Cool Climate Oenology & Viticulture Institute

Brock University

# Optimizing cold hardiness and improving overwintering success based on trials and experiences in Ontario

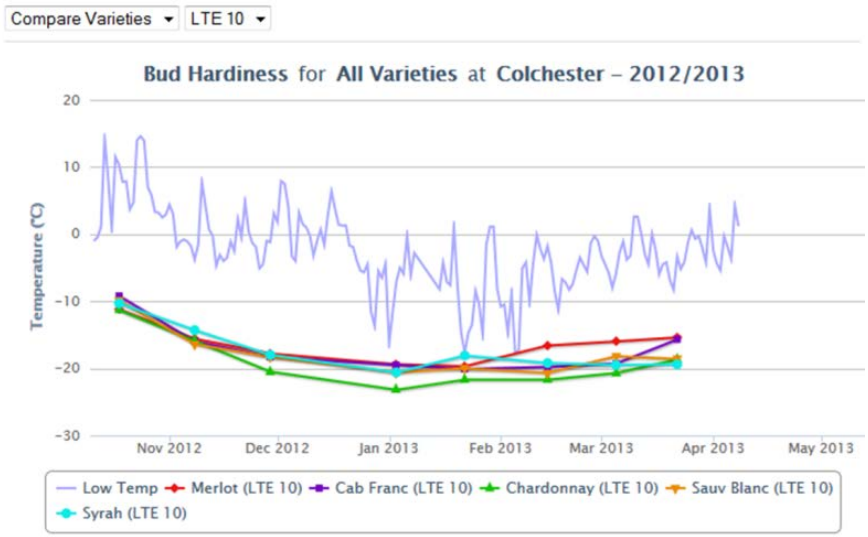
**Jim Willwerth, PhD**

**CCOVI Lecture Series**

**March 30, 2015**

# Grapevine Cold Hardiness Research

- *Vitis vinifera* wine grapes are not winter hardy
- Cold hardiness is limiting factor for growing many potential cultivars
- Need to optimize hardiness and protect vines from winter injury in an effective and economic way



# Changing climate

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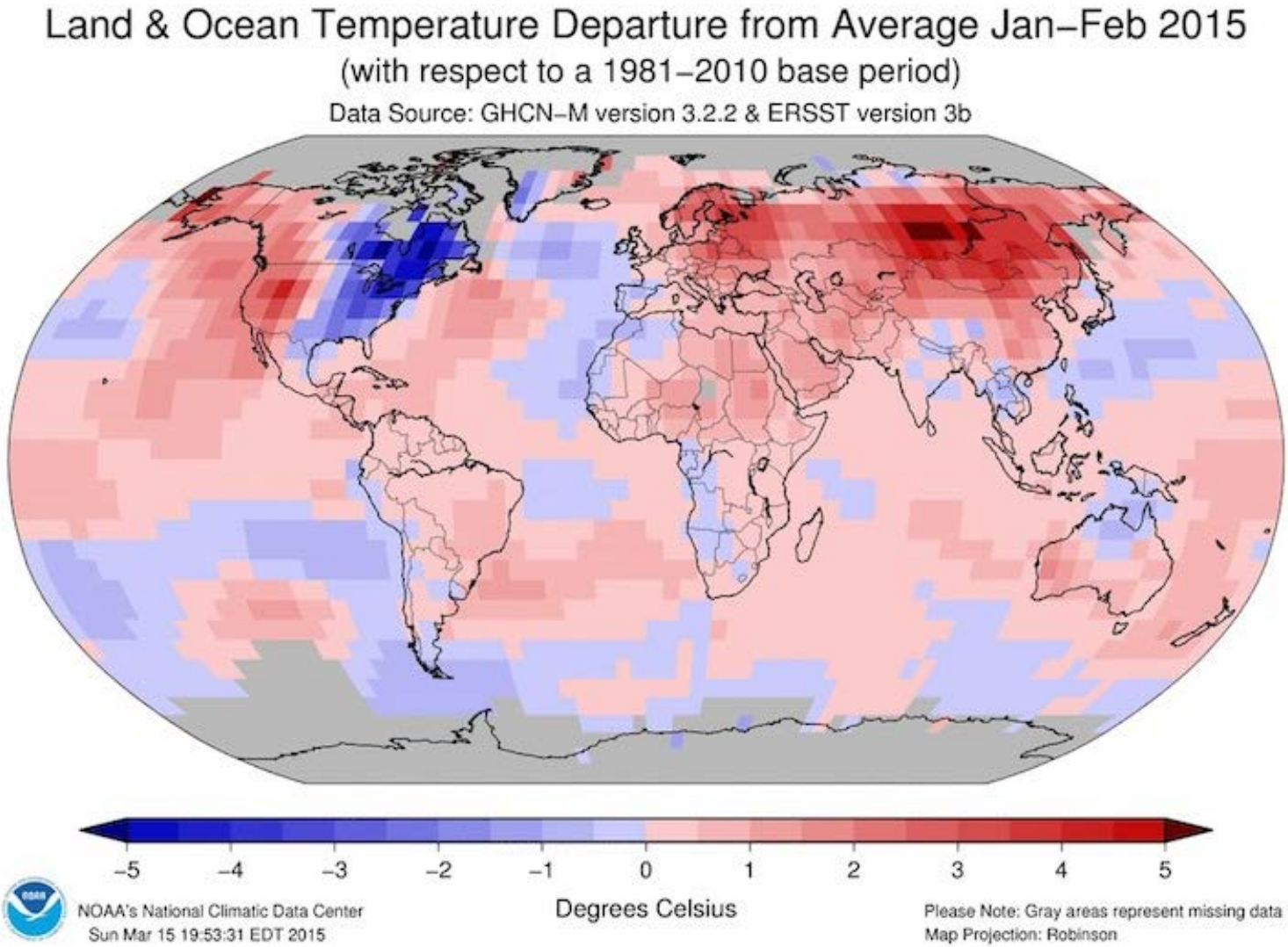

# Winter Injury

# Grapevine trunk split due to freezing

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# Emerged shoot killed by frost

# Emerged shoot damaged by frost

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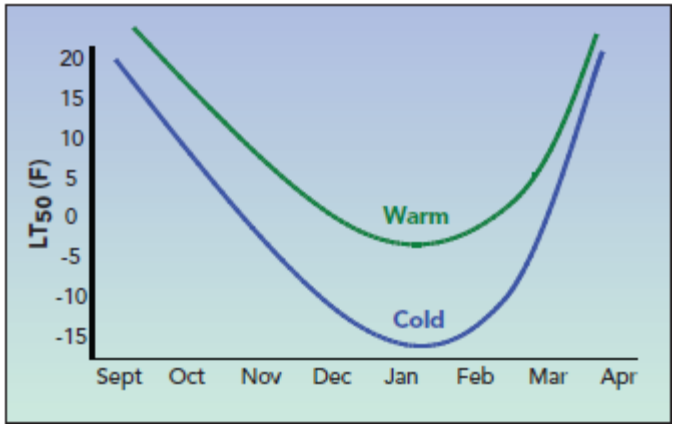
# What is Cold Hardiness?



- **Ability of plant tissue to survive freezing temperature stresses**
- **Very complex trait with many contributing factors**
- **Limited by inherent genetic potential**
  - *V. riparia* – 40C; *V. vinifera* -20's C
- **Influenced by environmental conditions**
- **Highly dynamic condition**




(MSU Extension Bulletin E2930, 2007)

