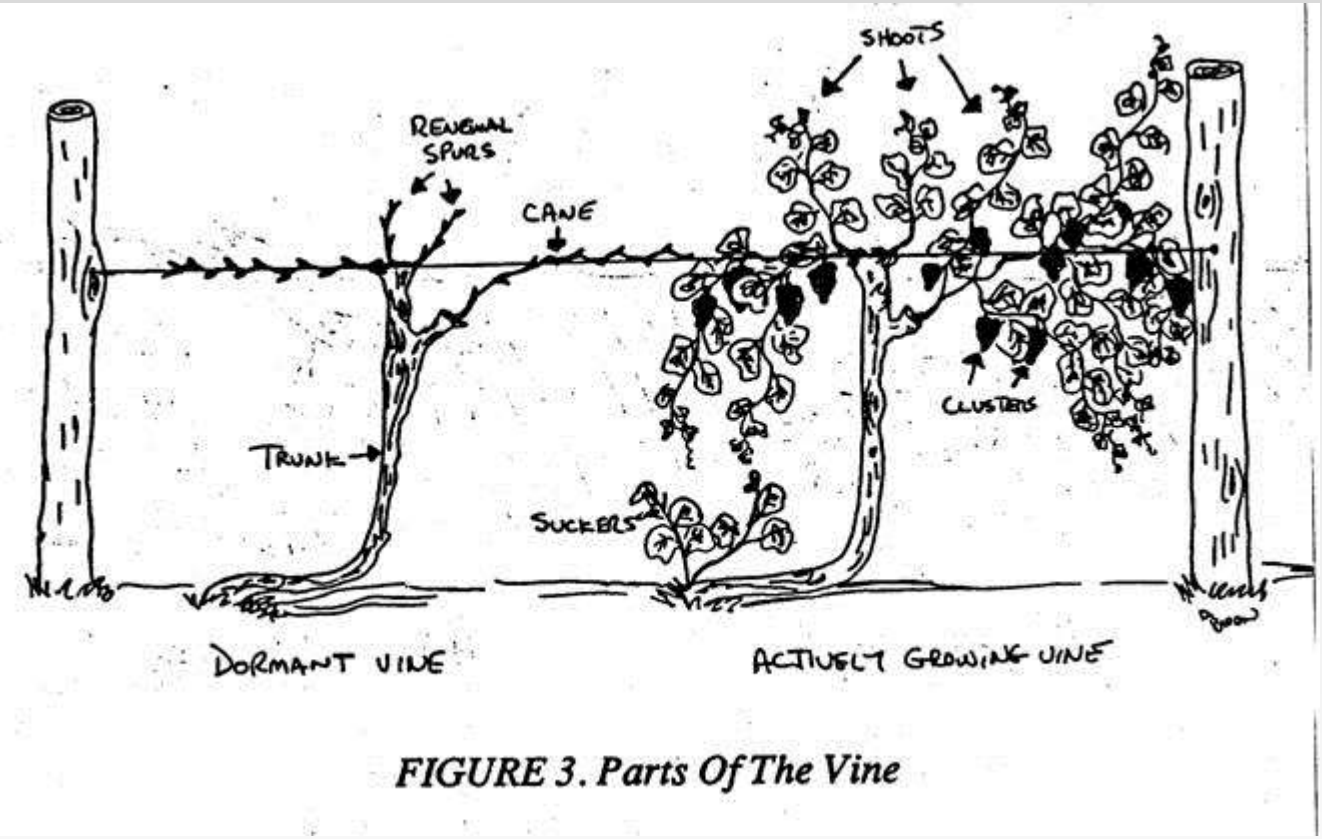


FIGURE 3. Parts Of The Vine

Planting for Training System

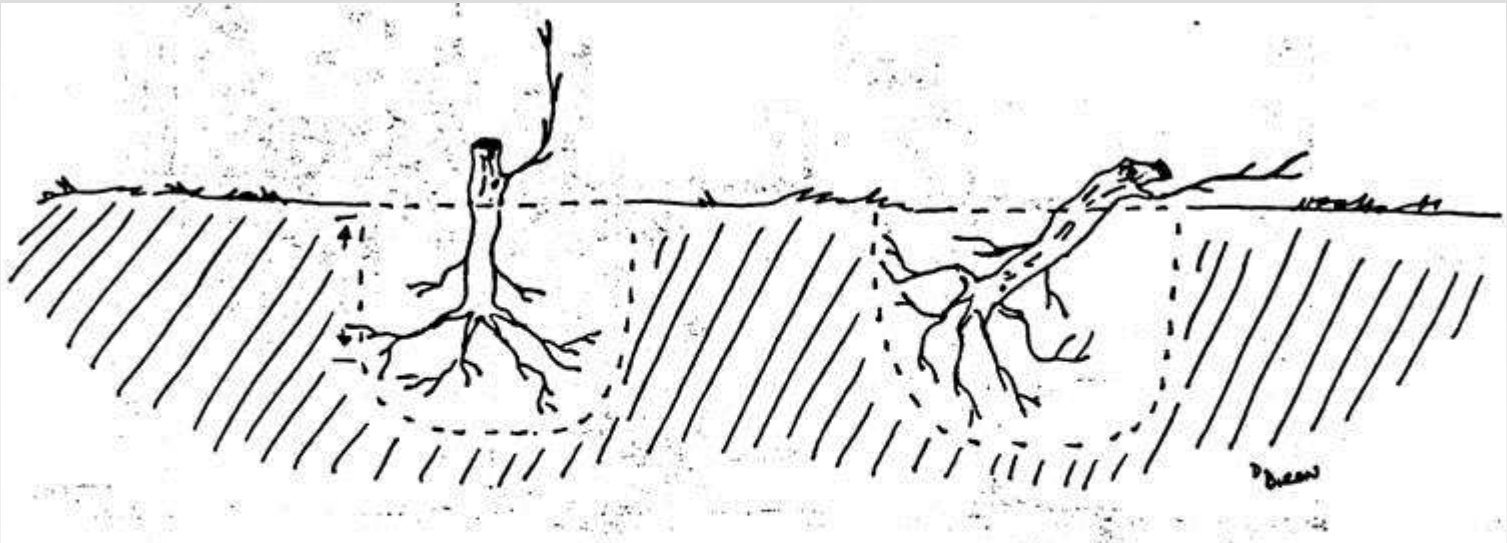


FIGURE 2. Setting Transplants

Before Spring Pruning

Save canes from last seasons 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

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 Grapes- *Hardiness*

Valiant

Beta (Alpha)

King of the North Bluebell

Swenson Red

Eidelweiss

Other Swenson cvs.

Worden

Fredonia

Concord

Somerset Seedless

Trollhaugen

Table Grapes- *Maturity*

Valiant (late Aug.)

Beta

Swenson Red (early Sept.)

Bluebelle (mid to late Sept.)

Eidelweiss

Suelter (late Sept.)

King of the North

Worden

Somerset Seedless

Trollhaugen

Mars

Vanessa

Wine Grapes

St Croix

St. Pepin

Lacrosse

Kay Gray

Petite Pearl

Frontenac

Prairie Star

Louise Swenson

Swenson White

Corot Noir (Tender)

Leon Millot

Marquette

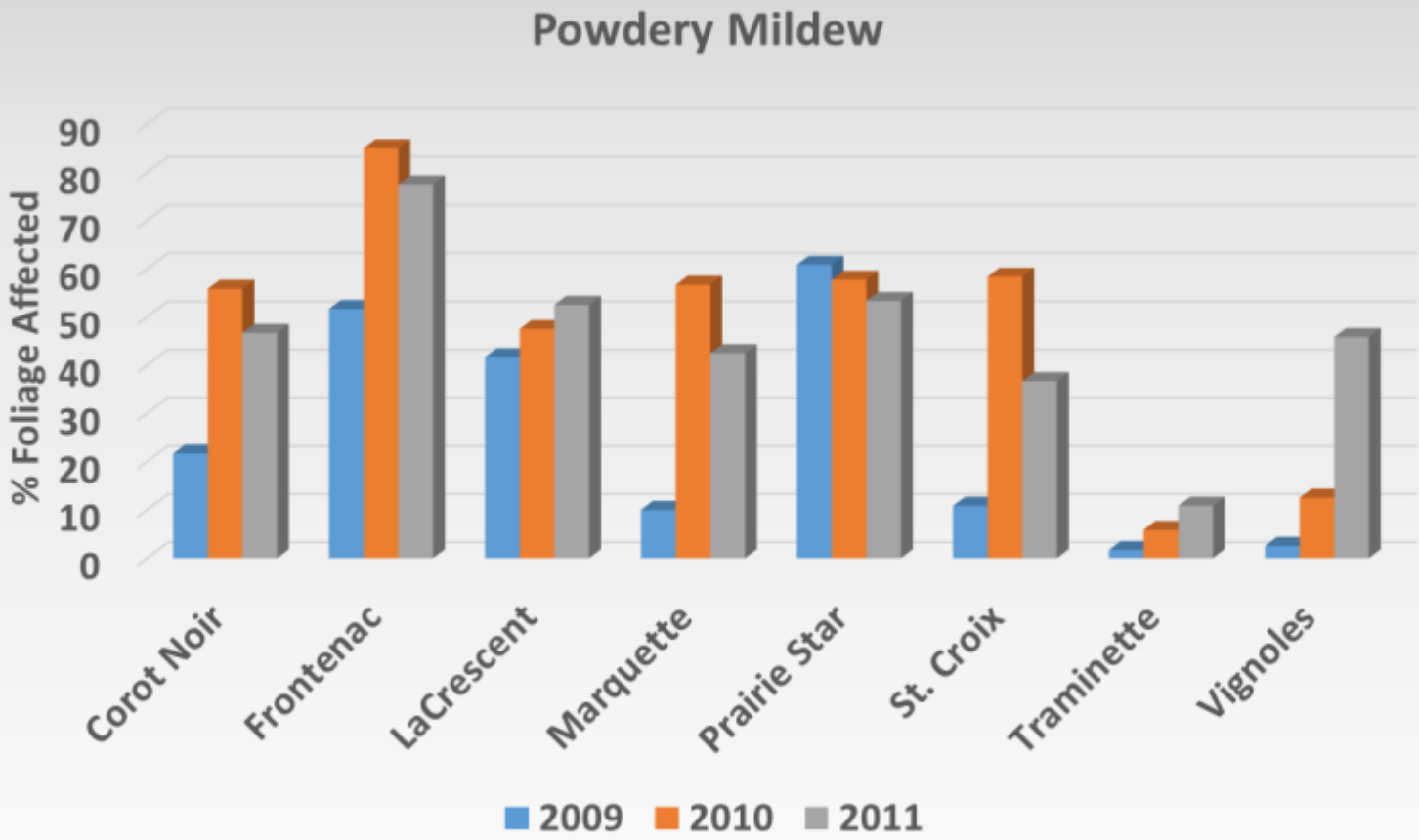
Traminette: 1996 Cornell release

- 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/ac (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



Berkett, L.P, Bradshaw, T.L., Kingsley-Richards, S.L., and M.C. Griffith. 2013. Disease evaluation of selected cold climate wine grape cultivars in Vermont, USA. IOBC-WPRS Bulletin 105:29-33.

