**Cool Climate Oenology & Viticulture Institute**

**Brock University**

# Protecting vineyards using large data sets: VineAlert and monitoring cold tolerance in grapevines

**Jim Willwerth, PhD**
**Cool Climate Oenology & Viticulture Institute**
**Brock University**

# Overview

- CCOVI has been actively involved with research and outreach initiatives concerning grapevine cold hardiness since 2010

- Launch of VineAlert risk management program in fall 2010

- Research program concerning cold hardiness – impacts of cultural practices and stress factors

- Funding through AAFC - Developing Innovative Agri-Products initiative (DIAP), Ontario Ministry of Economic Development and Innovation's (MEDI) Ontario Research Fund (ORF).

- Collaboration between AAFC, MEDI, Grape Growers of Ontario (GGO), CCOVI

# Where we are

# What is Cold Hardiness?

- **Ability of plant tissue to survive freezing temperature stresses**

- **Very complex trait with many contributing factors**

- **Limited by inherent genetic potential**
  - *V. riparia – 40°C; V. vinifera -20°C*

- **Influenced by environmental conditions**

- **Highly dynamic condition**



Figure 1. Profile of bud cold hardiness during the dormant season

# Cold Hardiness: Dynamic condition



Figure 1. Profile of bud cold hardiness during the dormant season

(CCOVI VineAlert Website)

# Freeze injury in grapes and tender fruit

- **Winter injury is greatest threat to success**
- **Substantial impact on Ontario's grape & wine industry in 1994, 2003, 2005, 2013**
- **2012 wiped out most of tender fruit (not grapes!)**
- **Can occur during acclimation, mid-winter, deacclimation or post bud break**

# Consequences of cold injury

- Loss of fruit
- Uneven or poor vegetative growth
- Loss of vines
- Disease incidence (crown gall)
- Loss of uniformity
- Loss of consistency
- Increased management costs
- Ultimately reductions in yield, quality and profit

# Current state of Ontario vineyards



- **Many different varieties grown**
- **Distinct growing regions**
- **Increased planting of sensitive varieties**
- **Increased plantings on 'marginal sites'**
- **More dependency on protection methods**
- **Market drives what is largely being planted**
  - International *V. vinifera* cultivars (Chardonnay, Riesling, Cabernet franc, Merlot, Sauvignon blanc, Pinot, Syrah)

# Protection strategies – wind machines

- Following winters of 2002/03 and 2004/05 grape producers invested heavily on wind machines to protect their vineyards

- Research done to determine effectiveness and proper use

- They do work under right conditions

# Wind Machine

# Problems with using Wind machines

## CONCERNS

- **Noise**
  - PR problems solved using
  data and working with organizations

- **WHEN to use them to avoid recreational use**

- **Associated noise complaints & costs to run machines**
  - Costs $30-40K and $40/h to run

# Knowledge is power for protecting crops from freeze injury

- **Understanding general cold tolerance of different vines is important** (i.e. Vidal vs Merlot)
- **Understanding how cold tolerant plants are at ANY GIVEN TIME is CRITICAL**
  - Fall vs mid-winter vs late winter vs spring vs post bud break
  - Used to dictate when wind machines needed
- **Develop methods to PREDICT cold hardiness and EFFECTIVELY TRANSFER this information to the industry**
- **Partnerships created with CCOVI to begin a way to do this**

# Cold hardiness research and monitoring program for Ontario (2010-present)

- Large program with research & outreach components
- Outreach includes cold hardiness monitoring program

Sampling and testing of:

- 9 varieties of most widely planted or most sensitive
- across Ontario within 3 appellations, 12 sub-appellations
- Weather information from over 32 stations
- Developed a web-based platform for effective technology transfer

# How we test cold hardiness - Differential Thermal Analysis (DTA)

- **Grapevine management and monitoring system for cold hardiness and injury**
- **Stores, displays, disseminates all information related to grapevine cold hardiness and injury**



**Vine Alert: Overview**
Grapevine management and monitoring system for cold hardiness and injury.

Overview | Recent | Bud Hardiness | Bud Survival | Alerts | Resources

**Grapevine Bud Cold Hardiness Database**

**Overview**

Welcome to the Ontario regional grapevine bud cold hardiness webpage. The information contained on this webpage is to provide grape growers with comparative levels of bud hardiness for cultivars at different locations throughout the dormant period. Monitoring bud cold hardiness throughout the dormant period is an invaluable tool to assist grape growers in managing winter injury. The data provided from this database will allow growers and researchers to see how cold-hardy grapevines are within a specific area. Cold hardiness is **not static** but varies throughout the dormant period and is determined through the grapevine's genetic potential and environmental conditions. Therefore, grapevine species and cultivars vary in terms of their cold hardiness. Bud sampling and testing will be done throughout the entire dormant season to monitor cold hardiness through the acclimation, maximum hardiness, and deacclimation periods. This ever-changing bud hardiness data can be helpful in determining when wind machine use or other freeze avoidance methods are warranted to protect the vines from winter injury.