# Cold Hardiness: Dynamic condition

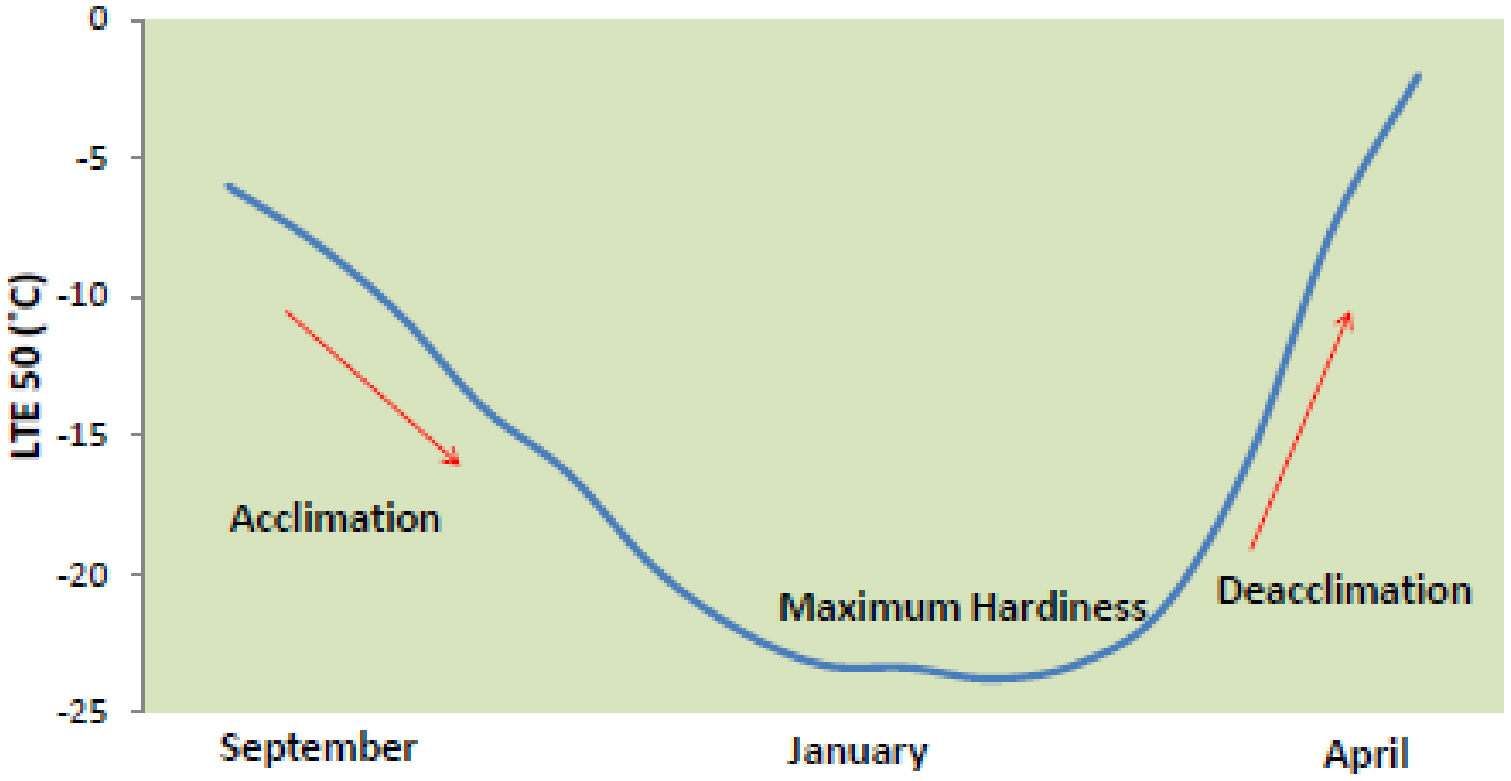



Figure 1. Profile of bud cold hardiness during the dormant season

(CCOVI VineAlert Website)

# How do we test the cold hardiness of a grapevine bud?

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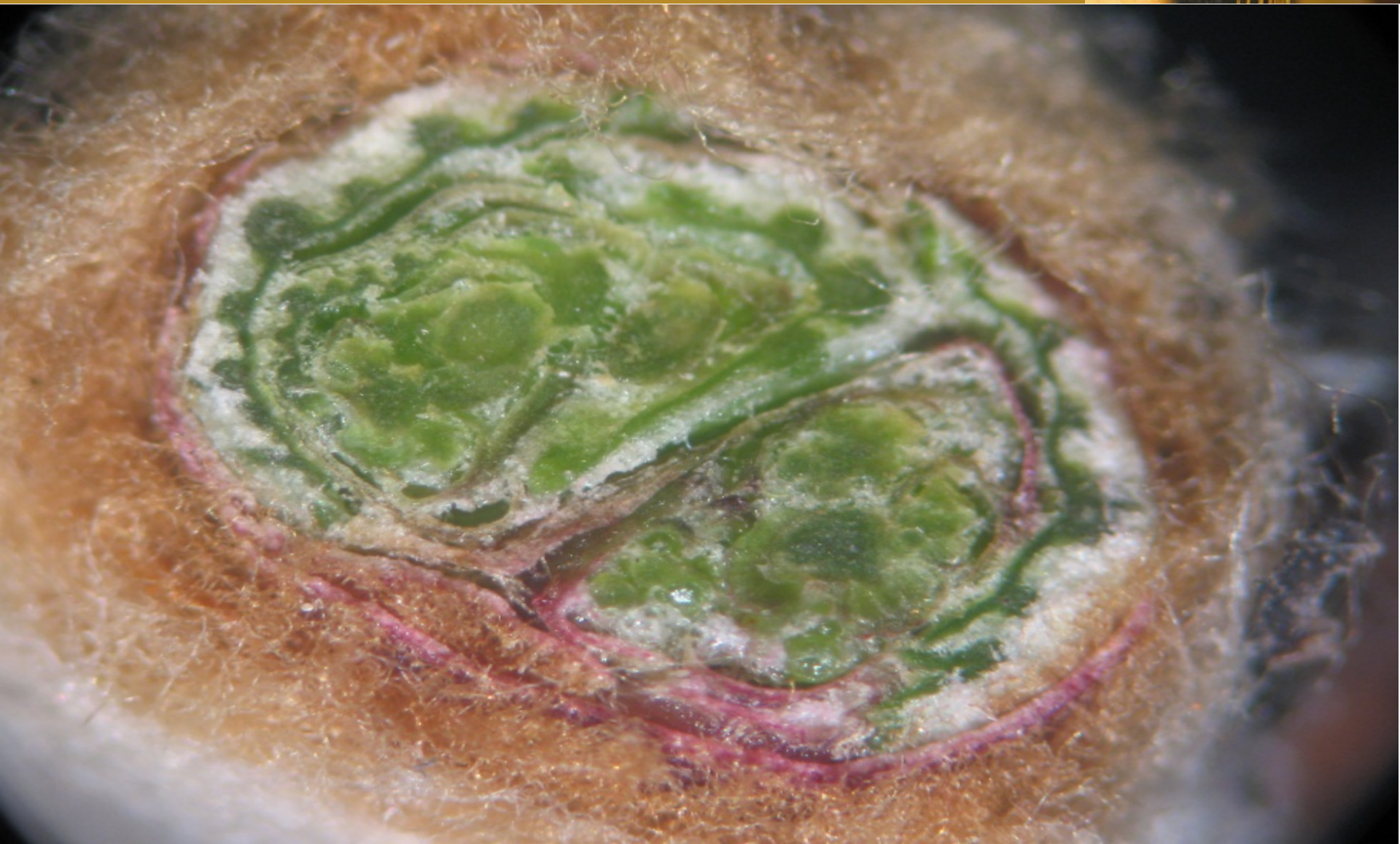

# How we test cold hardiness
# Differential Thermal Analysis (DTA)

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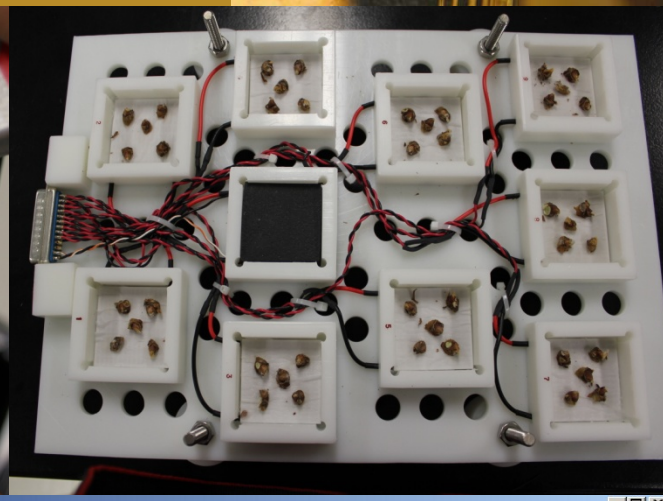

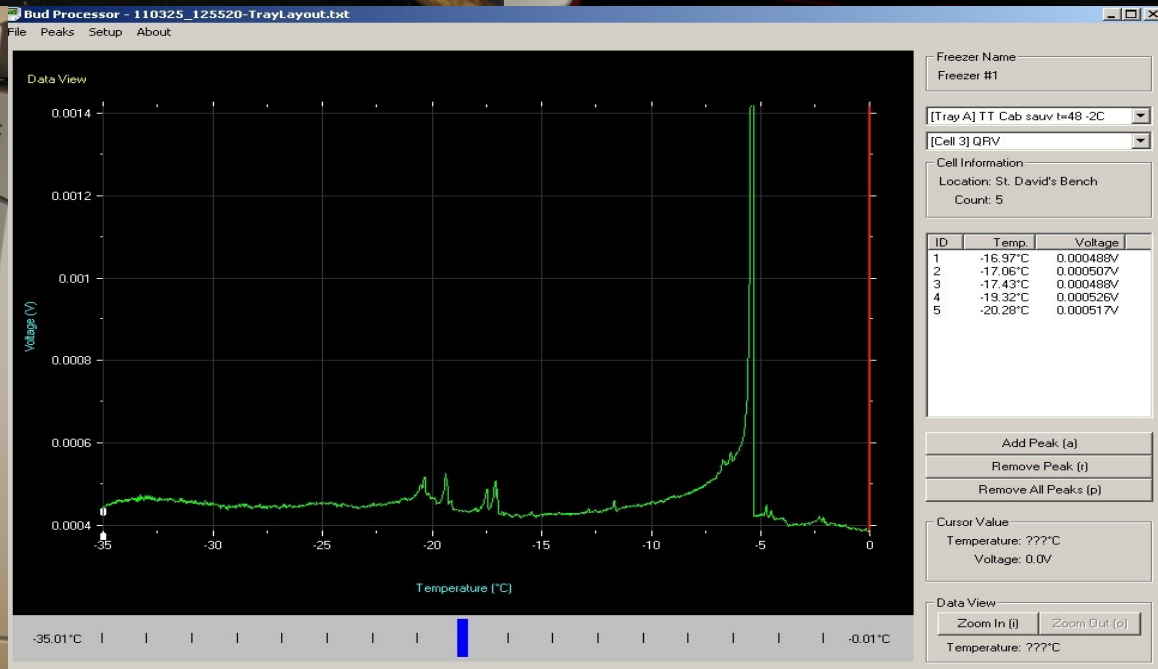

# Crop level x harvest date studies (2011-2015)

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- **Studying the impact of Crop level x harvest date**
- **S. blanc, Riesling, Chardonnay, P. noir, Merlot, C franc**
- **2 cropping levels**
  - 2 clusters/shoot; (full)
  - 1 cluster/shoot; (half)