Foliar Disease Incidence 2014-2015
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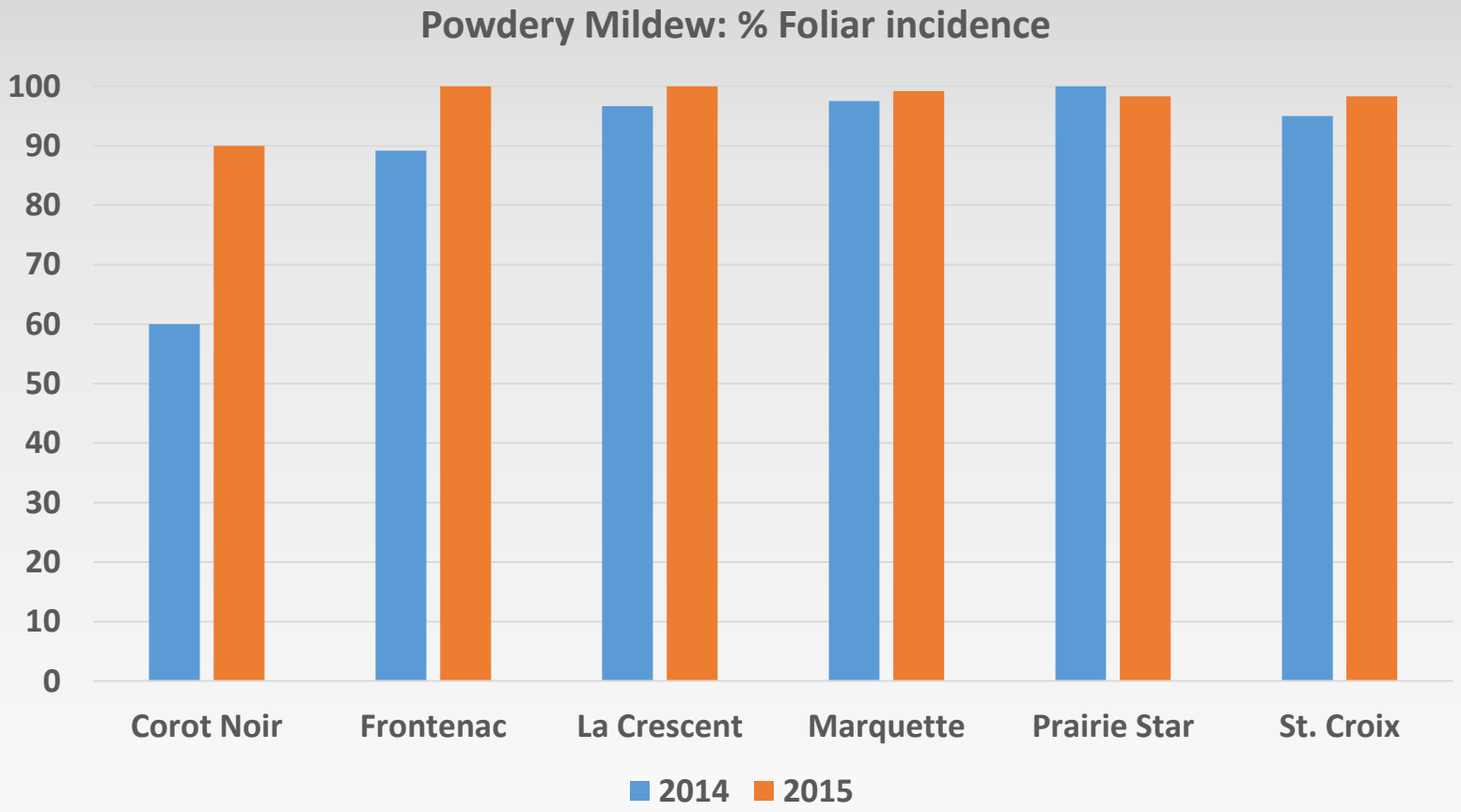

Unpublished data

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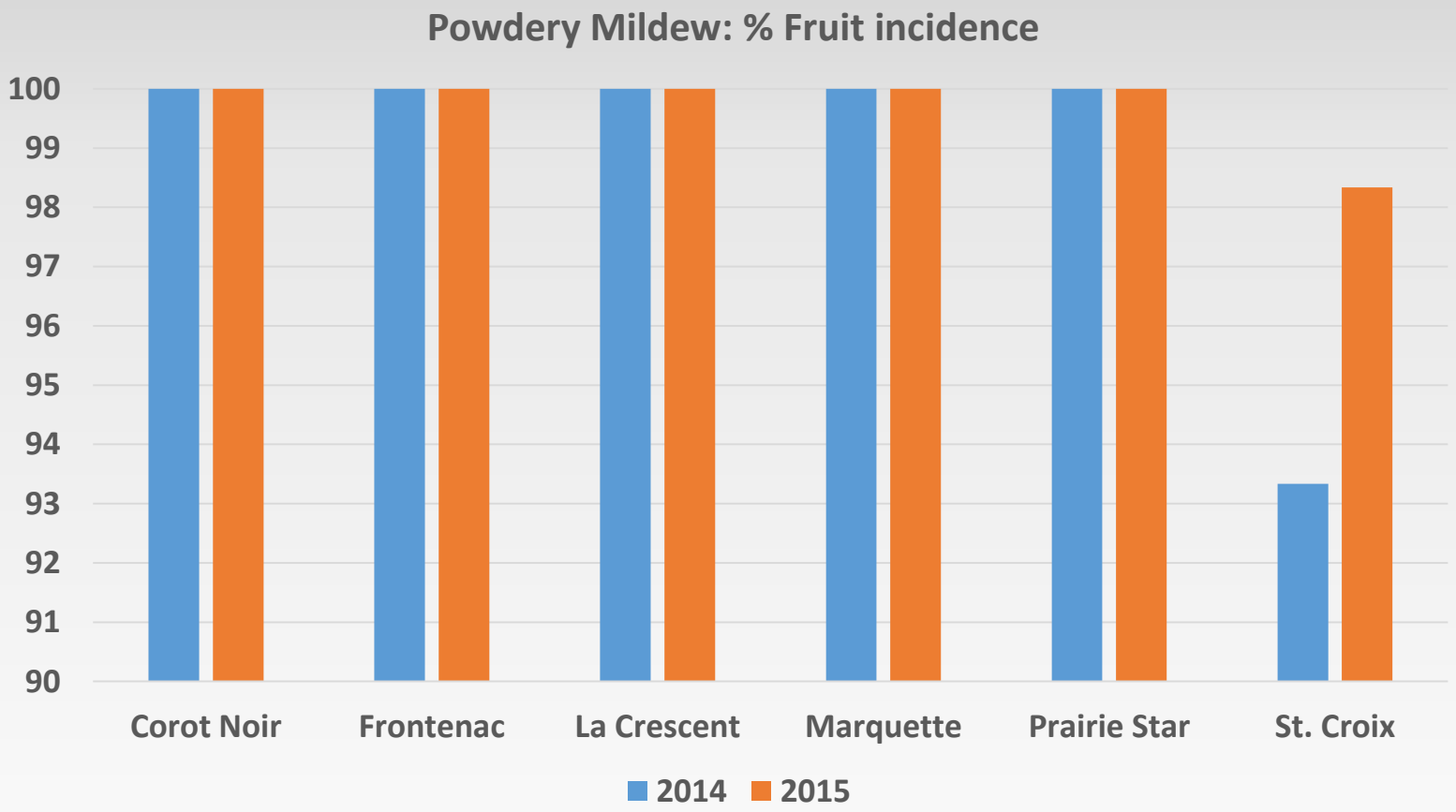