# Custom display of cold hardiness

# Cold hardiness profile – Chardonnay (Four Mile Creek)

# VineAlert depicting cold hardiness profiles for different varieties

# VineAlert stores multiple years of bud hardiness information

# Behind the scenes
# Weather data for
# Vineland – Cherry ave WIN station

| DateTime | Max Temp (°C) | Min Temp (°C) | Avg Temp (°C) | Rain (mm) | Avg RH (%) | Solar Rad (kJ/m²) |
|---|---|---|---|---|---|---|
| 3/14/2014 | 10.2 | -7 | 3.3 | 0 | 57.6 | 12767.7 |
| 3/15/2014 | 6.1 | -5.8 | 1.3 | 0 | 68.2 | 7617 |
| 3/16/2014 | -6 | -10.2 | -8.5 | 0 | 60.9 | 13451.1 |
| 3/17/2014 | -3.5 | -10.6 | -7 | 0 | 64.6 | 13037.6 |
| 3/18/2014 | 1.8 | -7.1 | -2.5 | 0 | 73.6 | 13926.4 |
| 3/19/2014 | 8.7 | -4.6 | 2.4 | 4 | 87.9 | 4212 |
| 3/20/2014 | 5.5 | -0.1 | 2.1 | 0.2 | 74.5 | 3472.9 |
| 3/21/2014 | 4.4 | -4.3 | -0.3 | 0 | 67.2 | 13869.2 |
| 3/22/2014 | 3.2 | -2.3 | 1 | 0.6 | 74.7 | 7488 |
| 3/23/2014 | -2.7 | -8.2 | -6 | 0 | 60.7 | 13552.6 |
| 3/24/2014 | -3 | -9.7 | -6.6 | 0 | 69.4 | 9896.1 |
| 3/25/2014 | 1.8 | -7.5 | -3.5 | 0 | 66 | 11723.2 |
| 3/26/2014 | -3.5 | -10.3 | -7.3 | 0 | 56.8 | 14403.9 |
| 3/27/2014 | 6.6 | -9.3 | -0.8 | 0.2 | 58.1 | 5807.4 |

Cool Climate Oenology & Viticulture Institute
Brock University

# VineAlert indicating possible winter injury from cold weather events

# VineAlert: Bud survival
# Tracking survival rates after cold events

# Cab franc cold hardiness profile – 2013/14, Colchester, LENS



Bud Hardiness Data for **Cab Franc** at **Colchester** in 2013/2014

80-90% damage

Low Temp — LTE 10 — LTE 50 — LTE 90

# Chardonnay cold hardiness profile- 2013/14, Beamsville Bench



Bud Hardiness Data for **Chardonnay** at **Beamsville Bench in 2013/2014**

Resulted in >40% damage

# Niagara Peninsula Bud Survival 2014

| Variety | Minimum Survival (%) | Maximum Survival (%) | Average Survival (%) |
|---|---|---|---|
| Cabernet franc | 6 | 88 | 66 |
| Cabernet sauvignon | 50 | 91 | 66.5 |
| Chardonnay | 34 | 93 | 71 |
| Gewurztraminer | 53 | 90 | 73 |
| Merlot | 30 | 84 | 54 |
| Pinot gris | 82 | 92 | 87 |
| Pinot noir | 48 | 97 | 84 |
| Riesling | 40 | 100 | 73 |
| Sauvignon blanc | 17 | 85 | 55 |
| Semillon | 47 | 47 | 47 |
| Syrah | 28 | 51 | 39 |
| **Average** | | | **67** |

# VineAlert: Alerts

- Free and easy sign up
- Get notified when data specific to you is updated
- Cold alerts and other messages related to current hardiness ratings and winter injury

- **www.ccovi.ca/vine-alert**

# Vine Alert: Alerts

Receive up-to-date notices when new Winter Injury and other data is available.

| Overview | Recent | Bud Hardiness | Bud Survival | Alerts | Resources |
|----------|--------|---------------|--------------|--------|-----------|

## Current Alerts for Jim Willwerth

You are currently set to receive the following types of alerts:

| Location | Variety | Remove |
|----------|---------|--------|
| Niagara Peninsula > **Four Mile Creek** | Chardonnay | Remove |
| Niagara Peninsula > **St. David's Bench** | Merlot | Remove |
| Niagara Peninsula > **Beamsville Bench** | Riesling | Remove |
| Prince Edward County > **Hillier** | Pinot Noir | Remove |
| Lake Erie North Shore > **Colchester** | Cab Franc | Remove |

## Add Alerts:

**Location:**

Niagara Peninsula ▾  Beamsville Bench ▾

Use Map »

**Variety:**

▾     Add Alert

# Example of Alert

## CCOVI Vine Alert

**vinealert**@ccovi.ca

Sent: Fri 21/03/2014 2:35 PM
To: Jim Willwerth

Hi Jim,

New Bud Hardiness data is available on the Vine Alert website for Chardonnay in Four Mile Creek, sampled on March 19 can view it by visiting the following link:
http://www.ccovi.ca/vine-alert/bud-hardiness#/a_3/sa_5/v_1

You can manage these alerts by visiting the following link:
http://www.ccovi.ca/vine-alert/alerts

For your reference, your login username is:
vitccovi

Thank you for using Vine Alert

# Example of Cold Alert

**GRAPEVINE COLD HARDINESS ALERT FOR LOW TEMPERATURES**

vinealert@ccovi.ca

Sent: Mon 20/01/2014 2:09 PM
To: Jim Willwerth

GRAPEVINE COLD HARDINESS ALERT FOR LOW TEMPERATURES

The following is an alert regarding grapevine cold hardiness and the low temperatures occurring in regions across Ontario over the next few days.