- **2 harvest dates**
  - Commercial harvest (> VQA min)
  - 3 weeks after 1st harvest

# Impact of Crop level and harvest date Sauvignon blanc: Acclimation (2011)

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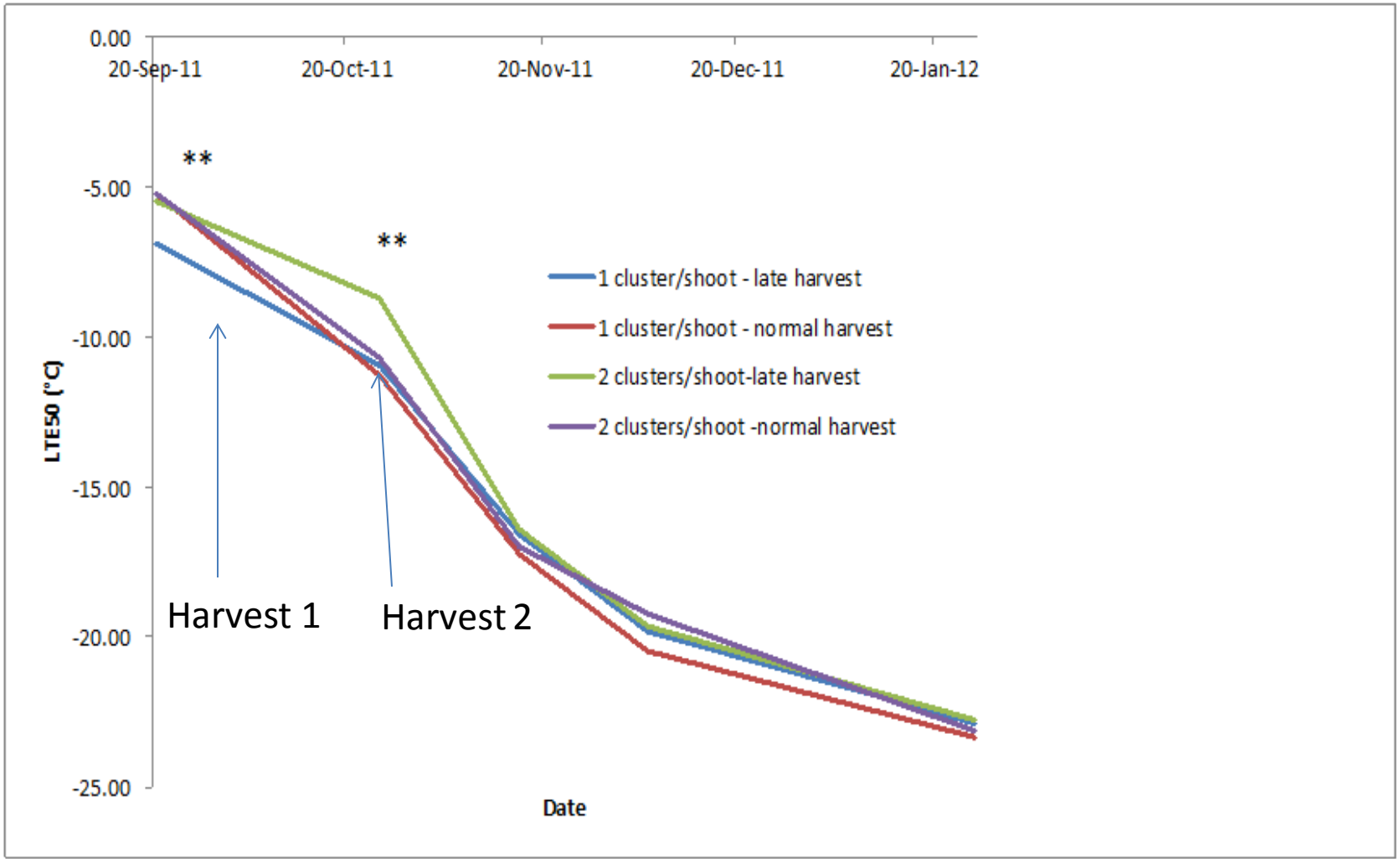
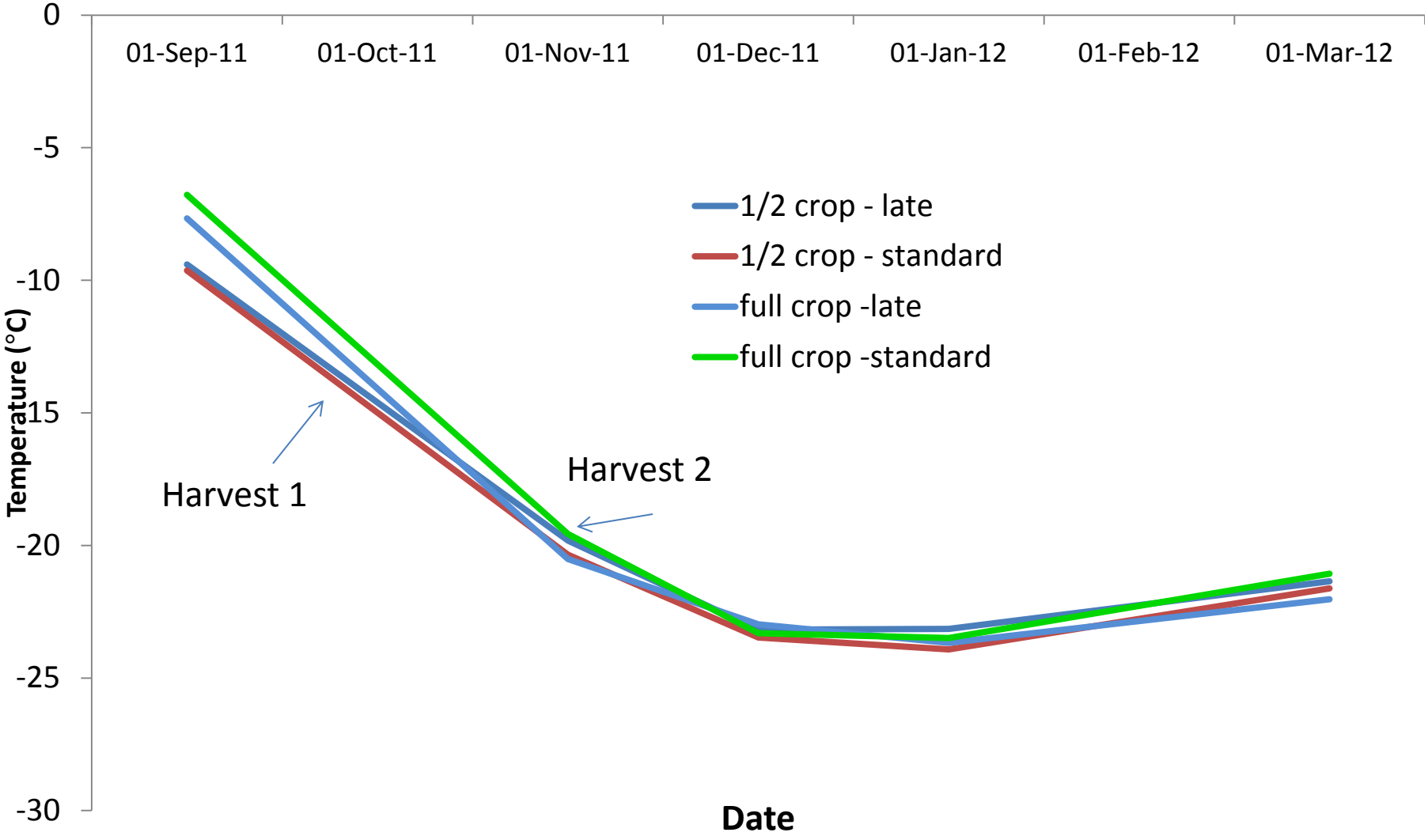


