Cool Climate Oenology & Viticulture Institute

Brock University

Freeze protection strategies in vineyards.

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CCOVI, Brock University

Symposium Vigne et Vin
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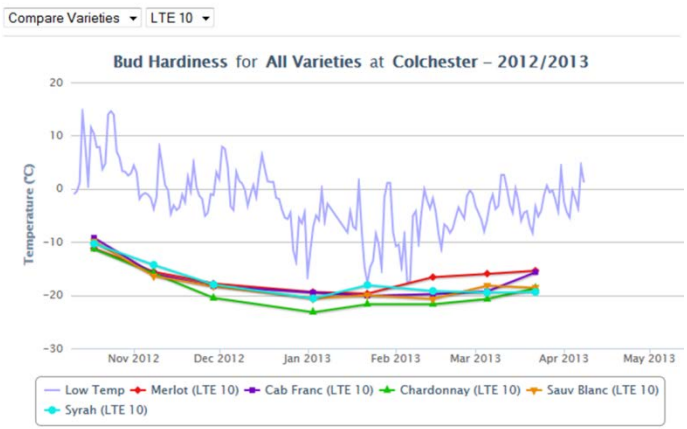
Overview

- Cold injury is a major contributor to economic loss due to poor yields, increased management costs and decreased fruit quality
- Cold hardiness is the main limiting factor for growing grapes in many regions across North America
- Research focused on cold hardiness identified as a priority by the Ontario grape and wine Industry
- 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, GGO, CCOVI

Grapevine Cold Hardiness Research

- *Vitis vinifera* wine grapes are not winter hardy
- Cold hardiness is limiting factor for growing many potential cultivars
- Need to understand important factors for our climate
- Optimization of cold hardiness to deal with cold winters and weather fluctuations during acclimation & deacclimation



Overall Objectives

- Monitor grapevine cold hardiness and create an advanced web-based database – VineAlert
- Further understand how to maximize grapevine cold hardiness and improve protection methods
- Impact of key vineyard management practices and understand the most critical factors involved
- Establish a grapevine cold hardiness ‘best practices’ guide for our climate

Freeze Injury

- **Can occur during acclimation, mid-winter, deacclimation or post bud break**
- **Also associated costs of removing trunks/vines, renewing vines, replanting etc.**

Types

- **Easy to see: buds, green tissue**
- **Not so easy to identify: phloem, xylem**
  - Trunk injury, shoot collapse during season
  - Crown gall

Consequences of cold injury

- Loss of fruiting buds
- Uneven or poor vegetative growth
- Inability to achieve vine balance
- Disease incidence (crown gall)
- Loss of uniformity
- Loss of consistency
- Loss of vines
- Ultimately reductions in yield, quality and $$$
- Need to minimize bud loss due to cold or physical injury - proper protection methods

What is Cold Hardiness?

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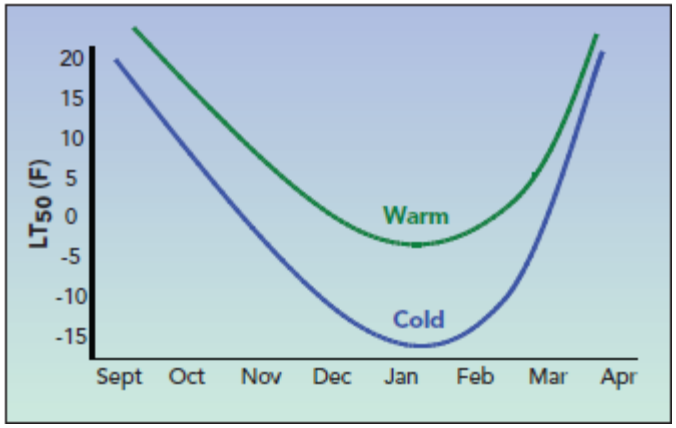
- **Ability of plant tissue to survive freezing temperature stresses**
- **Very complex trait with many contributing factors**
- **Limited by inherent genetic potential**
  - *V. riparia* – 40C; *V. vinifera* -20's C
- **Influenced by environmental conditions**
- **Highly dynamic condition**



(MSU Extension Bulletin E2930, 2007)