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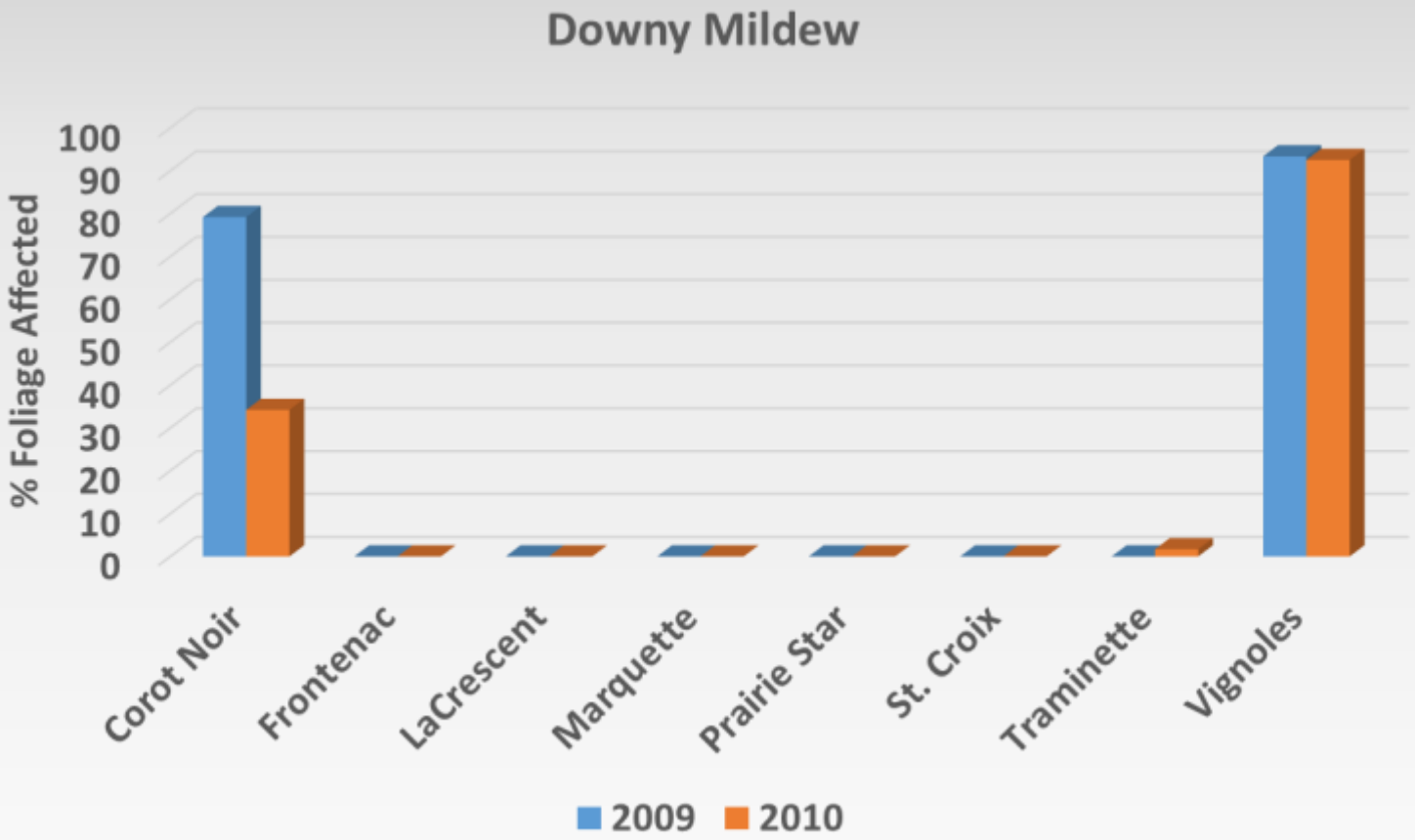

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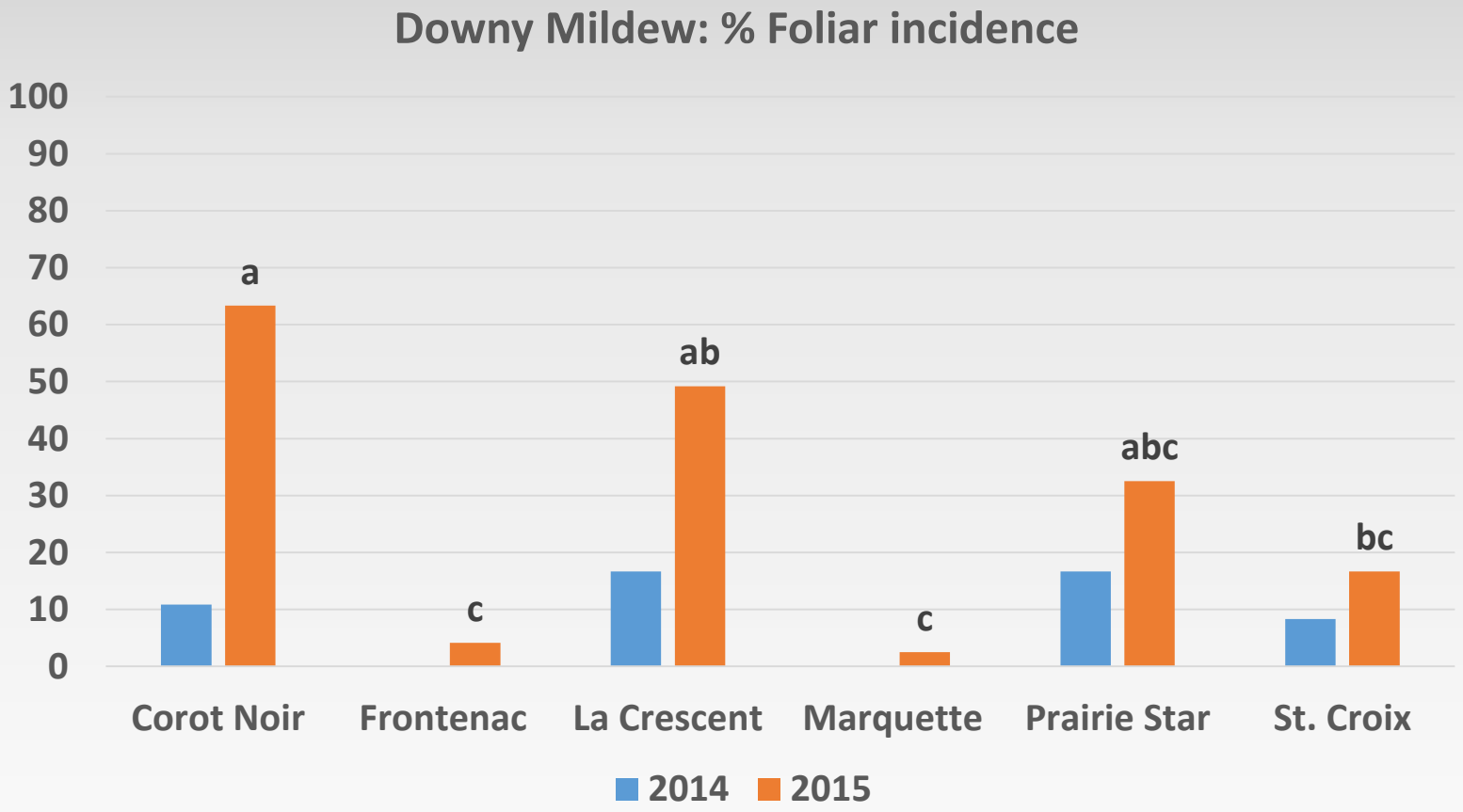
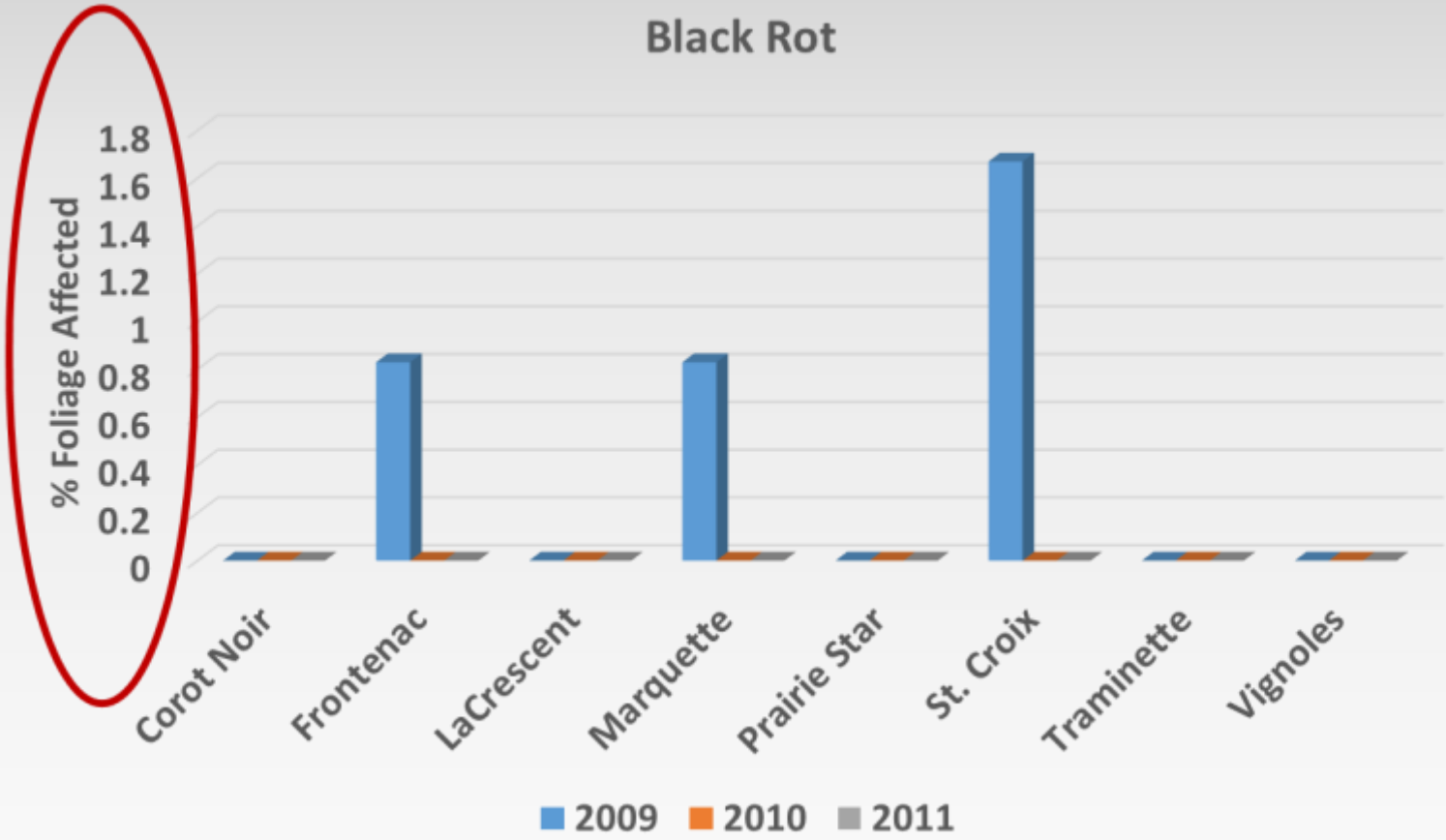