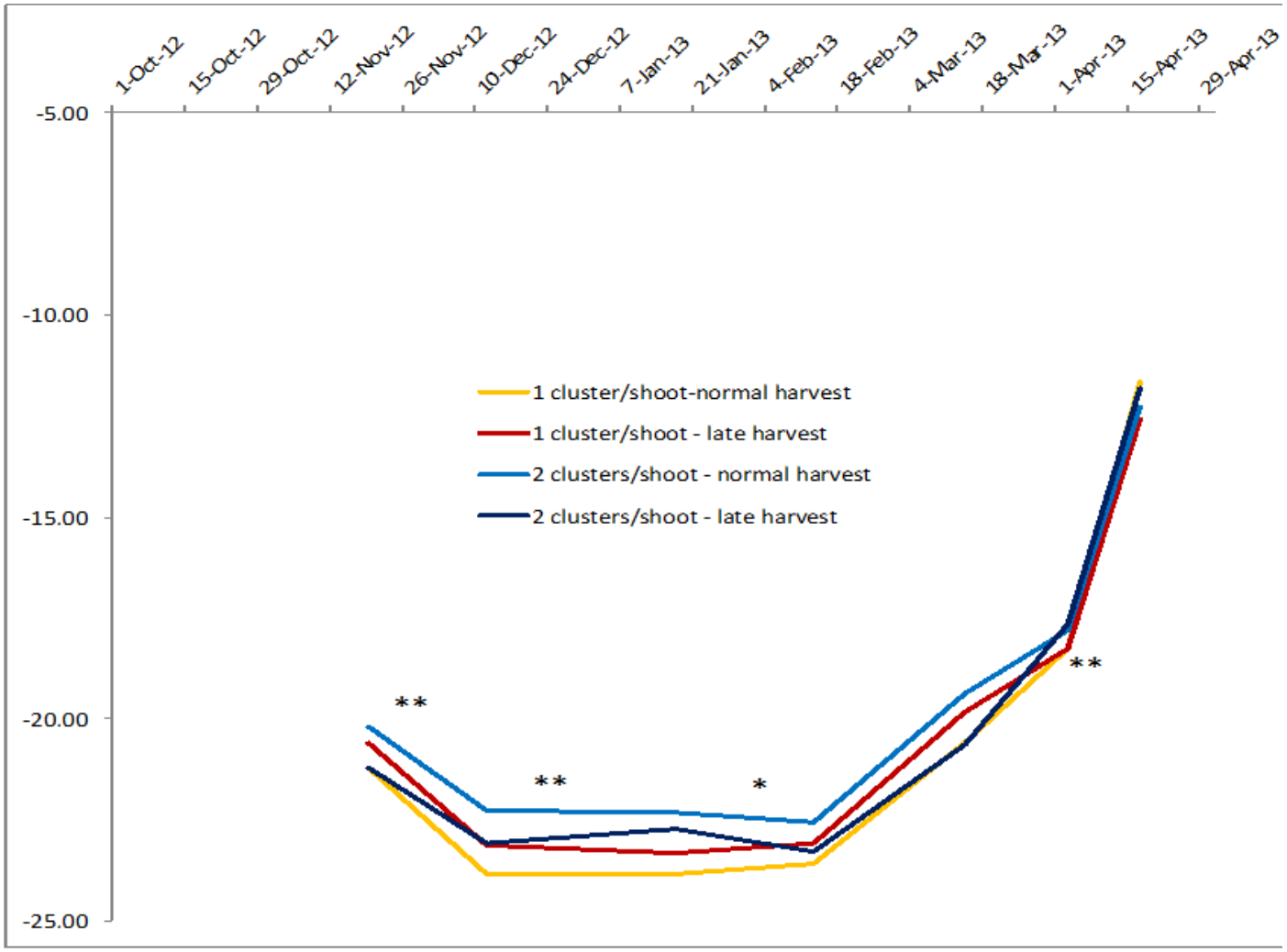
# Impact of Crop level and harvest date Sauvignon blanc: Acclimation (2012)


| Date | Treatment | LTE10 | LTE50 | LTE90 |
|---|---|---|---|---|
| 02-Nov-12 | Half crop/standard | -10.44 | -12.54 | -13.67 |
| | Full crop/standard | -10.74 | -12.09 | -13.88 |
| | Half crop/late | -10.23 | -11.96 | -13.44 |
| | Full crop/late | -9.67 | -11.84 | -13.98 |
| 21-Nov-12 | Half crop/standard | -18.15 | -19.47 | -20.85 |
| | Full crop/standard | -17.31 | -19.49 | -21.04 |
| | Half crop/late | -17.27 | -19.44 | -21.16 |
| | Full crop/late | -17.63 | -19.7 | -21.23 |
| 17-Dec-12 | Half crop/standard | -20.09 | -21.75 | -22.86 |
| | Full crop/standard | -20.01 | -21.96 | -23.18 |
| | Half crop/late | -19.27 | -21.48 | -23.35 |
| | Full crop/late | -20.34 | -22.07 | -23.86 |

# PINOT NOIR
# LTE 50 - 2011/12

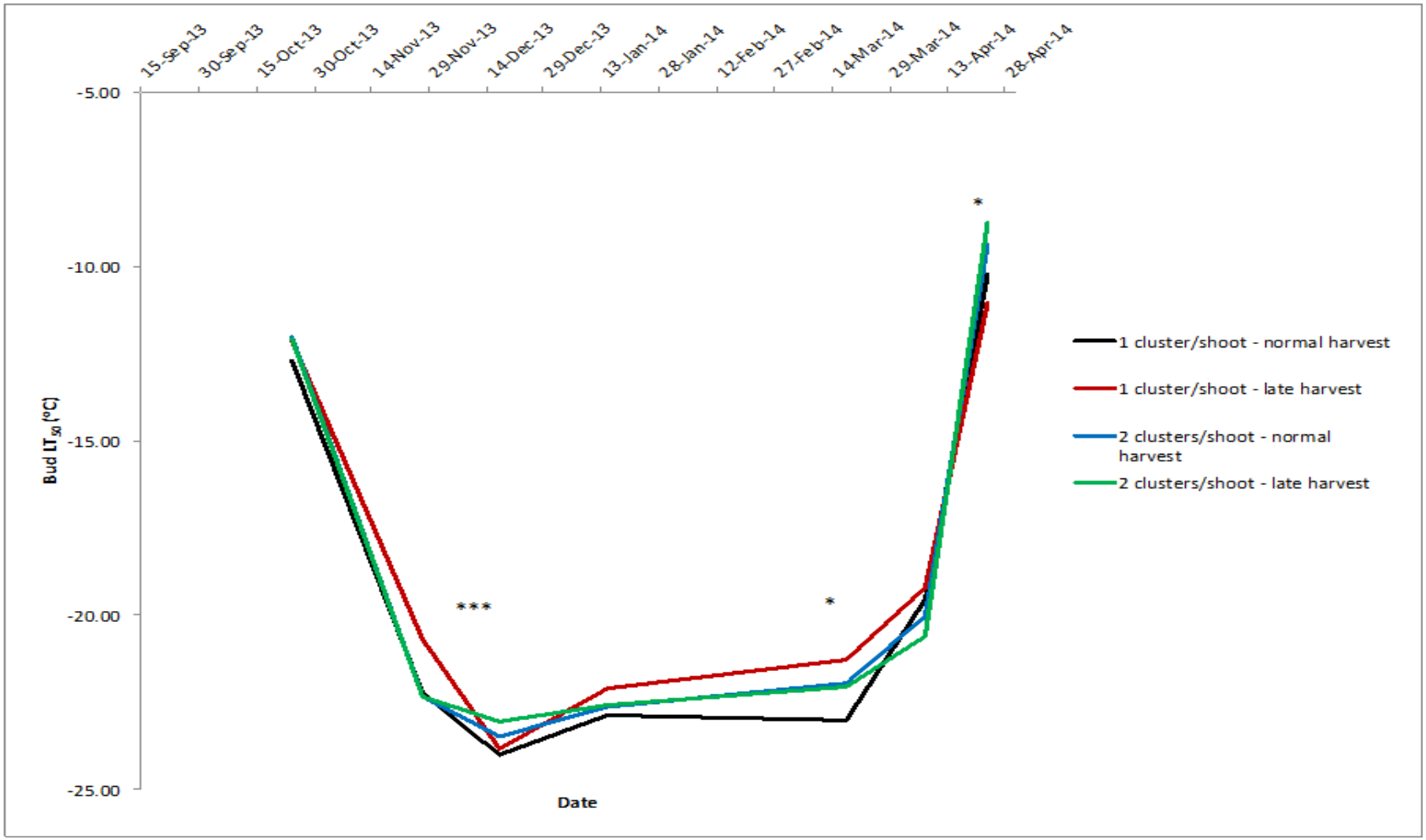



# PINOT NOIR
# LTE 50 – 2012/13




Impact of crop level and timing of harvest on cold hardiness dynamics of Pinot noir 2012/13. Vineland, ON. **, ** Indicate significance @ p<0.05, p<0.01, respectively*.

