CRAM
CENTRE DE RECHERCHE AGROALIMENTAIRE DE MIRABEL

Activity 5

Assessing Grapevine Cold Hardiness Under Climatic Conditions of Eastern Canada by Applying Various Techniques

2022 CGCN Webinar Series

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Activity 5

Part 5a

Monitoring system for evaluation of cold hardiness of several grapevine cultivars under climatic condition of Eastern Canada

Part 5b

Use of winter protection systems to reduce winter injuries of cold sensitive cultivars.

Part 5c

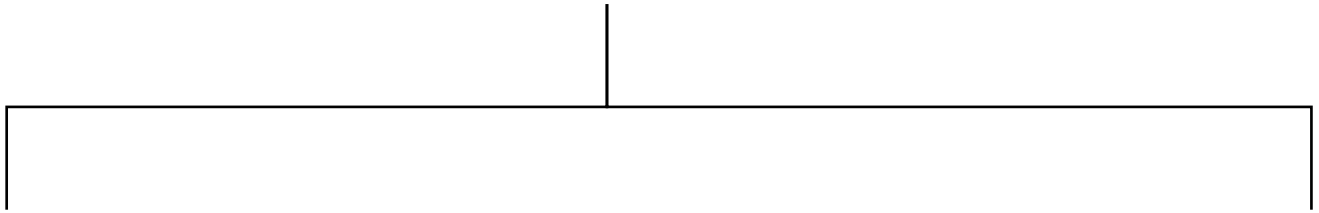
Use of rootstocks to improve cold hardiness of hybrid cultivars.

Outline

- Monitoring program
  - Background and methodology
  - Site and cultivar selection
  - Results from past and current years
  - Outcomes
- Geotextile project
  - Introduction to the technology
  - Materials and methods
  - Results and preliminary conclusions

Overview of activity 5a

Monitoring system for evaluation of cold hardiness of several grapevine cultivars under climatic condition of Eastern Canada