Unpublished data

Disease Incidence
'Typical' 4-5 Fungicide Program

Unpublished data

Foliar Disease Incidence: 2009-2012
'Typical' 4-5 Fungicide Program



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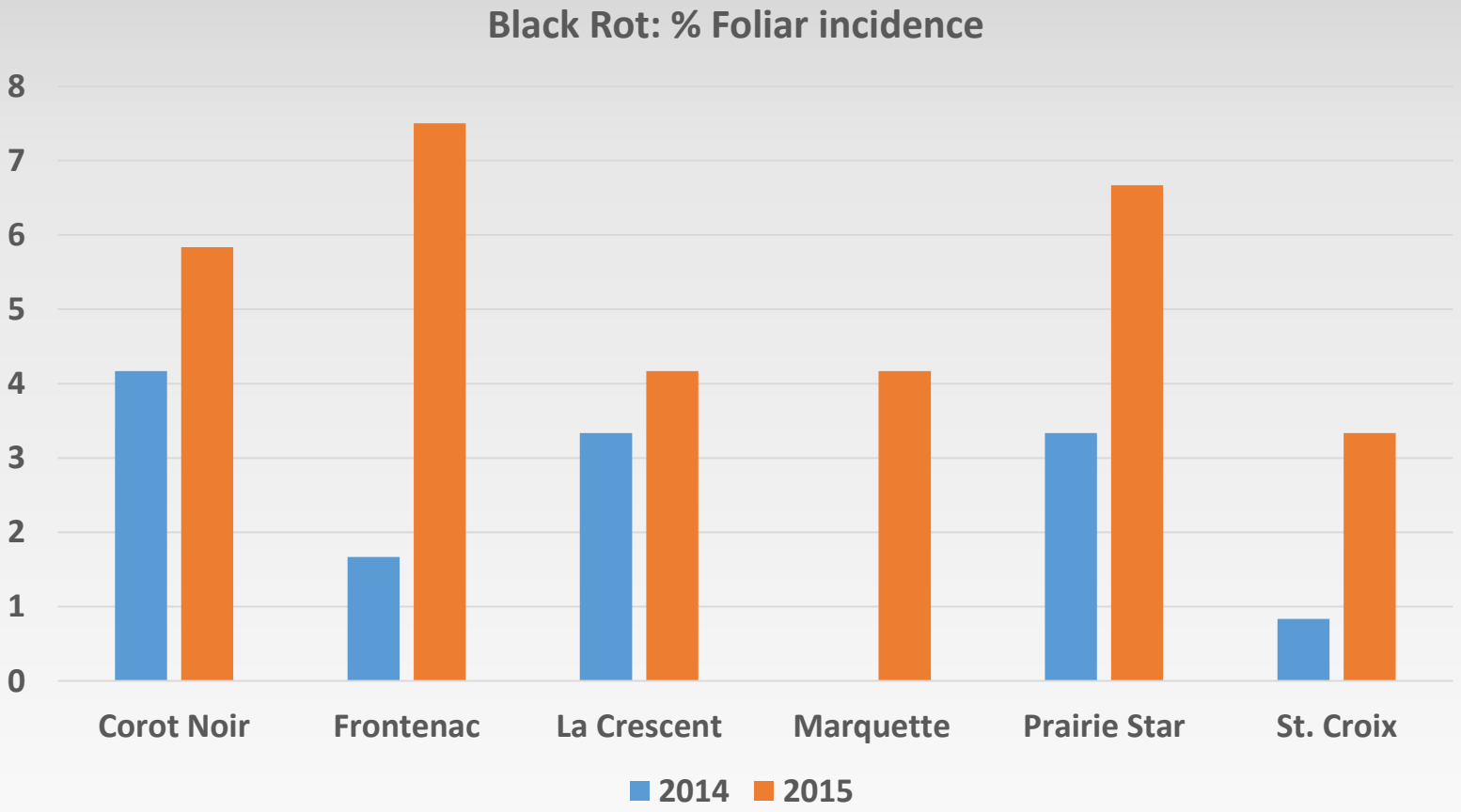
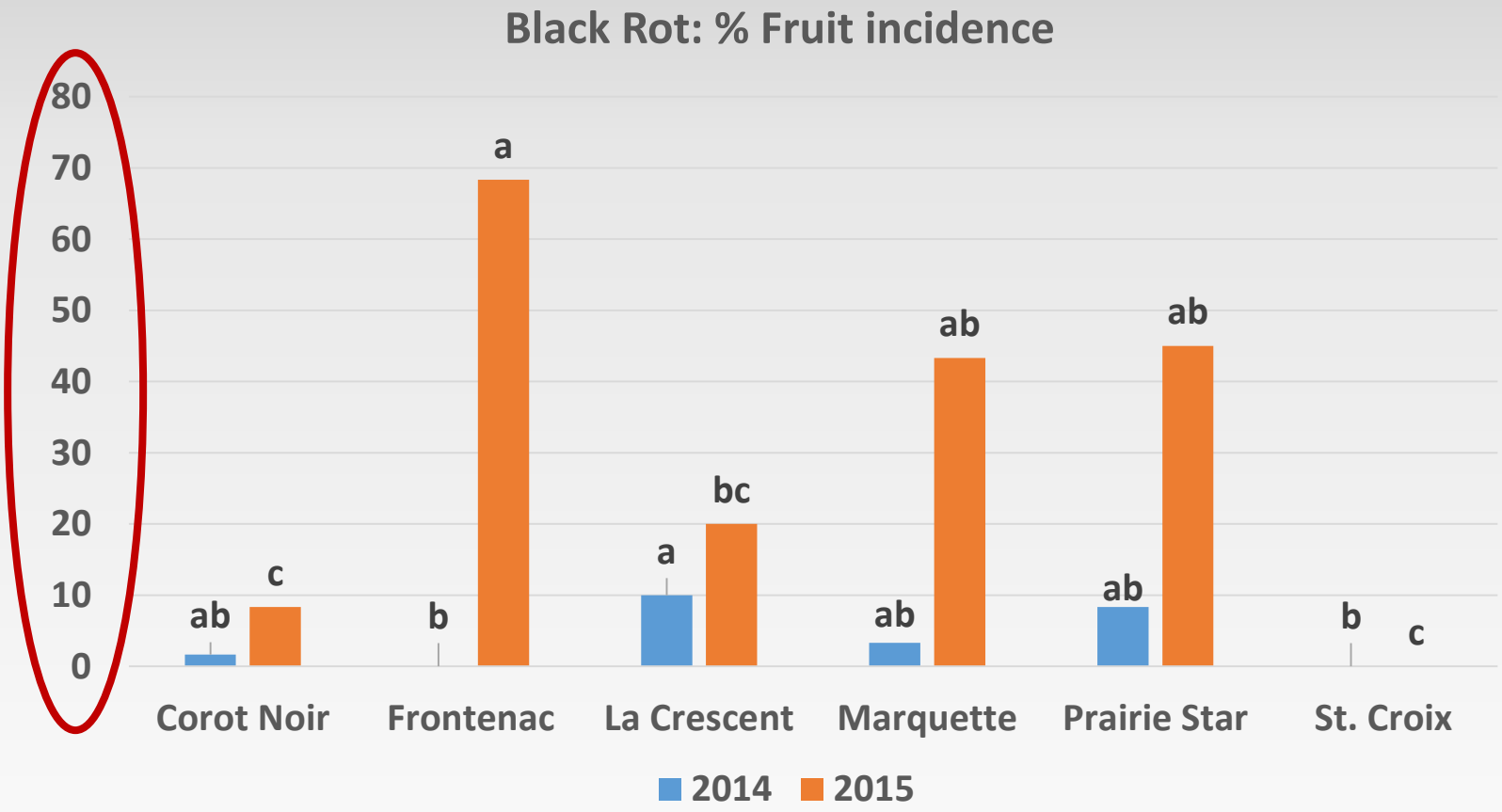