# RIESLING
# LTE50 – 2012/13




Impact of crop level and timing of harvest on cold hardiness dynamics of Riesling 2012/13. Vineland, ON. **, ** Indicate significance @ p<0.05, p<0.001, respectively*

# CHARDONNAY
# LTE data 2013/14


15-Sep-13
30-Sep-13
15-Oct-13
30-Oct-13
14-Nov-13
29-Nov-13
14-Dec-13
29-Dec-13
13-Jan-14
28-Jan-14
12-Feb-14
27-Feb-14
14-Mar-14
29-Mar-14
13-Apr-14
28-Apr-14

-5.00
-10.00
-15.00
-20.00
-25.00

Bud $LT_{50}$ (°C)

*
*

1.1 (Half, Normal)
1.2 (Half, Late)
2.1 (Full, Normal)
2.2 (Full, Late)

Date

# MERLOT (spring 2014)
# Light crop with earlier harvest

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# MERLOT (spring 2014)
# Heavier crop with late harvest

# Overcropped vine with stunted growth

# General yield responses


- **In better vintages (early season, warmer and drier falls) less of impact of crop level or harvest date on all varieties**
- **In poorer years (later, cooler and wetter), 1 kg/vine higher can make a difference of few degrees especially for Pinot noir, Merlot**

**General yield response from 3+years of data**

- (Most responsive) Pinot noir > Merlot > S. blanc > C. franc > Chardonnay > Riesling (least responsive)

- **Be mindful of plateau priced blocks that may have much higher yields**
  - Vine Balance is important

# Vine Health

- **It goes without saying that healthier plants will survive winter better**
- **Compromised health and/or development due to:**
  - Disease
  - Virus
  - Drought or too much water
  - Soil issues/compaction
  - Previous winter injury and vascular damage, crown gall or Mechanical injury (i.e. girdling)

# Soil and drainage

- Vines with ‘wet feet’ in poorly drained vineyard.
- Results in poor growth and poor cold acclimation

poor periderm formation on canes

# Optimizing vine cold hardiness


- **Plant material (matched to site conditions)**
- **Proper site selection and preparations**
- **Control disease, good canopy management**
- **Management of vigour and water through tiling or irrigation if needed**
- **Manage crop levels accordingly by variety and growing season**
- **Avoid cumulative effects of winter injury by renewing and replacing vine parts**
- **Combination of factors: cultivar x environment, cultural practices and overall management**
  - BE AWARE that choices you make can impact hardiness enough to make a difference.
- **Cold hardiness is very complex with many factors and interactions to be considered**

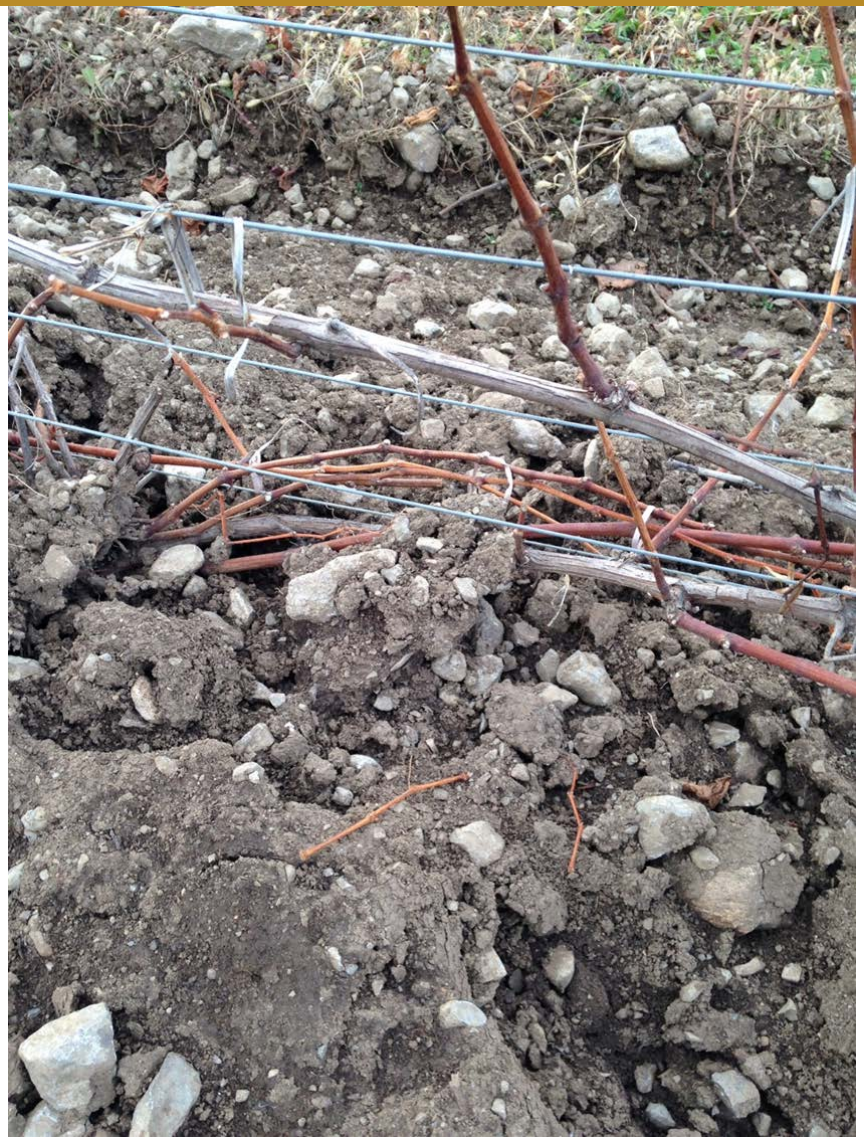
# Freeze protection strategies


- Wind (Wind machines, Helicopters)
- Burying plants or parts of plants with soil or snow
- Geotextiles
- Mulches
- Heat sources (Fires, smoke, equipment)
- Sprinklers (frost protection)
- Combination of different strategies

# Use of Geotextiles for winter protection


- **Geotextiles are materials used for winter protection of crops but have diverse applications across many industries**
- **Used in Quebec vineyards**
- **Interest in Ontario vineyards have increased as of late**
- **Why?**
  - *Vinifera* need protection in some areas
  - Concern about moving soils
  - Concern about damaging buds
  - Bud rot/loss
  - POOR YIELDS
  - Last few winters!

# Here’s one problem



# Evolution of research


- **Determined that there was a need to study these materials in Ontario vineyards**
- **Research Questions**
  - How effective are these materials at mitigating damaging cold temperatures?
  - Do these materials cause a ‘greenhouse effect’?
  - What impact is there on bud hardiness and survival?

- **Help determine ‘best practices’**
- **Study in Prince Edward County**
  - Sugarbush vineyards with Margaret Appleby (OMAFRA)
  - Geotextile: Hibertex Pro

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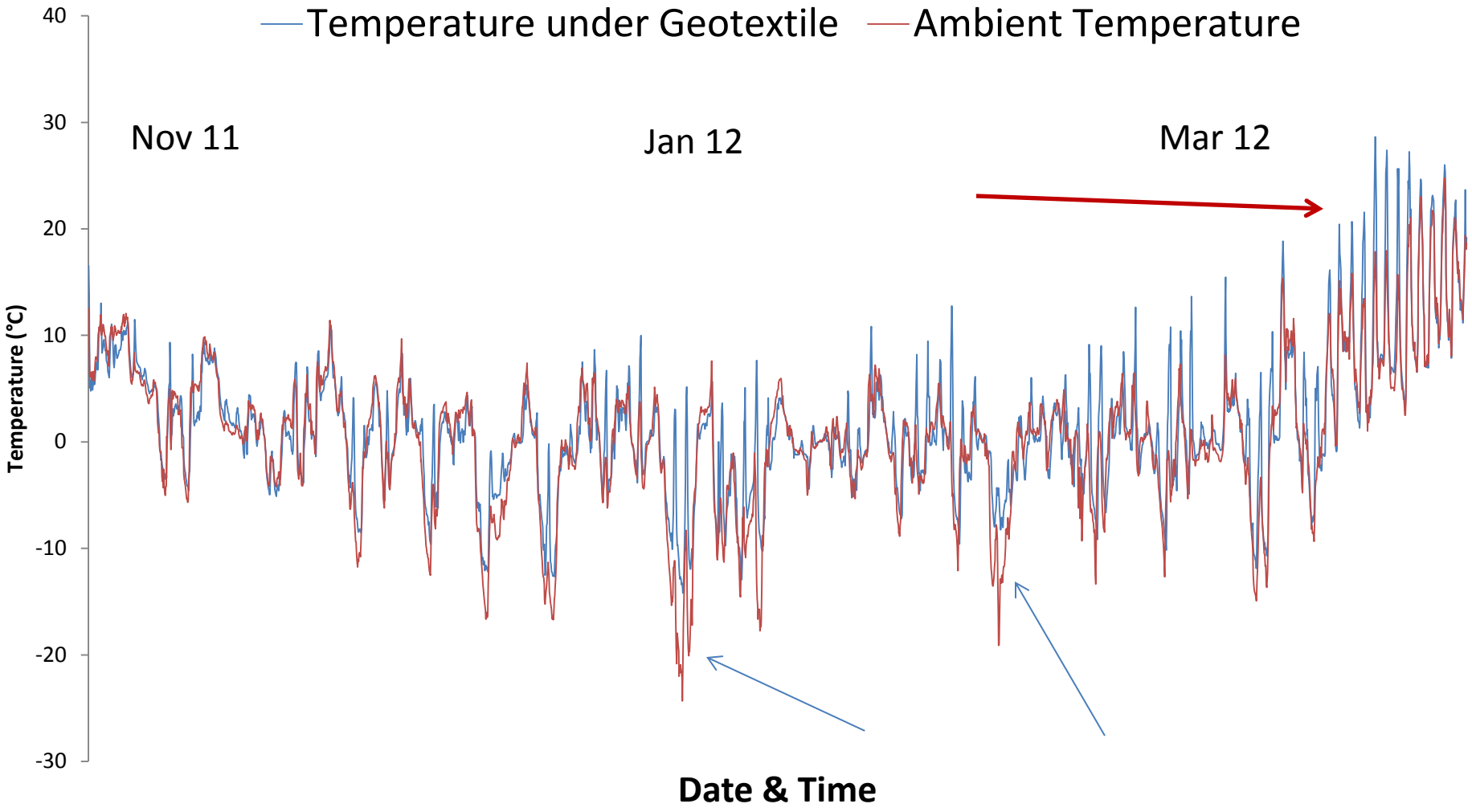
# Geotextile experiment I