Cold Hardiness: Dynamic condition

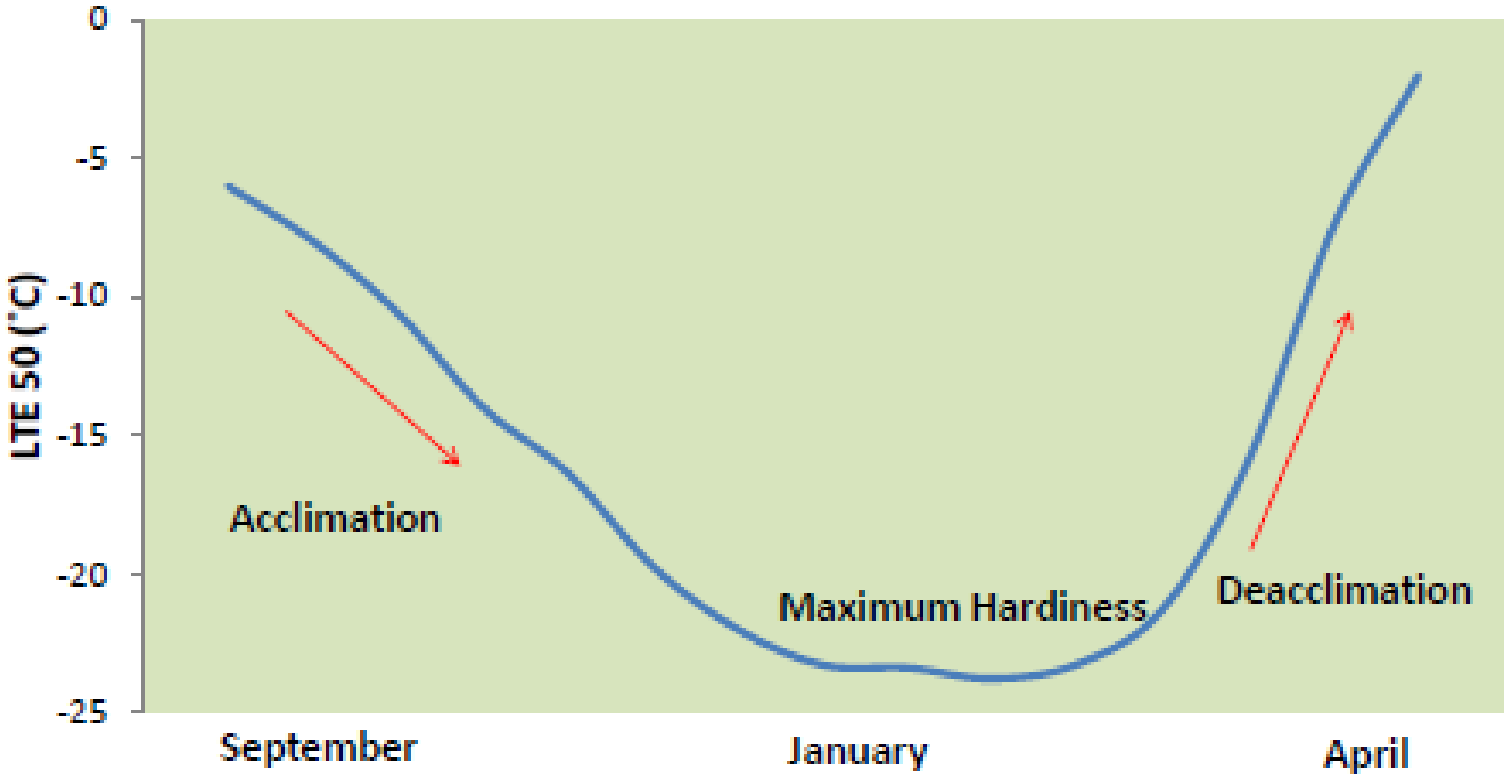


Figure 1. Profile of bud cold hardiness during the dormant season

(CCOVI VineAlert Website)

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

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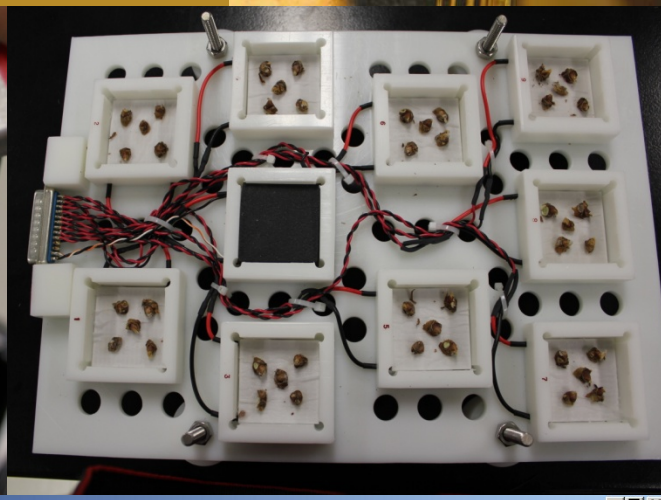