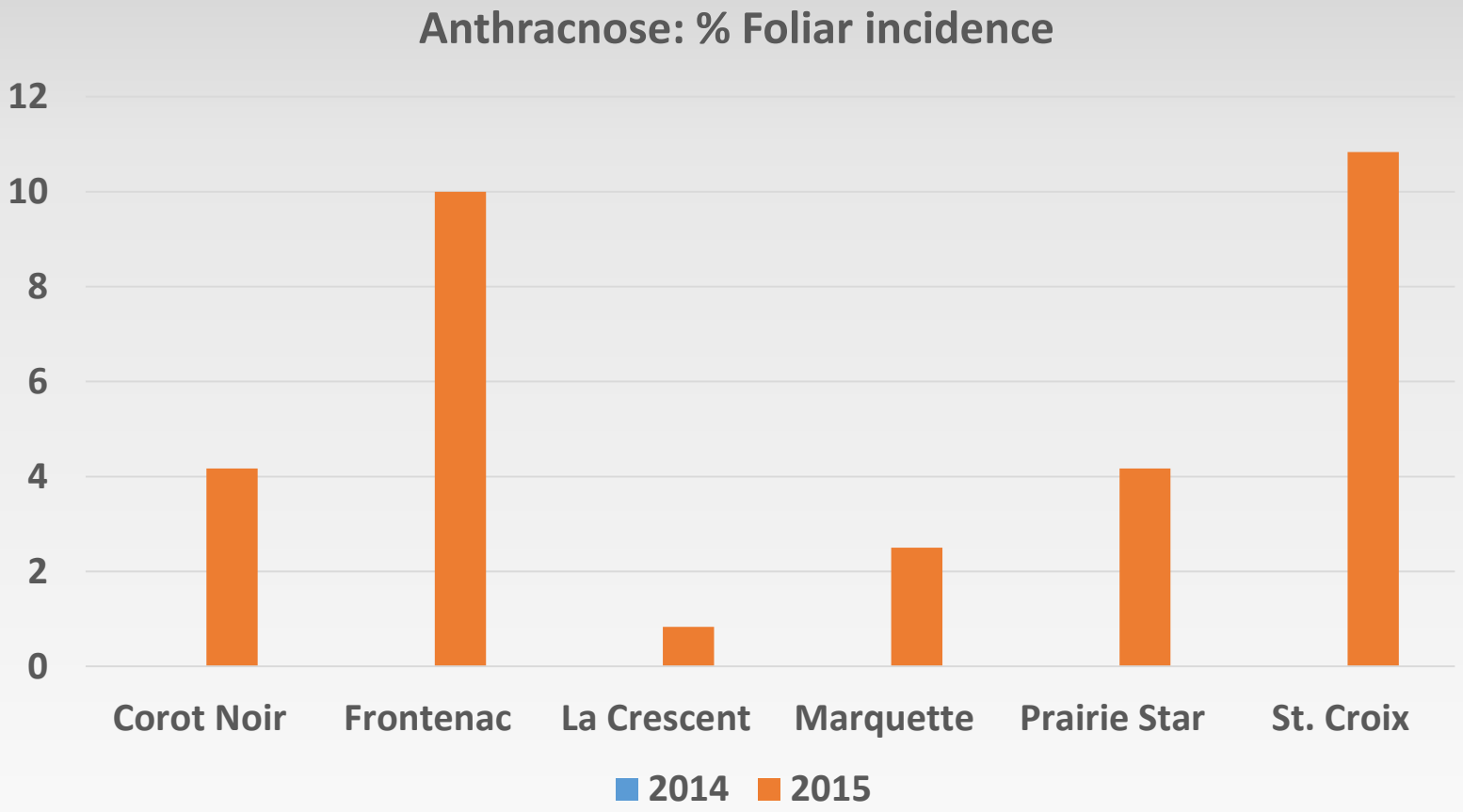
Data unpublished

Cluster Disease Incidence: 2014-2015
'Typical' 4-5 Fungicide Program



Data unpublished

Foliar Disease Incidence: 2014-2015
'Typical' 4-5 Fungicide Program



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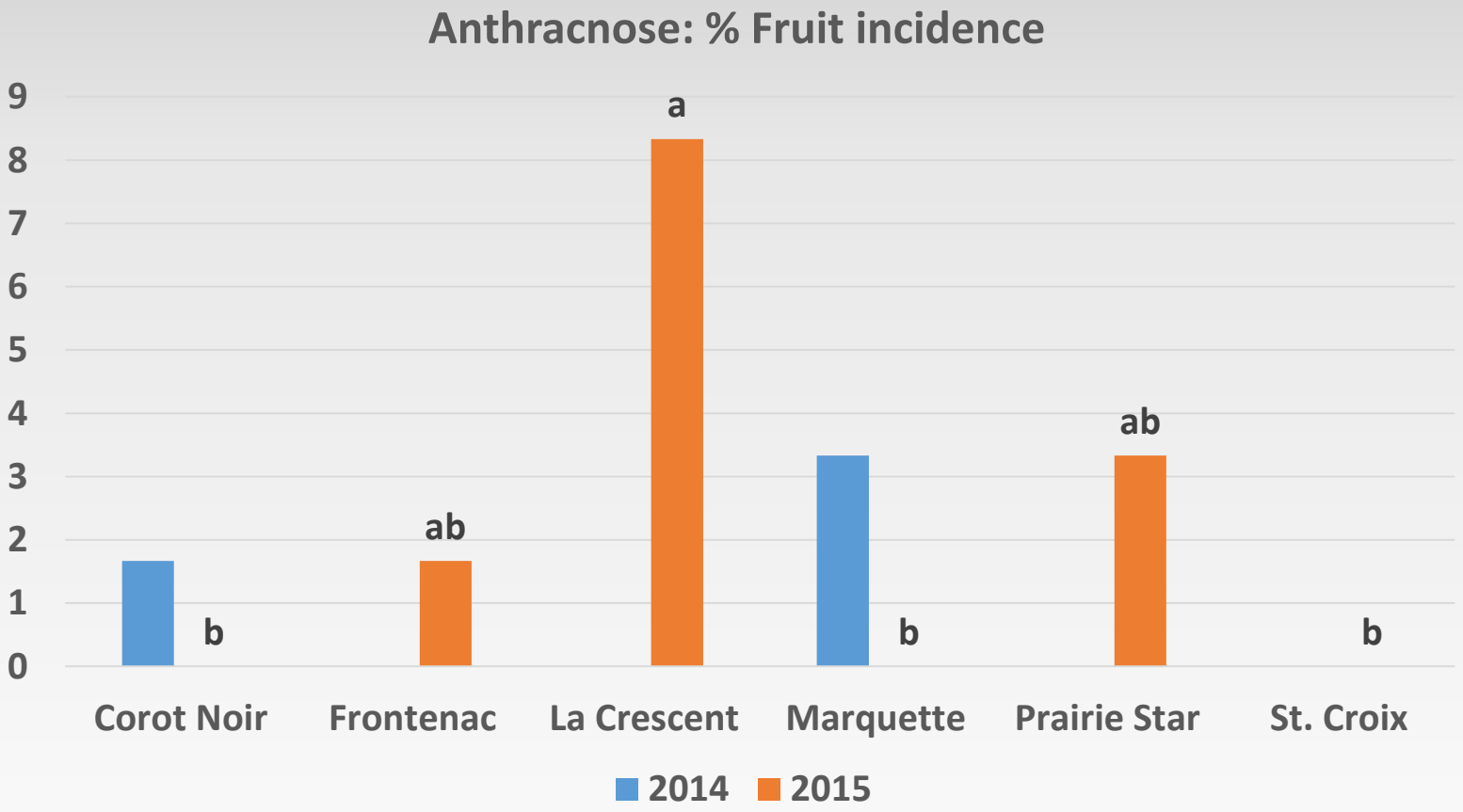
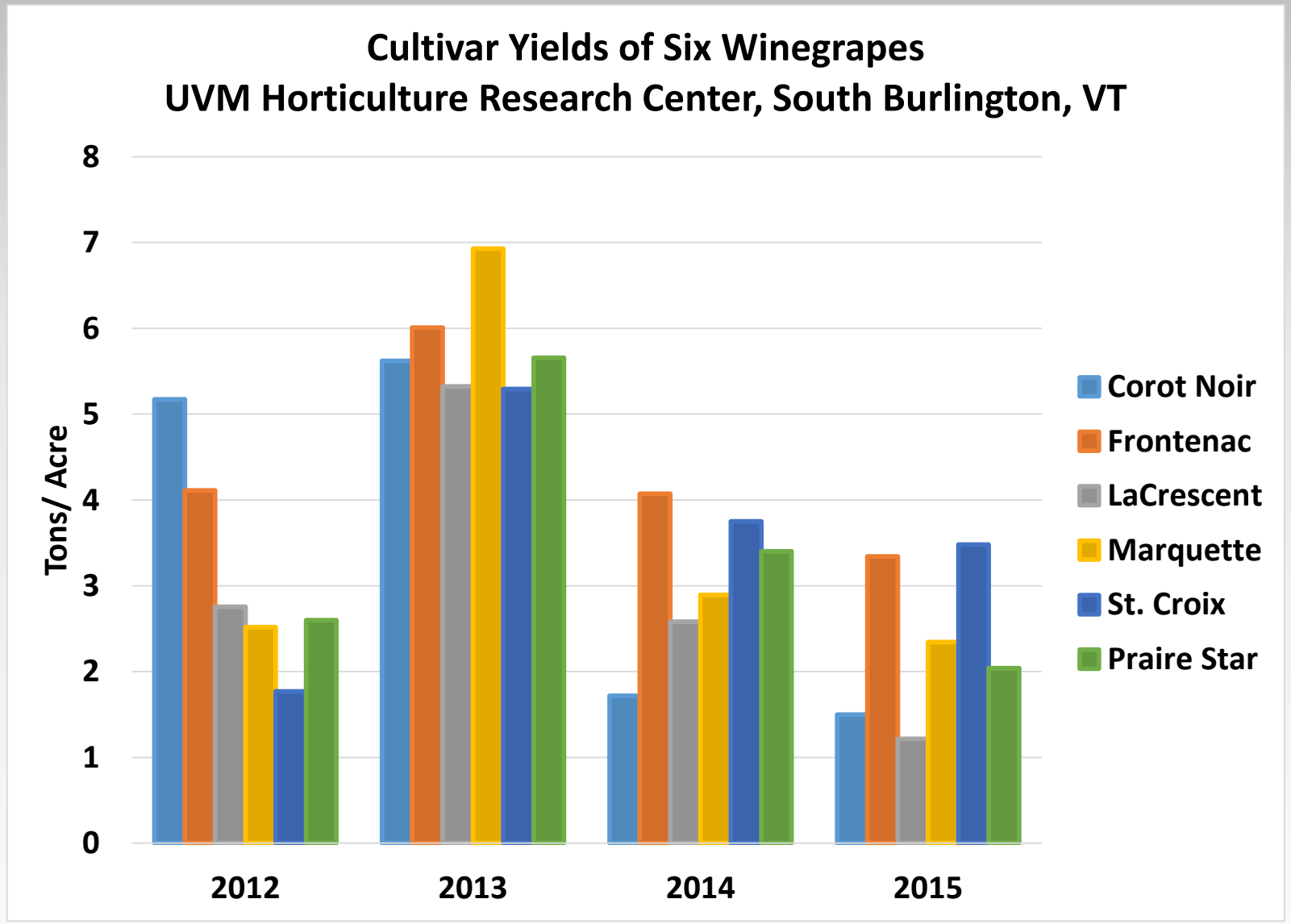
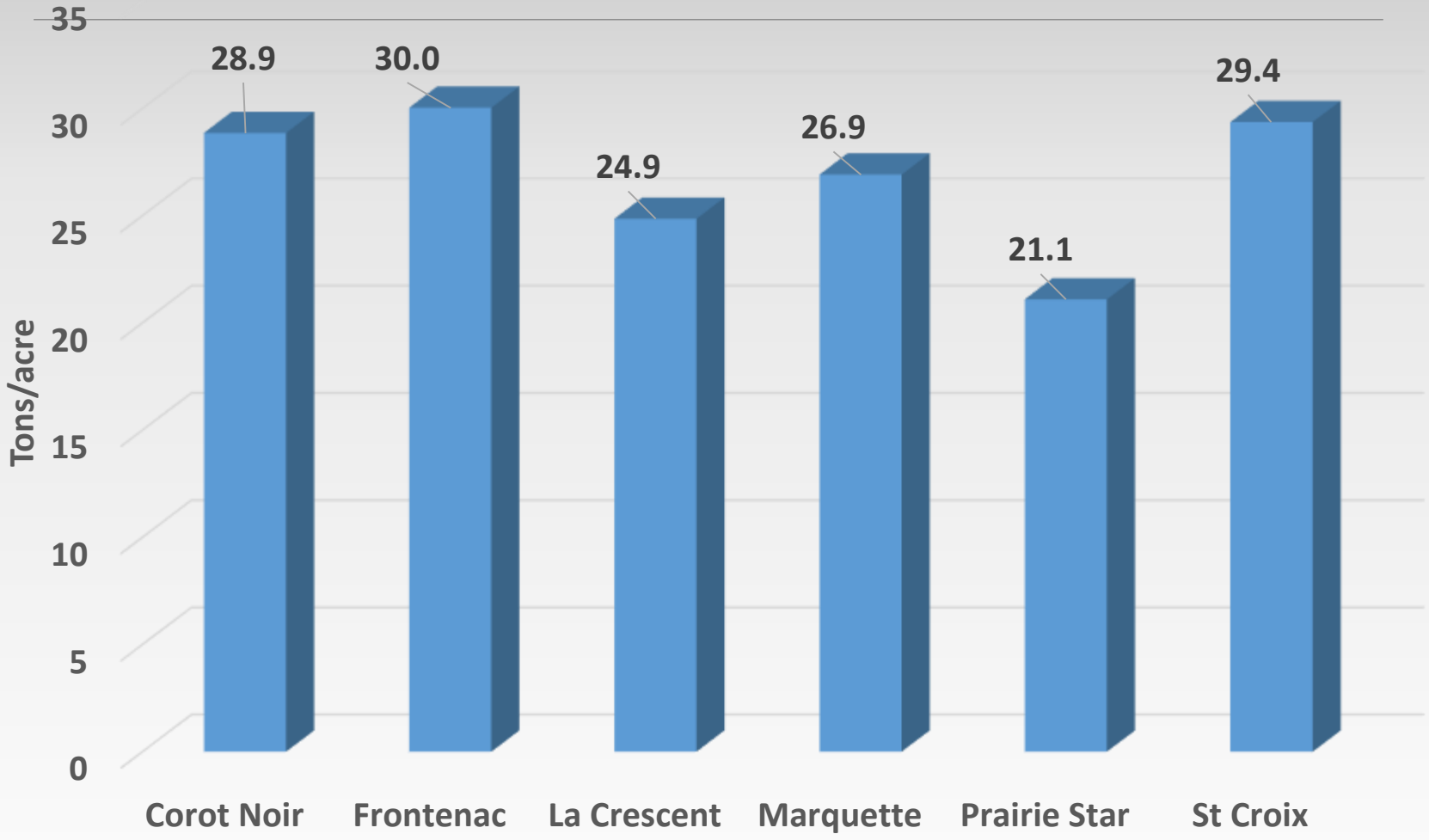
Fruit Disease Incidence: 2014-2015
'Typical' 4-5 Fungicide Program