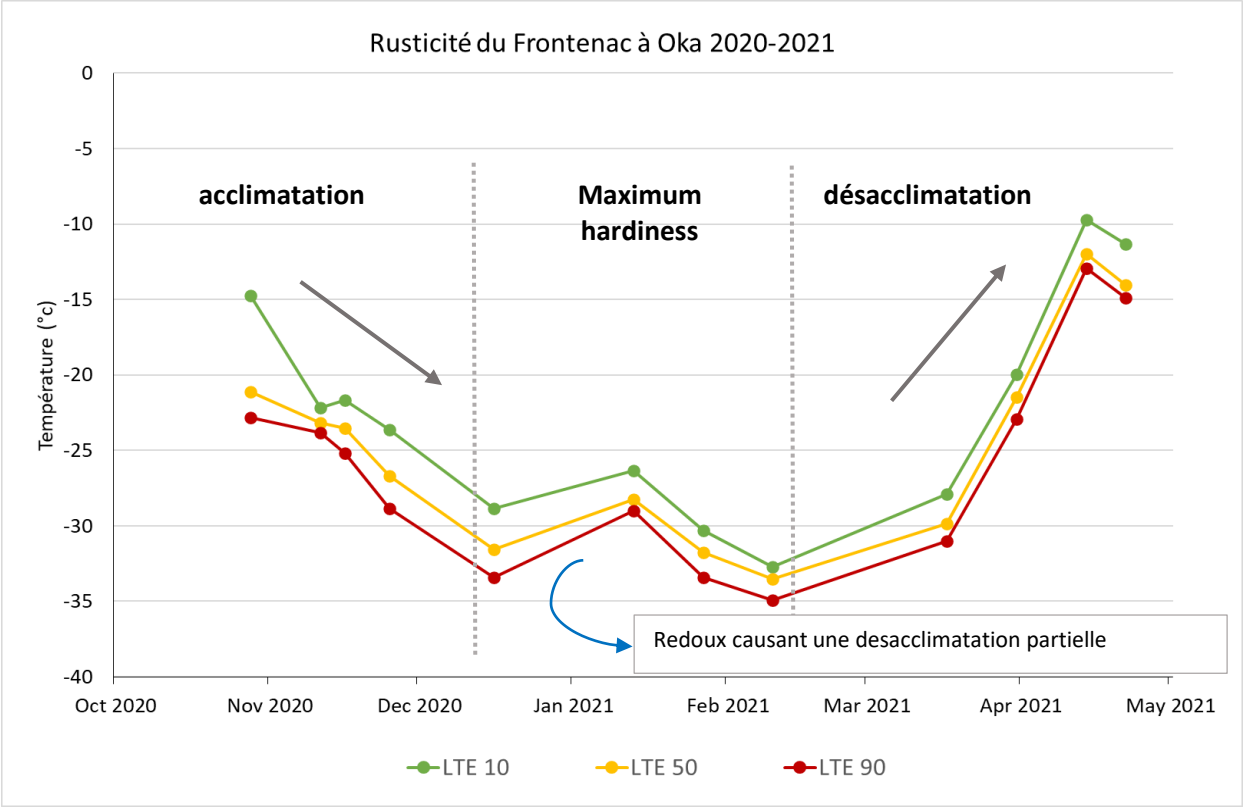


Establishment of a monitoring system for periodic data acquisition on bud hardiness (LTE 10, 50, 90) in order to understand grapevine physiology related to cold hardiness and to support producers in optimizing the use of frost protection methods

Development of modeling related to grapevine physiology of several cultivars under eastern climatic conditions of Canada.

5a: Background

- Cold hardiness is dynamic, generally considered to be separated into acclimation, max hardiness, and deacclimation
  - Closely related to the change in temperature
- Set of physiological, structural and biochemical changes that increase vine tolerance to cold temperature
  - Freezing is avoided at the molecular level by supercooling
- Factors that impact vine health will generally have an impact on cold hardiness
  - Overcropped/undercropped vines
  - Pest, disease, maybe virus?
  - Water-logged soil
- Without protection, cold temperatures significantly limit the choice of cultivar
  - *V. vinifera*: -18°C to -25°C
  - Hardy hybrids: -29°C to -35°C



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Variety	Vigor	Cold hardiness	References
Red			
Baltica	moderate	-29°C to -34°C	1, 2
Concord	high	-26°C to -32°C	4, 5
De Chaunac	moderate/high	-26°C to -32°C	1, 4
Frontenac	high	-29°C to -34°C	1, 2, 3, 4
Léon Millot	high	-26°C to -32°C	1, 3, 4, 5
Marechal Foch	moderate	-26°C to -32°C	1, 3, 4, 5
Marquette	high	-29°C to -34°C	1, 3
Petite Perle	moderate	-29°C to -34°C	1, 3
Sabrevois	moderate	-29°C to -34°C	1, 3
Skandia	moderate	-29°C to -34°C	1, 2, 3
White			
St. Croix	moderate/high	-29°C to -34°C	1, 2, 3, 5
Frontenac blanc	high	-29°C to -34°C	1, 2, 3
Frontenac gris	high	-29°C to -34°C	1 , 2, 3
La Crescent	high	-29°C to -34°C	1, 2, 3
Louise Swenson	low	-29°C to -34°C	1, 2, 3
Seyval	moderate	-23°C to -29°C	1, 3, 4, 5
St.Pepin	moderate	-29°C to -34°C	1, 3, 5
Traminette	moderate/high	-23°C to -29°C	1, 4
Vandal Cliche	moderate/high	-26°C to -32°C	1
Vidal	moderate	-20°C to -26°C	1, 4, 5