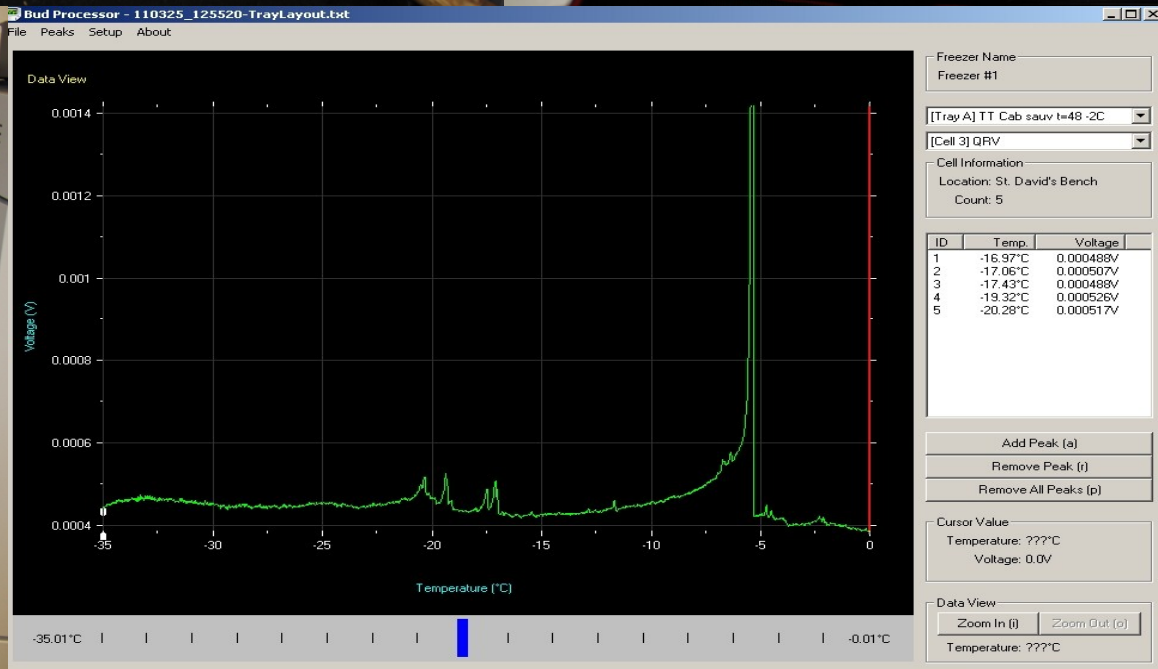

Cultivar differences in cold tolerance

- Ontario alone grows over 32 varieties (VQA-approved)
- *V. vinifera (different groups of origin)*
- French hybrids
- New hybrids with extreme cold hardiness
- New cultivars to our region
- Variation within and between these categories

Cultivar differences in cold tolerance

- **Some key Cool Climate cultivars in Ontario**

Cultivar	DATE	LTE10	LTE50	LTE90
Riesling	07-Feb-13	-23.1	-24.4	-26.0
Chardonnay	14-Feb-13	-21.4	-23.9	-25.3
Pinot noir	14-Feb-13	-21.4	-22.9	-24.1

Cultivar differences in cold tolerance

Bordeaux varieties (2012/13)

Cultivar	DATE	LTE10	LTE50	LTE90
Malbec	07-Feb-13	-22.25	-23.7	-25.11
Petit verdot	07-Feb-13	-22.35	-23.99	-25.68
Cab Sauvignon	06-Feb-13	-21.64	-23.87	-24.97
Sauvignon blanc	14-Feb-13	-20.71	-22.03	-23.7
Merlot	05-Feb-13	-17.48	-20.08	-22.41
Cabernet franc	14-Feb-13	-21.32	-22.87	-24.25

Cultivar differences in cold tolerance

Other cultivars (2012/13)

Cultivar	DATE	LTE10	LTE50	LTE90
Gewurztraminer	07-Feb-13	-19.8	-22.6	-25.0
Semillon	07-Feb-13	-18.1	-21.4	-24.3
Tannat	07-Feb-13	-20.8	-22.5	-23.9
Tempranillo	07-Feb-13	-18.9	-21.9	-23.8
Viognier	07-Feb-13	-21.2	-23.8	-25.6
Sangiovese	07-Feb-13	-20.6	-21.9	-23.0
Auxerrois	22-Jan-13	-21.85	-24.3	-25.8

Cultivar differences in cold tolerance

Other cultivars (2012/13)

Cultivar	DATE	LTE10	LTE50	LTE90
Regent	14-Feb-13	-20.08	-22.99	-24.49
Bianca	14-Feb-13	-22.7	-24.19	-25.52
HG01	14-Feb-13	-22.12	-23.68	-24.94
Gr7	12-Feb-13	-22.12	-23.63	-24.81
Frontenac	12-Feb-13	-24.44	-26.31	-27.35
Sabrevois	12-Feb-13	-21.46	-22.54	-24.08
Marquette	12-Feb-13	-23.19	-25.32	-26.61

Freeze protection strategies

- **Wind (Wind machines, Helicopters)**
  - ½ of Ontario industry protected with WM
- **Burying plants or parts of plants with soil**
  - All *vinifera* protected in PEC, ON.
- **Geotextiles**
- **Mulches**
- **Heat sources (Fires, smoke, equipment)**
- **Sprinklers (frost protection)**