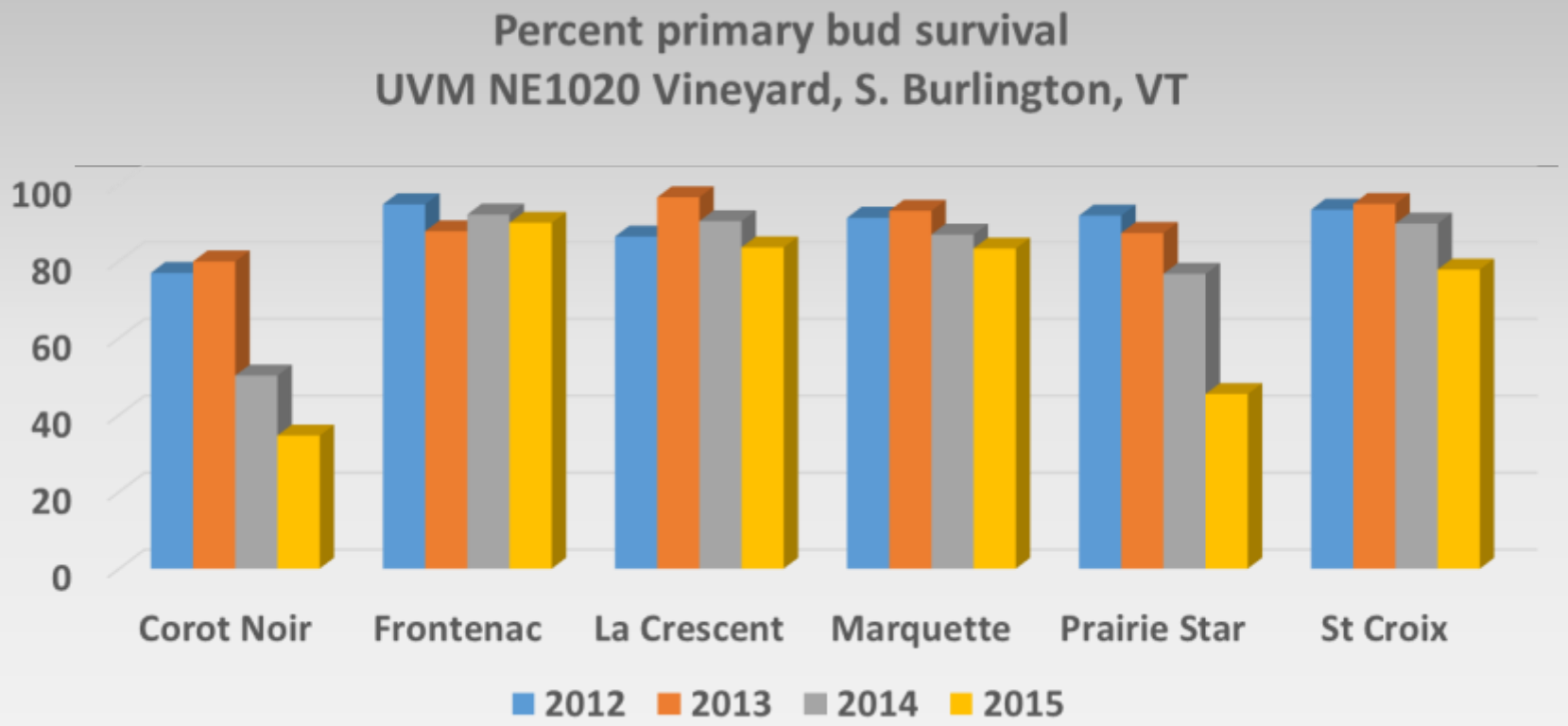


Data unpublished


Cultivar Yields of Six Winegrapes
UVM Horticulture Research Center, South Burlington, VT
Tons/ Acre
0
1
2
3
4
5
6
7
8
2012
2013
2014
2015
Corot Noir
Frontenac
LaCrescent
Marquette
St. Croix
Praire Star

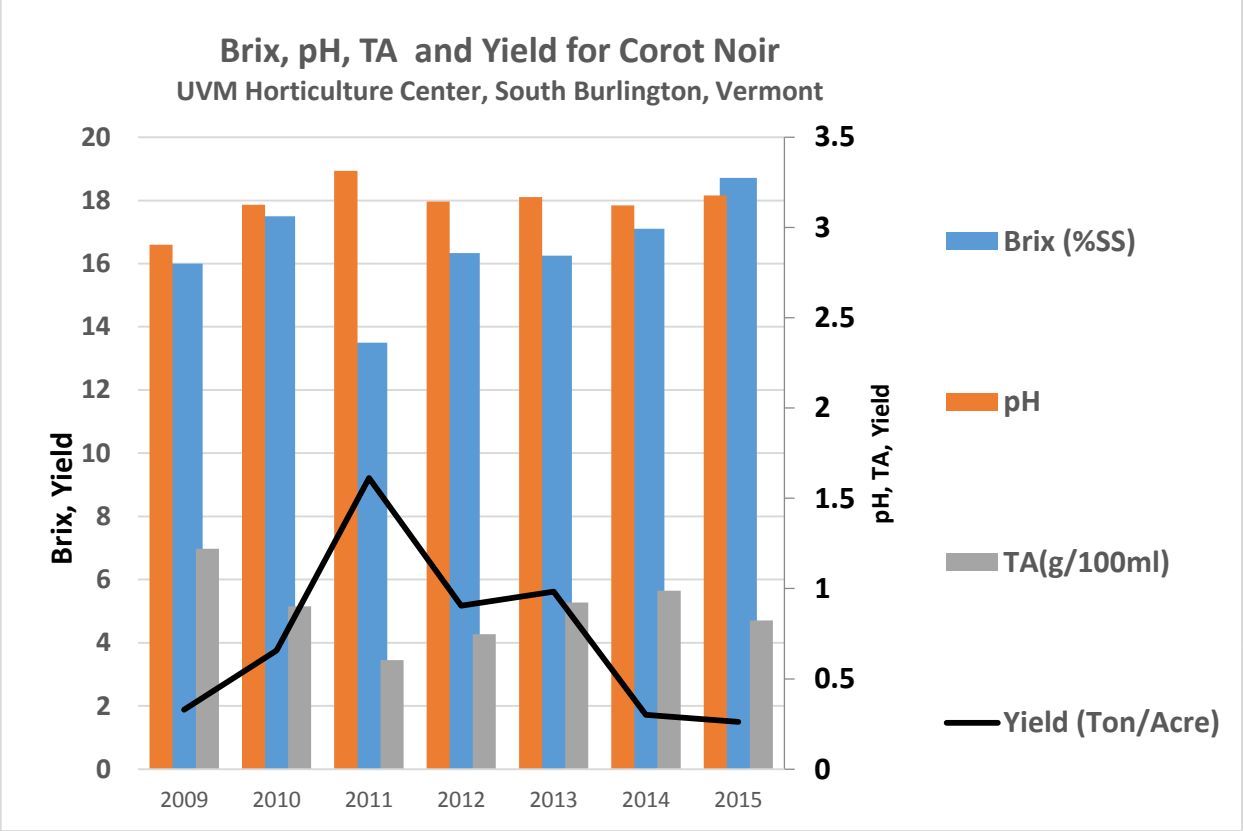
Cumulative Yield, 2009-2015
UVM Horticulture Research Ctr, S. Burlington, VT