- 8 panels of vines under textile
- Randomized within Chardonnay block
- 2 methods
- Textile above laid down canes on low wire
- Textile tented above spur pruned vine
- Temperature recorded under geotextile and ambient temperature
- Buds sampled for cold hardiness

# Impact of Geotextiles on temperature

# Impact of geotextiles on bud hardiness


| Treatment | Date | LTE10 | LTE50 | LTE90 |
|---|---|---|---|---|
| | 13-Dec-11 | -18.7 | -22.04 | -23.53 |
| Aerial canes | 18-Jan-12 | -20.7 | -23.4 | -25.2 |
| | 29-Feb-12 | -21.4 | -22.64 | -23.58 |
| | 27-Mar-12 | -6.9 | -11.1 | -13.1 |
| | | | | |
| | | | | |

| Treatment | Date | LTE10 | LTE50 | LTE90 |
|---|---|---|---|---|
| | 13-Dec-11 | -18.63 | -21.35 | -23.11 |
| Geotextile | 18-Jan-12 | -16.72 | -22.81 | -24.52 |
| | 29-Feb-12 | -20.8 | -22.32 | -23.57 |
| | 27-Mar-12 | -6.7 | -11.4 | -13.5 |


# Other findings

- Materials were removed mid-March during warm period
- Vines unearthed shortly after
- Cold temperatures (-6) at end of April killed many primary buds
- Interesting observation was that panels covered with geotextile had much better crop compared to buried vines

# Geotextiles II
# The Expanded Study (2012-)


- **Two types of materials**
  - White Polyester felt
  - White Polyester felt with black LDPE
- **Different timings of removal**
  - Beginning of deacclimation (March)
  - Mid to end of deacclimation (April)

- **Compared to burying of vines and control**
- **Two Locations – PEC and Vineland**
- **Two cultivars – Chardonnay and Pinot noir**
- **Temperatures monitored using dataloggers**

# The materials

# Canes tied below materials

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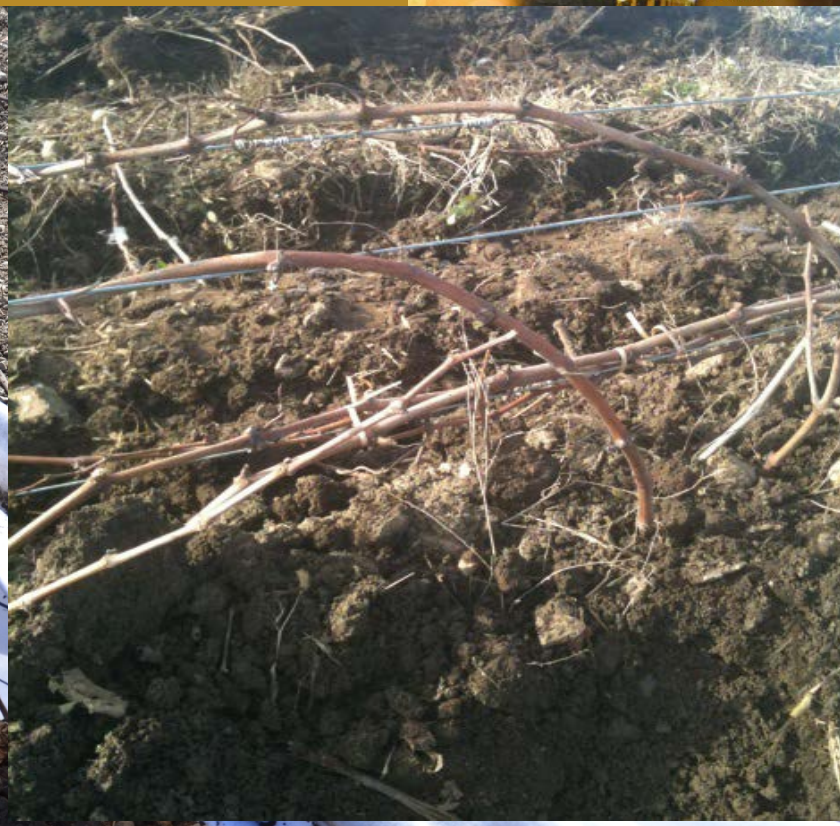

# Vine microclimate temperatures during acclimation to mid-winter using different grapevine protection methods within Prince Edward County. Wellington, ON. (2012-13).

| November (last 2 weeks of the month) | | | | |
|---|---|---|---|---|
| | Ambient | Polyester felt | Polyester felt with black LDPE | Under Soil |
| Monthly mean temperature (°C) | 1.01 | 1.14 | 1.15 | 1.76 |
| Absolute Maximum temperature (°C) | 12.10 | 16.54 | 13.79 | 9.63 |
| Absolute Minimum temperature(°C) | -8.67 | -7.27 | -5.95 | -2.95 |
| **December** | | | | |
| | Ambient | Polyester felt | Polyester felt with black LDPE | Under Soil |
| Monthly mean temperature (°C) | -0.26 | -1.57 | 0.53 | 1.22 |
| Absolute Maximum temperature (°C) | 15.34 | 9.26 | 14.7 | 10.54 |
| Absolute Minimum temperature(°C) | -11.33 | -6.55 | -6.99 | -3.07 |
| **January** | | | | |
| | Ambient | Polyester felt | Polyester felt with black LDPE | Under Soil |
| Monthly mean temperature (°C) | -3.47 | -2.96 | -2.78 | -1.54 |
| Absolute Maximum temperature (°C) | 13.38 | 17.42 | 16.37 | 8.74 |
| Absolute Minimum temperature(°C) | -23.41 | -19.07 | -19.38 | -10.27 |

# Vine microclimate temperatures during mid to late winter months using different grapevine protection methods within Prince Edward County. Wellington, ON. (2012-13).


| February | | | | |
|---|---|---|---|---|
| | Ambient | Polyester felt | Polyester felt with black LDPE | Under Soil |
| **Monthly mean temperature (°C)** | -6.54 | -3.74 | -3.16 | -1.52 |
| **Absolute Maximum temperature (°C)** | 5.54 | 6.84 | 5.95 | -0.09 |
| **Absolute Minimum temperature(°C)** | -25.38 | -17.64 | -13.97 | -6.52 |
| | | | | |
| **March** | | | | |
| | Ambient | Polyester felt | Polyester felt with black LDPE | Under Soil |
| **Monthly mean temperature (°C)** | -1.269 | -0.558 | -0.248 | -0.338 |
| **Absolute Maximum temperature (°C)** | 11.297 | 10.687 | 13.185 | 3.142 |
| **Absolute Minimum temperature(°C)** | -11.79 | -9.47 | -11.11 | -3.48 |