Use of Geotextiles for winter protection

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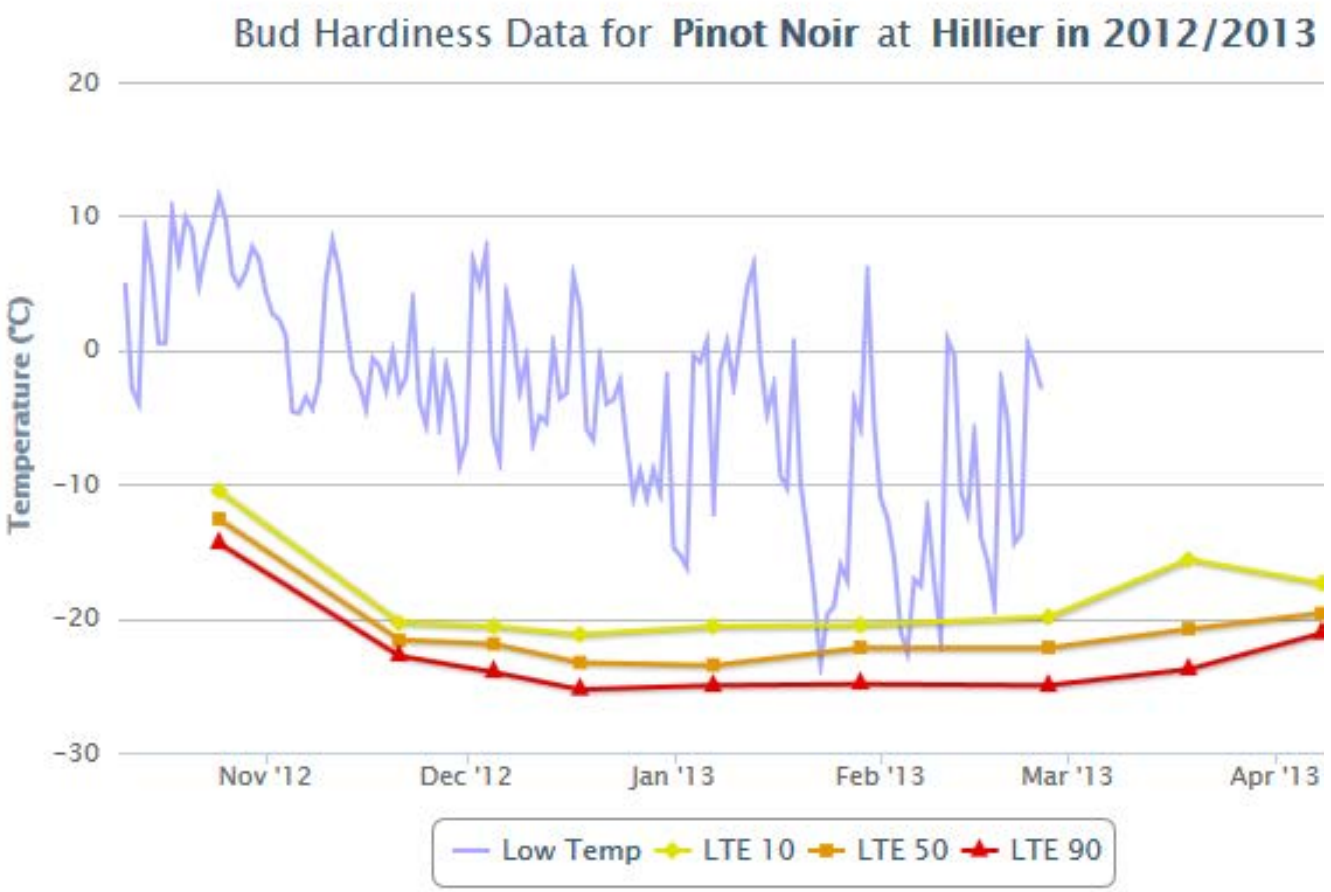
- **The need for protection**



Use of Geotextiles for winter protection

- **Geotextiles are materials used for winter protection of crops**
- **Used in Quebec vineyards**
- **Interest in Ontario vineyards have increased as of late**
- **Why?**
  - *Vinifera* need protection in some areas
  - Concern about damaging soils
  - Concern about damaging buds
  - Bud rot / loss
  - POOR YIELDS
  - Timing and weather

Buried canes – research from Cornell (Goffinet 2005-06)

- Experiment inspired by the severe winter injuries of 04-05
- Bud survival measured on both buried and aerial canes of Gewürztraminer, Pinot Gris and Cabernet
- Aerial canes in general proved more cold-hardy than buried canes, and buried canes experienced delayed shoot development once they were unburied
- Temperatures were relatively mild.