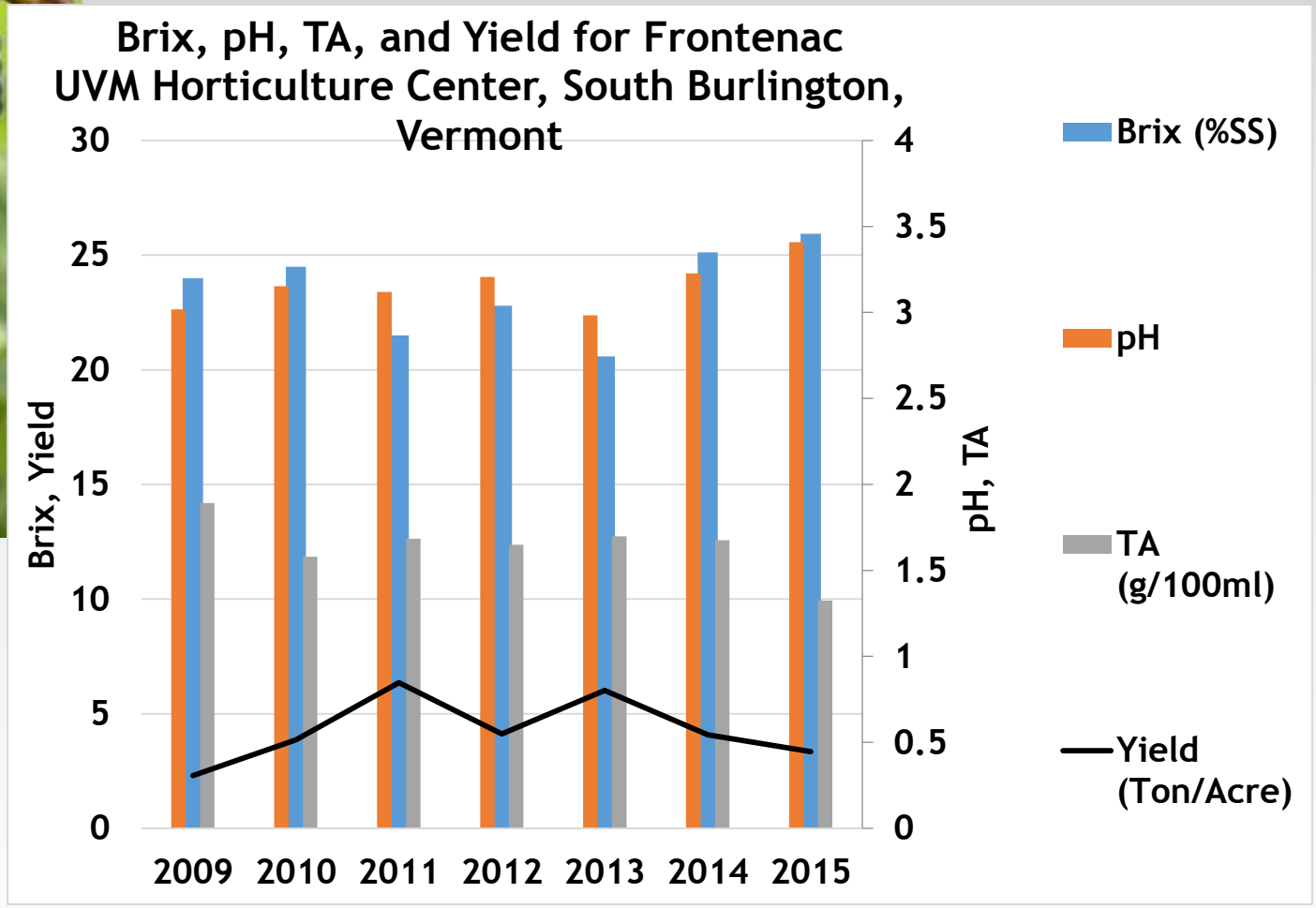


Corot Noir	**77b**	**80b**	**50c**	**35b**
Frontenac	**95a**	**88ab**	**92a**	**90a**
La Crescent	**86ab**	**97a**	**90ab**	**84a**
Marquette	**91a**	**93a**	**87ab**	**83a**
Prairie Star	**92a**	**87ab**	**77b**	**45b**
St Croix	**93a**	**95a**	**90ab**	**78a**