# Temperatures during dormant period

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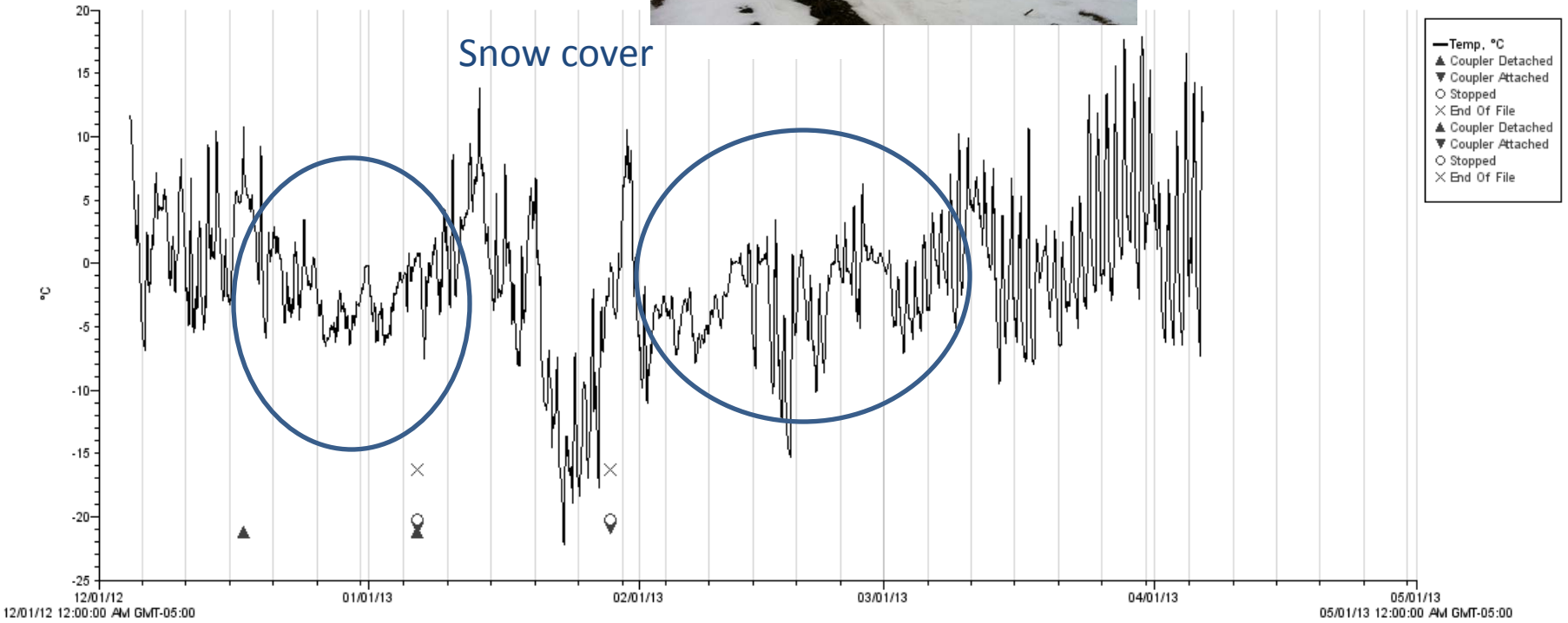

# Bud cold acclimation and Mid-Winter Hardiness levels


| Chardonnay | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Treatment** | Date | LTE10 | LTE50 | LTE90 | Date | LTE10 | LTE50 | LTE90 |
| **Control** | 05-Dec-12 | -21.37 | -23.38 | -25.15 | 29-Jan-13 | -17.81 | -23.75 | -25.58 |
| **Polyester felt with black LDPE** | 05-Dec-12 | -20.7 | -22.56 | -25.19 | 29-Jan-13 | -17.54 | -23.73 | -26.29 |
| **Polyester felt** | 05-Dec-12 | -17.81 | -21.69 | -23.64 | 29-Jan-13 | -20.49 | -23.84 | -25.79 |
| | Pinot Noir | | | | | | | |
| **Treatment** | Date | LTE10 | LTE50 | LTE90 | Date | LTE10 | LTE50 | LTE90 |
| **Control** | 05-Dec-12 | -19.35 | -23.31 | -25.01 | 29-Jan-13 | -19.14 | -24.55 | -26.25 |
| **Polyester felt with black LDPE** | 05-Dec-12 | -19.98 | -22.57 | -24.09 | 29-Jan-13 | -18.79 | -24.01 | -26.12 |
| **Polyester felt** | 05-Dec-12 | -20.54 | -22.63 | -24.14 | 29-Jan-13 | -22.57 | -24.79 | -25.89 |

Warmer fall temperatures under geotextiles reduced cold tolerance

# Deacclimation and Mid-Winter Hardiness levels


| Chardonnay | | | | |
|---|---|---|---|---|
| Treatment | Date | LTE10 | LTE50 | LTE90 |
| Control | 08-Apr-13 | -16.26 | -18.2 | -20.77 |
| Polyester felt with black LDPE (removed) | 08-Apr-13 | -15.08 | -17.36 | -20.24 |
| Polyester felt with black LDPE | 08-Apr-13 | -13.95 | -16.83 | -20.04 |
| Polyester felt (removed) | 08-Apr-13 | -16.45 | -18.57 | -20.41 |
| Polyester felt | 08-Apr-13 | -14.28 | -15.48 | -17.52 |

Predicted grapevine bud cold hardiness ratings for Chardonnay and Pinot noir using different protection strategies within Prince Edward County. Wellington, ON. (2012-13).

# Influence of protection strategy on yield components


| Chardonnay | | | | | |
|---|---|---|---|---|---|
| | Polyester felt - Early Removal | Polyester felt - Late Removal | Polyester felt with black LDPE - Early Removal | Polyester felt with black LDPE - Late Removal | Buried under soil |
| **No. of shoots/vine** | 12 | 12 | 11 | 11 | 10 |
| **No. of clusters/ vine** | 13a | 12a | 14a | 12a | 6b |
| **Pinot noir** | | | | | |
| | Polyester felt - Early Removal | Polyester felt - Late Removal | Polyester felt with black LDPE - Early Removal | Polyester felt with black LDPE - Late Removal | Buried under soil |
| **No. of shoots/vine** | 13a | 11ab | 9b | 13a | 9b |
| **No. of clusters/ vine** | 15a | 11a | 4b* | 10a | 3b |

Influence of protective strategy on yield components. Wellington, ON.

* material was removed from vines prematurely due to high winds

# Findings


- **Geotextiles do moderate minimum temperature extremes**
- **Snow cover remains on vines longer with white geotextiles than buried vines**
  - This improves hardiness and temperature moderations
- **Some impact on bud hardiness (maximum)**
- **Yields improved considerably**
- **Vine health better (less rot, better periderm, less crown gall).**

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

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- **Our advanced cold hardiness database and alerting system during periods of risk**