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, Dubois Agrinovation

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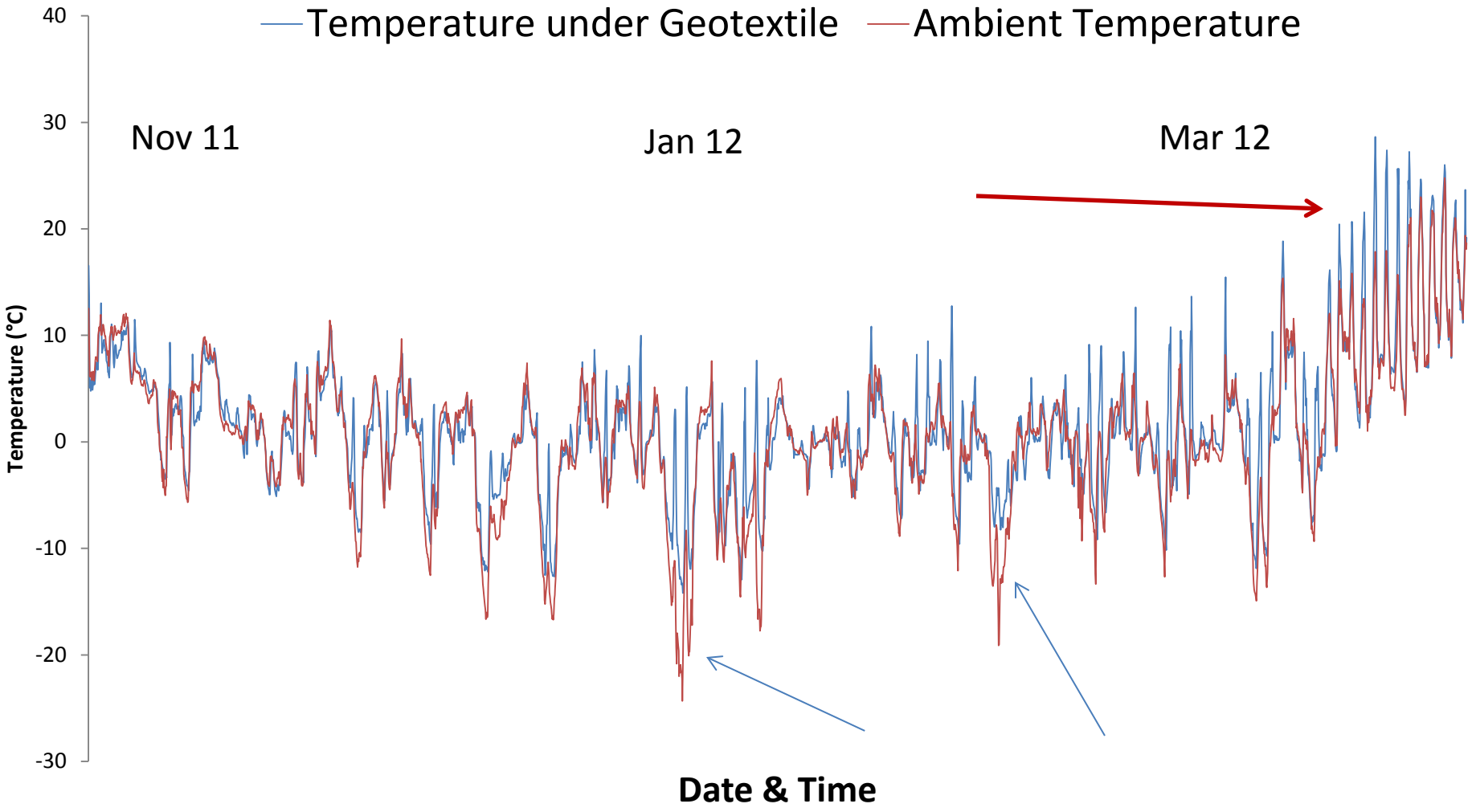
Geotextile experiment I

- 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 from last year

- 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 100% crop compared to buried vines which had around 20-30% of a normal crop at harvest

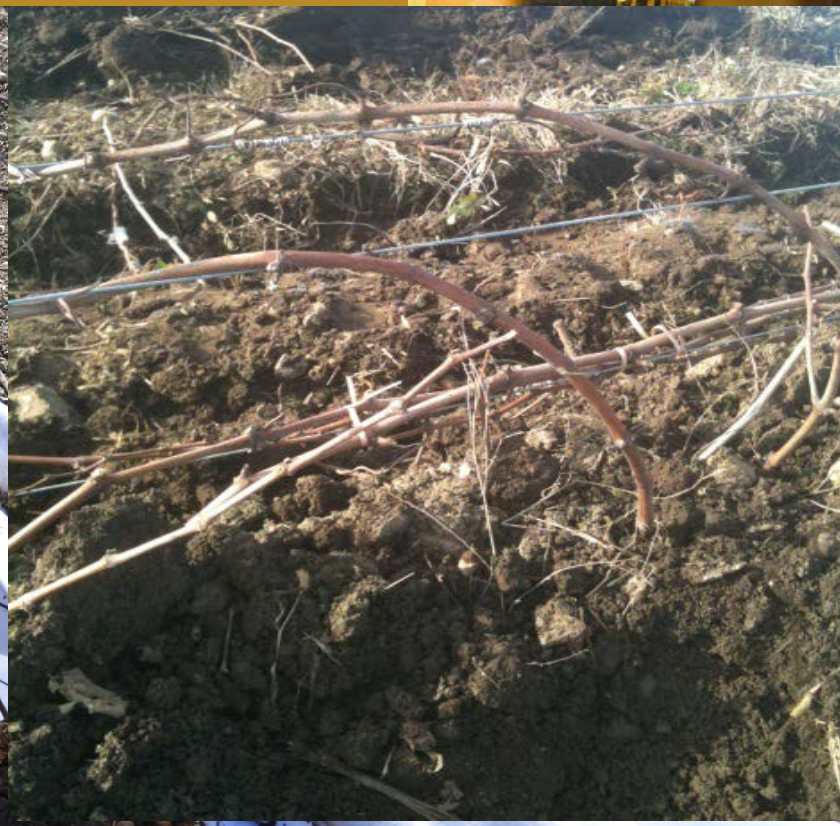
Geotextiles II
The Expanded Study (2012-)