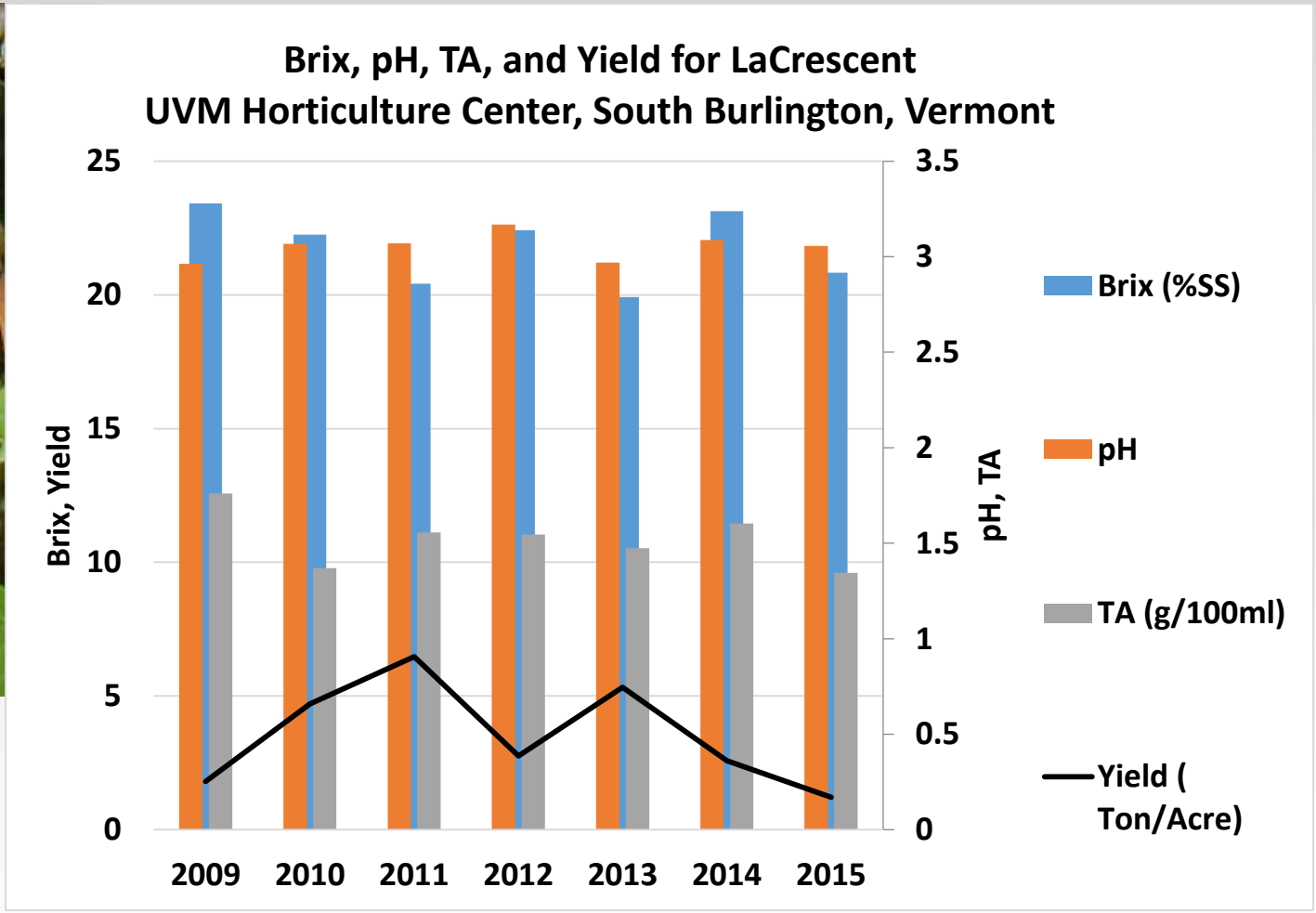
Corot Noir: 2006 Cornell release



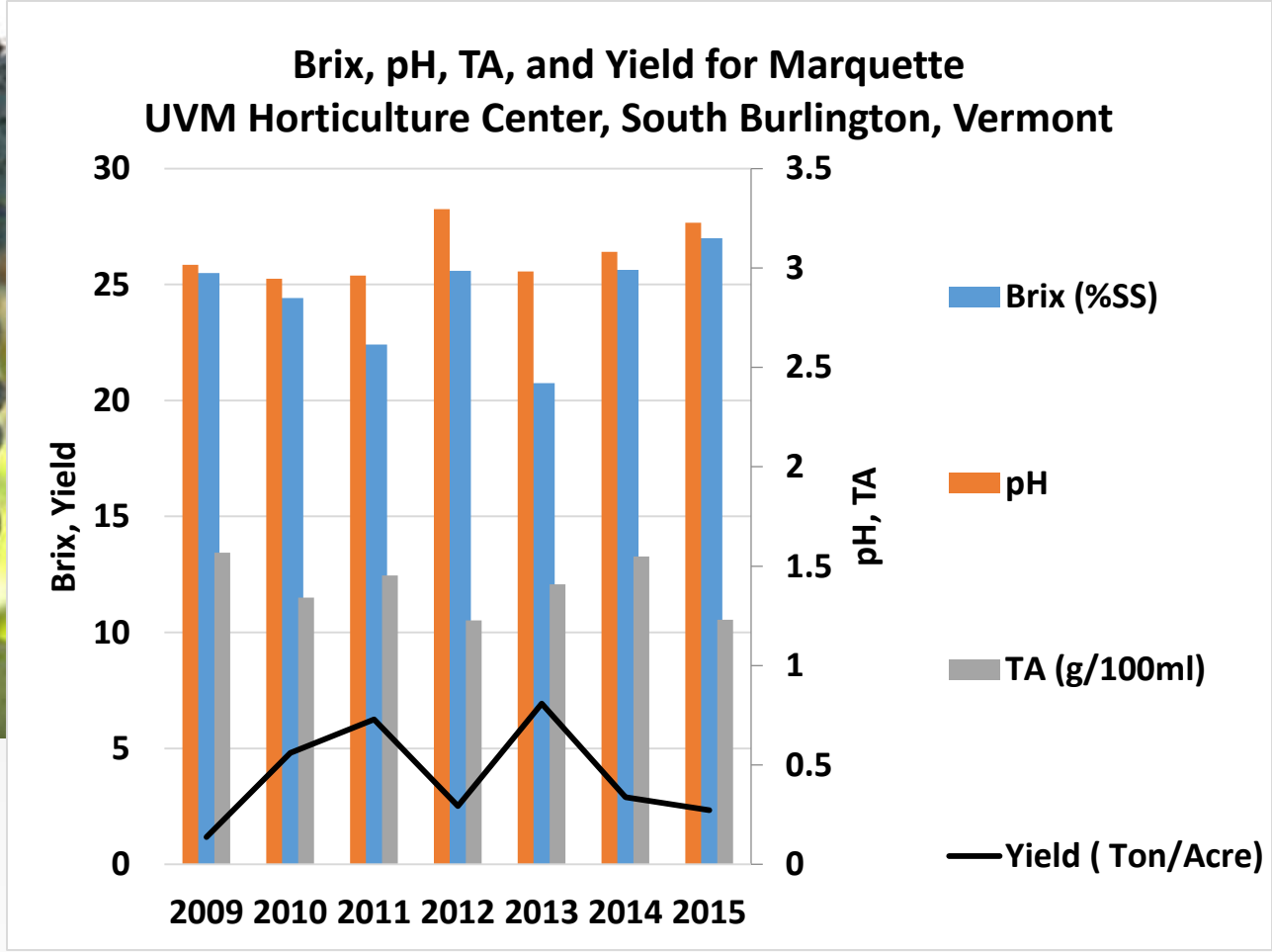
Frontenac: 1996 University of Minnesota release



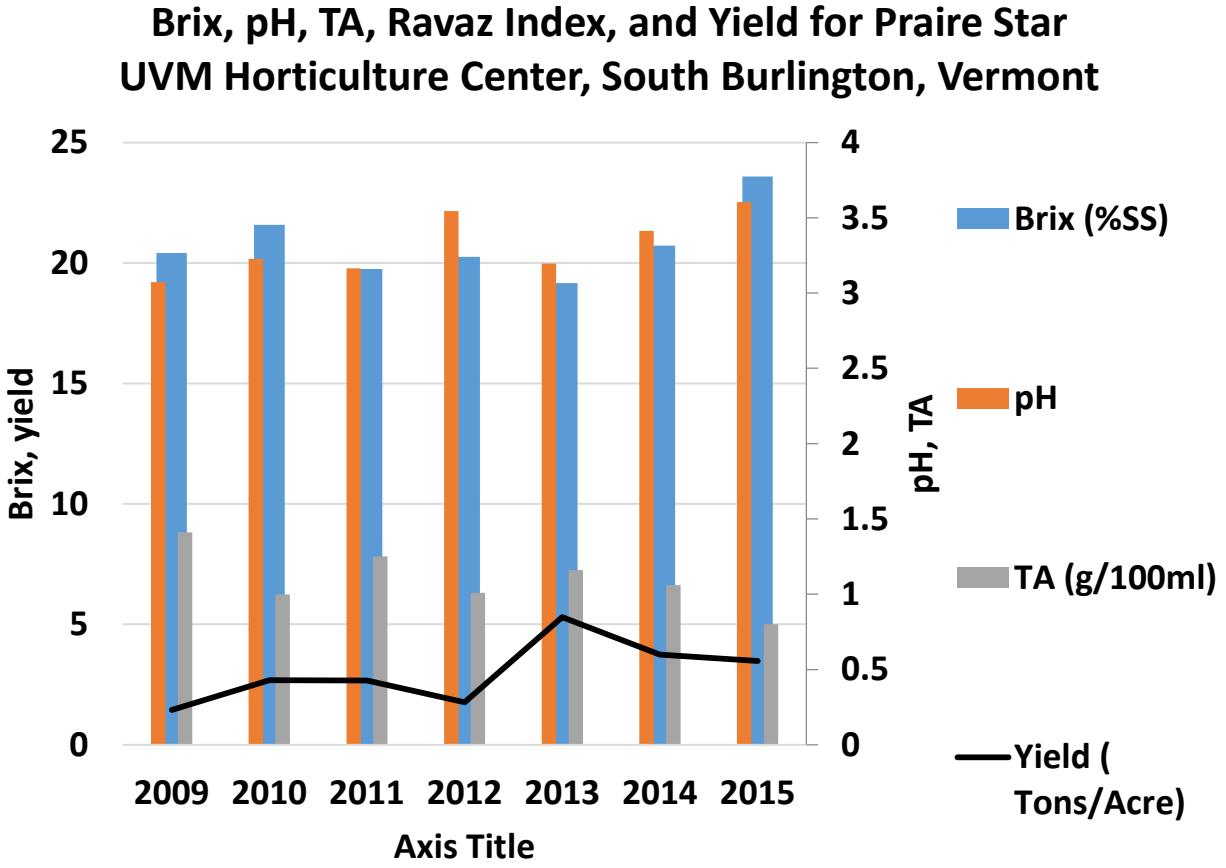
LaCrescent: 2002 University of Minnesota release



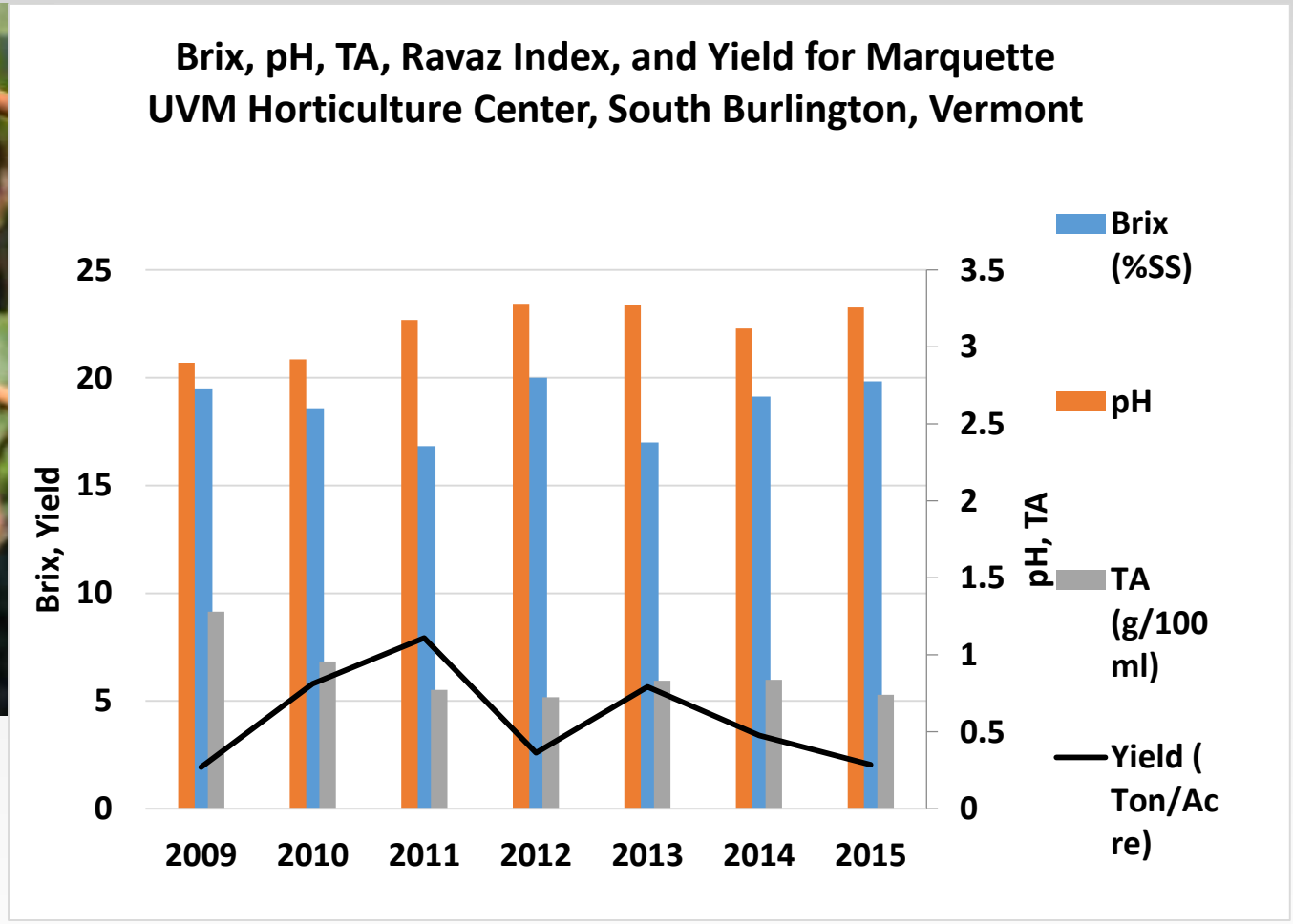
Marquette: 2006 University of Minnesota release



Prairie Star: 2000 Elmer Swenson release



St Croix


Brix, pH, TA, Ravaz Index, and Yield for Marquette
UVM Horticulture Center, South Burlington, Vermont
Brix, Yield
pH, TA
25
20
15
10
5
0
3.5
3
2.5
2
1.5
1
0.5
0
2009
2010
2011
2012
2013
2014
2015
Brix (%SS)
pH
TA (g/100 ml)
Yield (Ton/Acre)

‘Corot noir’

‘St. Croix’

‘Frontenac’

‘Marquette’

‘La Crosse’

‘Prairie Star’

‘Brianna’

‘La Crescent’

‘Frontenac Gris’

‘Louise Swenson’

‘Mars’

‘Swenson Red’

Grape Cultivar Information

- Iowa State University Viticulture:

http://viticulture.hort.iastate.edu/cultivars/cultivars.html