From our latest cold hardiness testing, the most sensitive cultivars (Merlot, Sauvignon blanc, Syrah) may sustain some freeze damage when temperatures drop below -19C. THE LATEST COLD HARDINESS DATA can be viewed at http://www.ccovi.ca/vine-alert/recent

Viable grape buds may sustain injury if temperatures reach these critical temperatures and will therefore continue to impact bud survival numbers so it is important to monitor vineyard temperatures and be prepared to use protective measures if required.

Start-up temperatures for wind machines should be adjusted to account for what we are currently seeing with vine cold hardiness. For optimal use of wind machines, it is suggested that the start-up temperatures be set at 2 to 3 degrees warmer than temperatures at which injury might occur.  It is also important to monitor wind speeds along with temperatures.  Wind speeds are estimated to be 20-25 km/hr or higher for the next 24 hours.  Under these conditions there will NOT be an inversion layer of warm air so operation of the machines will not be of any value. Also, there is high potential for damage to machines themselves under high winds or gust conditions.

Please note:  Cold hardiness ratings are estimates only and the information provided is for general guidance.  Cold hardiness ratings are site specific and may vary based on vine health, viticulture practices and site conditions, among other factors.  Any decisions for protection strategies should be based on your own information and site conditions.

Jim Willwerth, PhD
Senior Scientist in Viticulture
Brock University | Cool Climate Oenology and Viticulture Institute
Niagara Region  |  500 Glenridge Ave.  |  St. Catharines, ON  L2S 3A1
brocku.ca/ccovi

# VineAlert: Resources

- **Resource section has cold hardiness information**
- **Glossary of important terms**
- **Links to weather, latest findings and other cold hardiness programs around North America**

# Benefits of this program for the grape & wine industry

- **Through thousands of data sets/year growers have been able to access regionally-specific information to protect their crops**

- **VineAlert has helped protect vineyards every winter since its launch**
  - Some significant cold events in 2010, 2011, 2013 where wind machines were very effective

- **To date our greatest accomplishment was winter of 2012**

- **Tender fruit was largely wiped out due to unseasonal temperatures**

- **What happened for grapevines?**

# Cold hardiness 2012 vs 2014

Bud Hardiness Data for **Chardonnay** at **Four Mile Creek in 2011/2012**

Period of high risk – over 1 month

# How did VineAlert help?

- Our data indicated that vines had lost over 15 degrees of cold hardiness in 2 weeks
- Immediately sent alerts to all growers signed up to our program and worked with Industry to get message across
- Start-up temps adjusted and wind machines used on many occasions past bud break
  - first incident was 3 days after our data was released
- No major damage
- However tender fruit and apples sustained major injury

**Helicopter being used to protect vineyard after VineAlert informed grower of potential risk related to cold damaging temperatures**

# Just the beginning…..

- **This program has been very well received due to short term gains however the real power is likely in the long term**

- **Currently working on 'real-time' alert features and data collection**

- **Develop more collaborations and begin more analyses of data sets**

# How data analytics can protect vineyards

- **Large data sets and use of an online interactive database allows for growers to make informed management decisions to protect crops**
  - Immediate benefits to the industry
  - Big Return on Investment!
- **Allows for research, outreach and service**
- **Transfer of information and in a timely manner is the key**
- **Has led to many other initiatives and has supported other projects**
  - Ontario Varietal plan, pre-harvest monitoring program, cultivar evaluation and breeding programs, cold hardiness monitoring in tender fruit, research

# How can big data and data analytics protect vineyards

**Longer term**

- **Large data sets allow for modelling of cold hardiness dynamics**

- **Extrapolation of data to other regions**

- **Develop strategies for existing & emerging regions and improve site x variety selection**
  - Climate, cold hardiness, phenology and maturity
  - Use of geomatics

- **Future models to predict what we can grow and where we can potentially grow them.**

- **Robust data sets are essential**

# Data is the most powerful tool we have

- Agriculture will change dramatically across Canada and the world
- Rising populations, changing climate, food and water shortages
- Scientific and technological innovations
- Real-time data collection and information transfer
- Precision farming and predictive analysis
- Building models and simulations to predict future conditions and make proactive decisions

# Acknowledgments

# Cold hardiness testing  2010-present

- # of freezer units – 3
- Locations – 31
- # of commercial varieties tested – >40
- Buds tested to date: 111,001
- Climate data: 266,805

Cool Climate Oenology & Viticulture Institute

Brock University

http://www.ccovi.ca/vine-alert