# Historical ‘cold years’ (02/03, 04/05)

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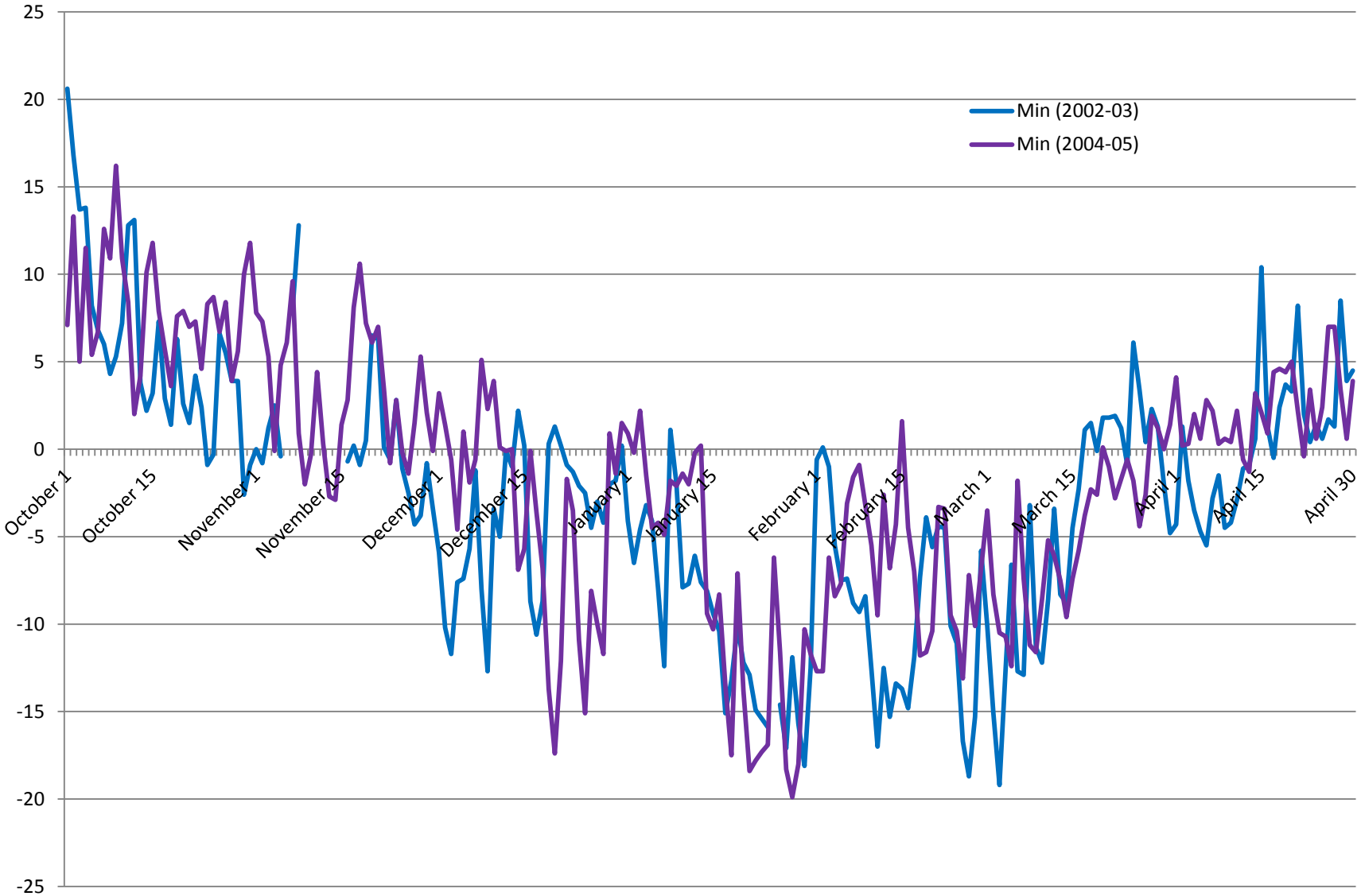
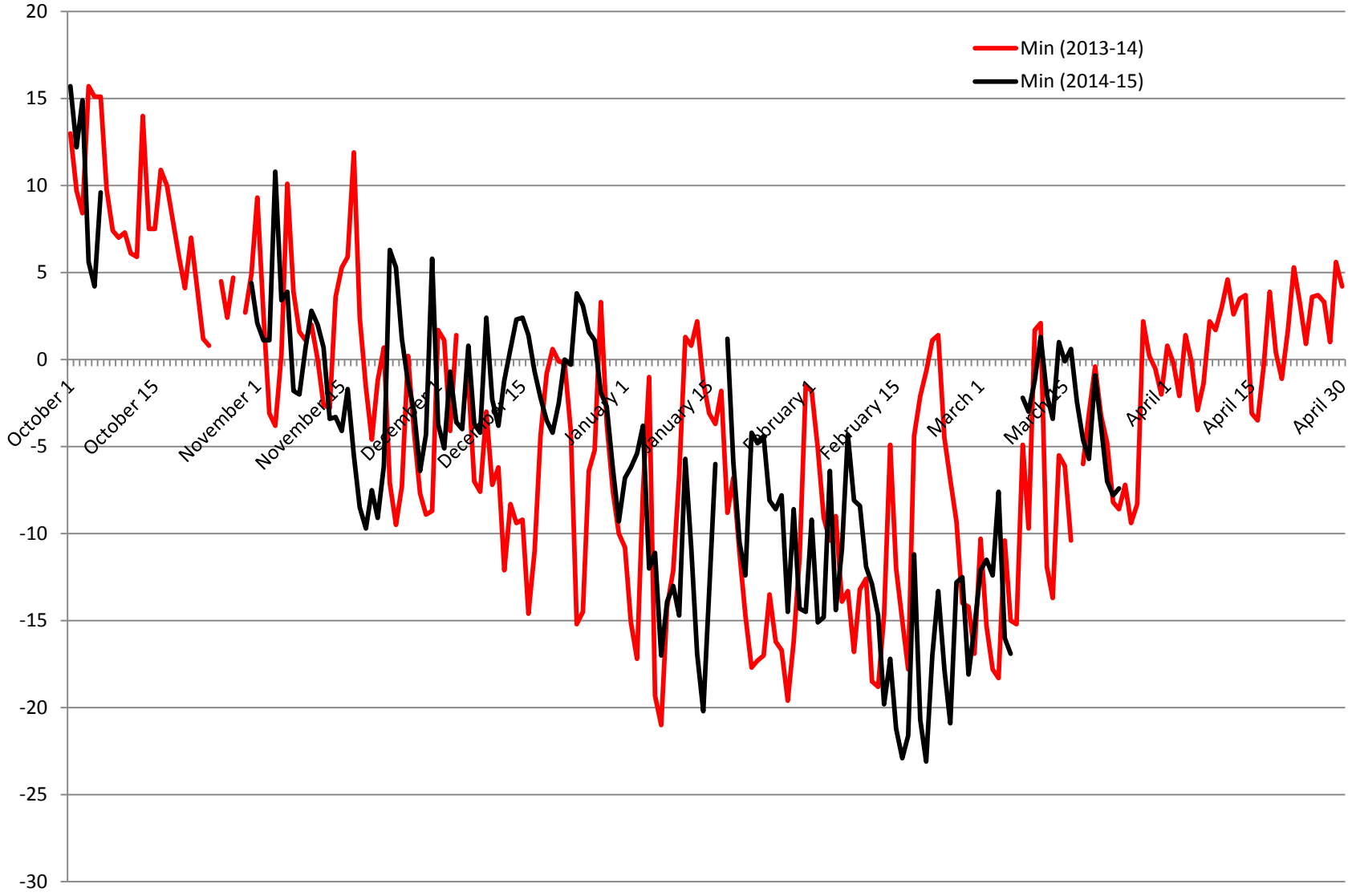
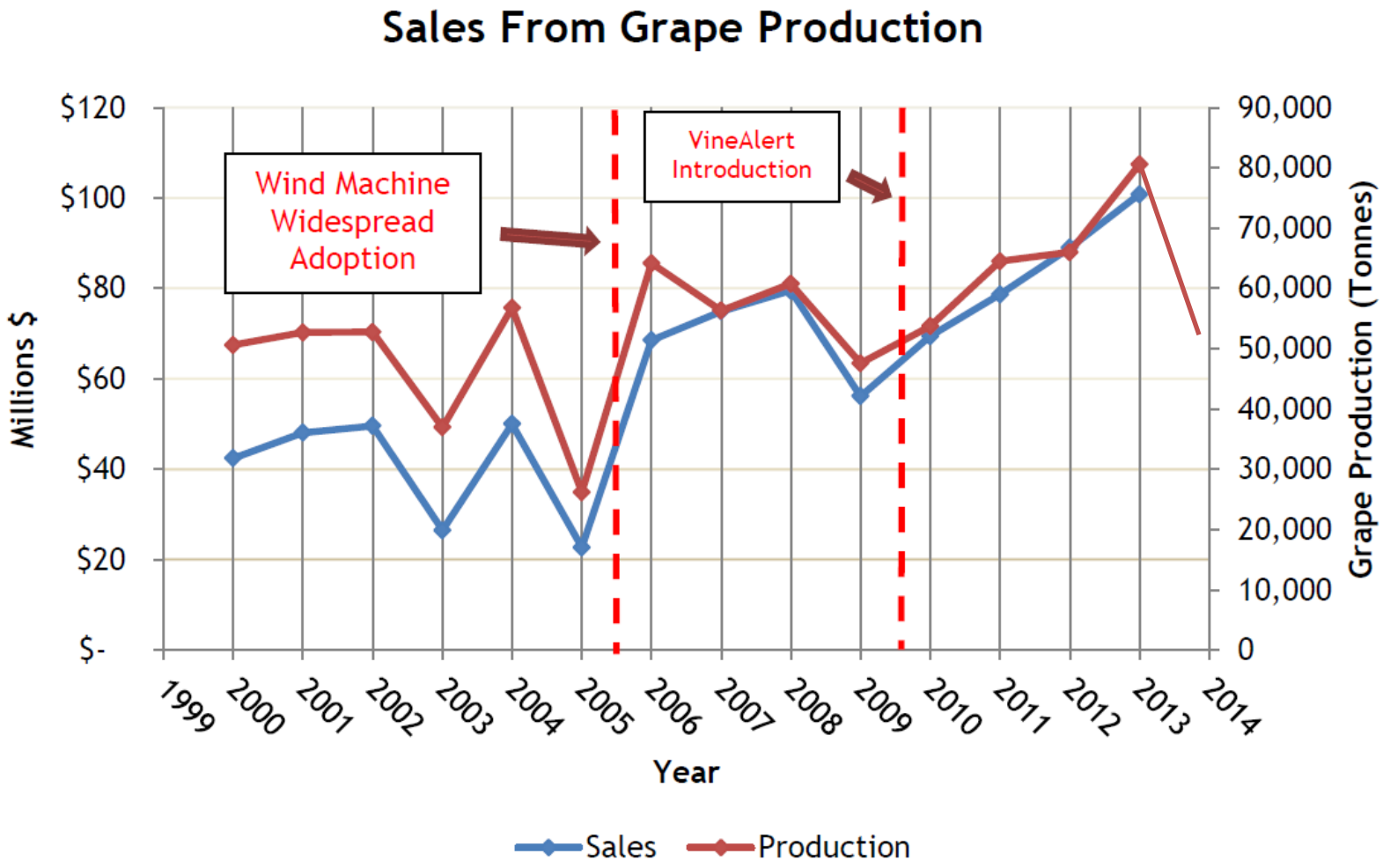


# Tough winters in Ontario (last 2 years)

# Tonnage and Sales (1999-2014)

**(Economic analysis of VineAlert, Goodman School of Business, 2014)**

# Acknowledgements



- Grower and winery partners
- All grower cooperators for VineAlert sampling and variety testing
- CCOVI: Mary Jasinski, Lisa Dowling, Dr. Andy Reynolds, Dr. Debbie Inglis, Dr. Belinda Kemp, Dr. Wendy McFadden, Linda Tremblay, Lori Quammie, Dr. G. Pickering
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- Brock Technical Services
- Dwight Follick
- Vineland Research and Innovation Centre: John Jansen, Ray Kaczmarski
- Niagara College:  Dr. Mike Duncan

# Acknowledgements

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Grape Growers of Ontario

Ontario Grape & Wine Research Incorporated

WIN Weather INnovations Incorporated

KCMS

Ontario Research Fund

Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

Federal Economic Development Agency for Southern Ontario

# Thank you

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