- **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



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

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

Table 3. Predicted grapevine bud cold hardiness ratings for Chardonnay and Pinot noir using different protection strategies within Prince Edward County. Wellington, ON. (2012-13).

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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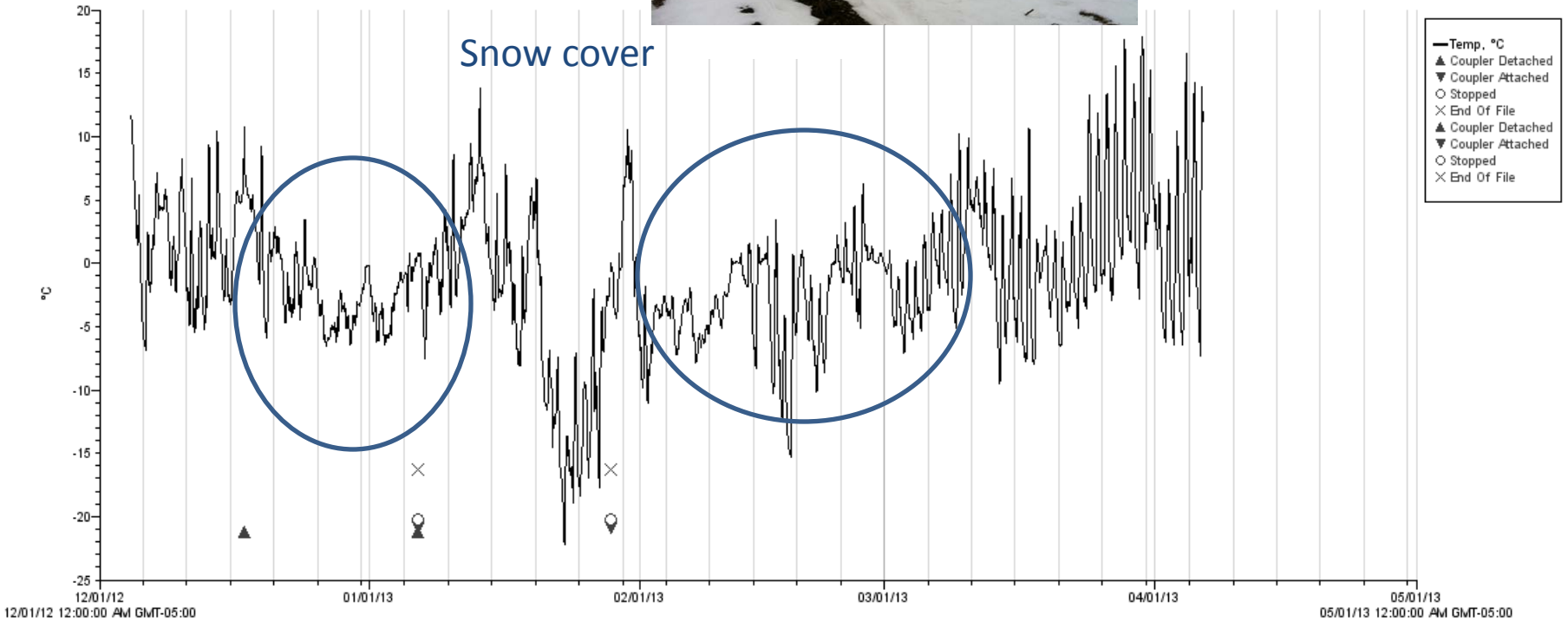
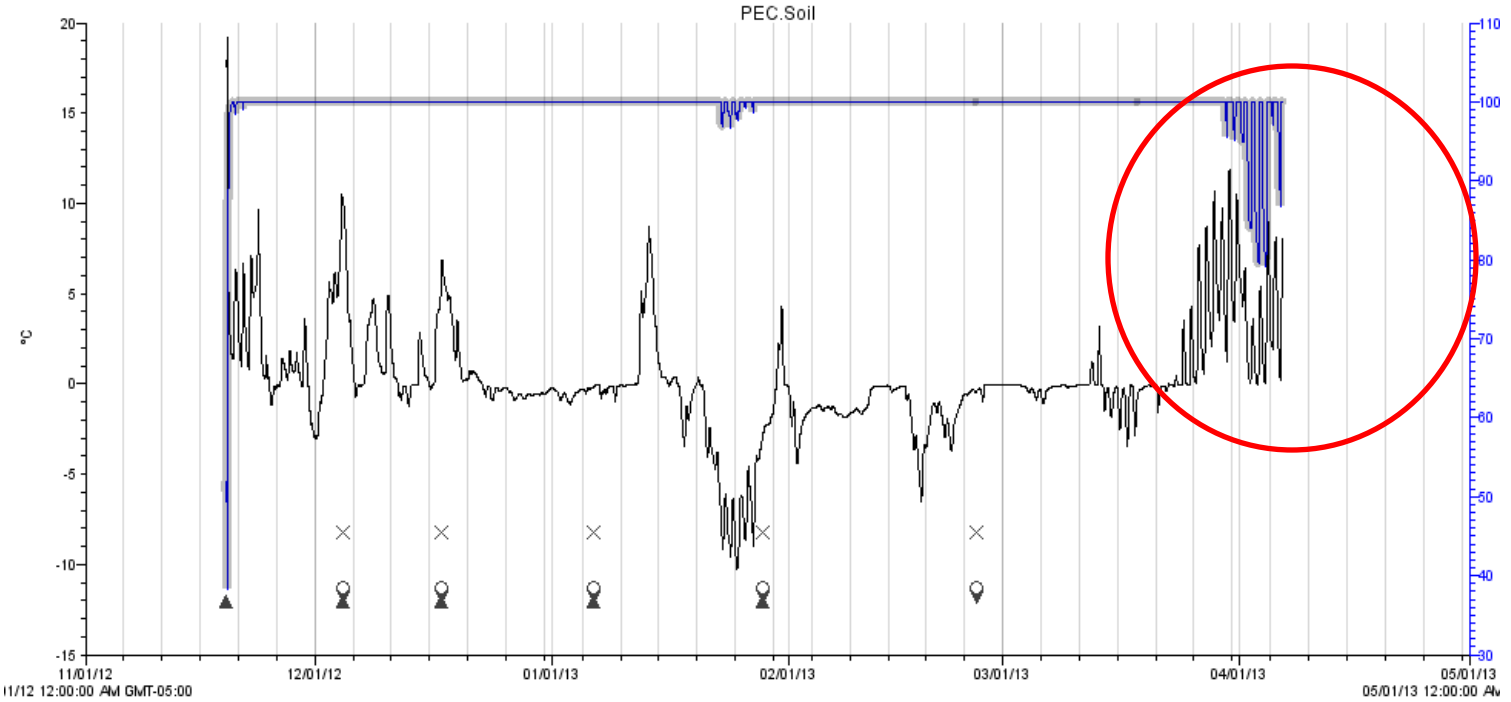
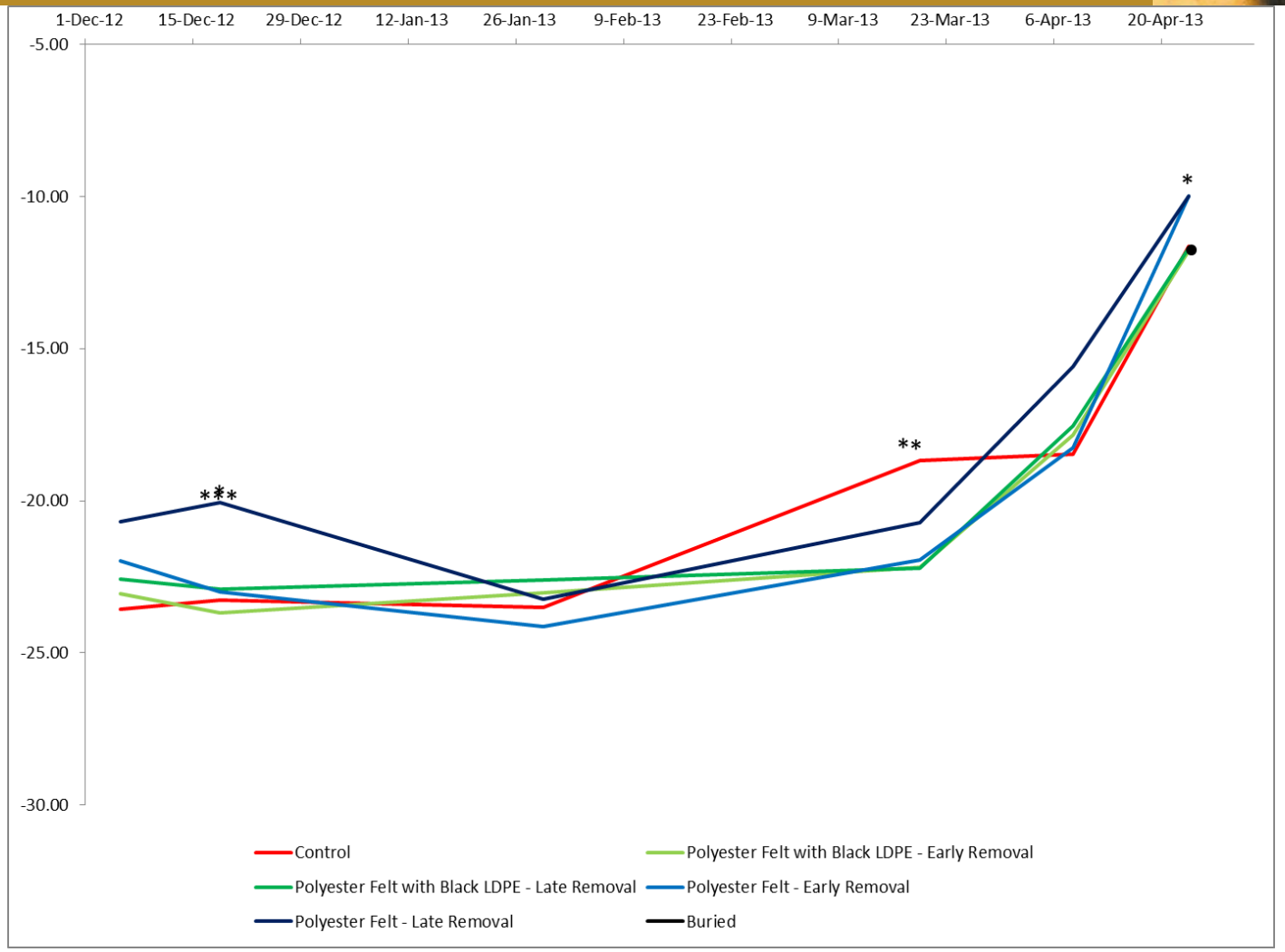


What lies Beneath?

- **Most interesting story is what happens below soil and materials with warmer temps**



Impact of protection strategy on bud hardiness (Chardonnay)



Cold hardiness dynamics (LTE50) of Chardonnay using different protection methods within Prince Edward County. Wellington, ON. (2012-13). *, **, * *indicate significance at p<0.05, p<0.01, p<0.001, respectively.***

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).

Findings after removal of materials Impact on Bud break

Chardonnay					
	Polyester felt - Early Removal	Polyester felt - Late Removal	Polyester felt with black LDPE - Early Removal	Polyester felt with black LDPE - Late Removal	Control
% Budbreak	51.1a	32.4b	45.1ab	32.1b	46.9a
Pinot noir					
	Polyester felt - Early Removal	Polyester felt - Late Removal	Polyester felt with black LDPE - Early Removal	Polyester felt with black LDPE - Late Removal	Control
% Budbreak	27.2a	35.7a	32.8a	45.8a	34.2a

Influence of protective strategy on budbreak on May 7, 2013. Vineland, ON.

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

Preliminary observations and thoughts

- **Geotextiles do moderate minimum temperature extremes**
- **Snow cover remains on vines longer with white geotextiles than buried vines**
  - This improves hardiness and temperature moderations
- **Materials can improve cold hardiness at certain times of year**
- **Some impact on bud hardiness (maximum)**
- **Yields improved considerably and vine health looks better (less rot, better periderm, less crown gall).**

Preliminary observations and thoughts

- **Greenhouse effects when soils are warmer (fall, late winter/spring)**
- **Timing and removal of application**
  - Implications of too early or too late
- **Logistics**
- **Economics**

  cost factors and durability
- **Another factor that has appeared in some areas…..**

Conclusions and final thoughts

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- Cold Injury is a major threat to the grape and tender fruit sectors
- Understanding how to get optimal vine hardiness and the best winter protection
- Critical for vine balance, uniformity, consistency and ultimately quality

Conclusion

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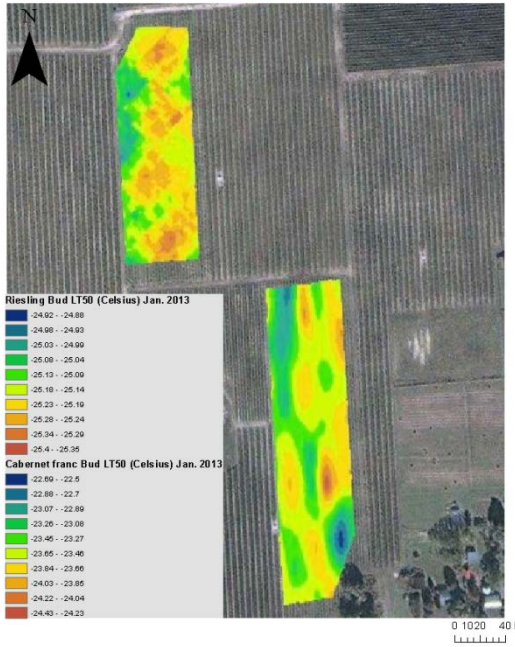
- Research (experimentation), outreach, innovation are key to success for pushing boundaries, improving quality and profits
- At one point no one thought wind machines would help so much in ON….what's next????



Acknowledgments

Thank you for your attention.

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