1-Dubé et Turcotte 2011

2-Provost et al. 2013

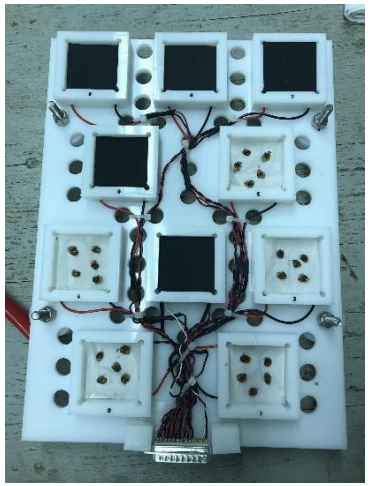
3-Plocher and Parke 2008

4-Wolf 2008

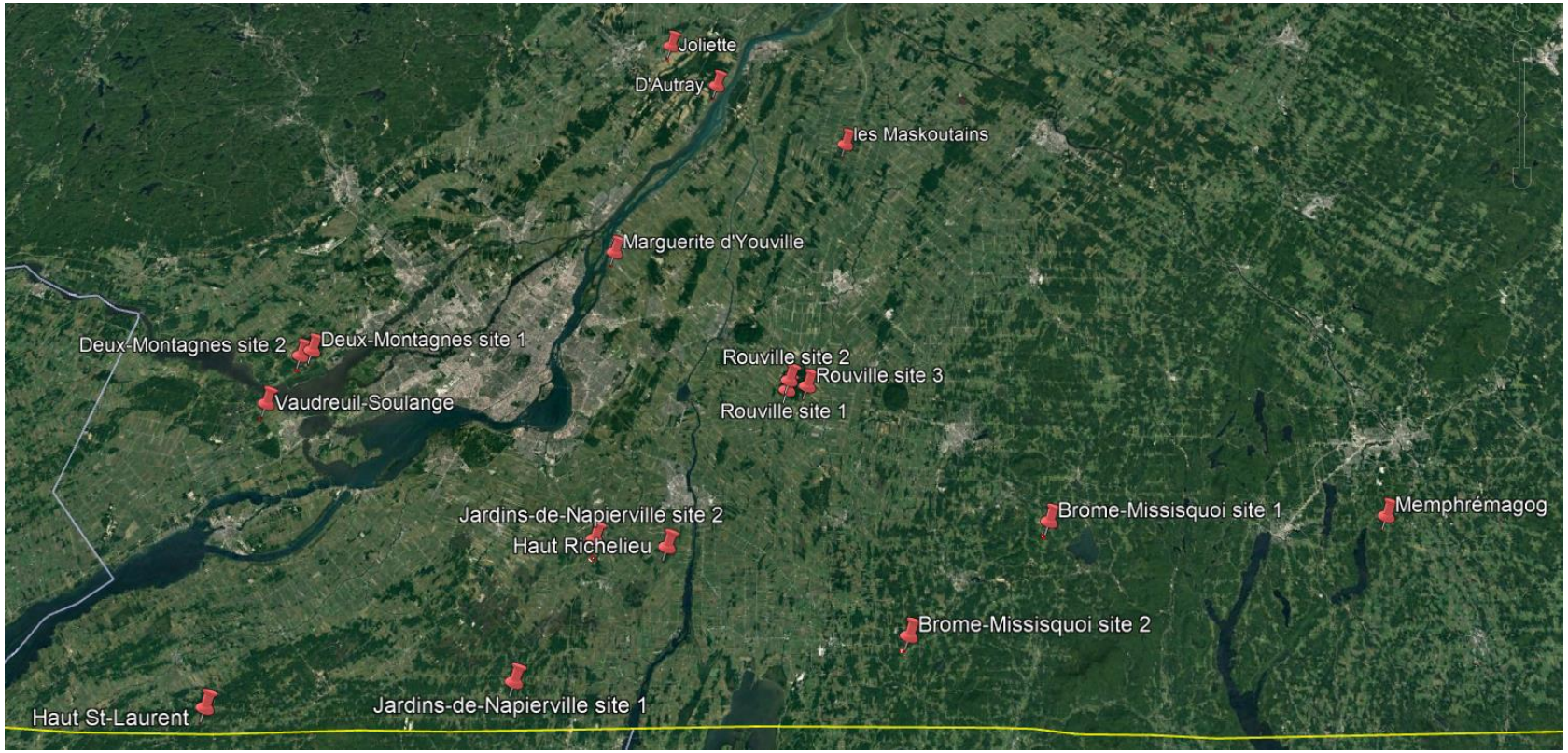
5-Reisch et al. 1993

5a: Methodology

- Cold hardiness evaluation by differential thermal analysis (DTA; Mills et al 2006, Willwerth et al. 2014)
  - Bud survival, yield, etc.
- Replication and frequency of sampling:
  - Year 1 and 2: 4 to 5 vines randomly sampled in vineyard, one cane/vine, bud 3-7 (20 to 25 buds)
  - Year 3: 9 vines, same bud position (45 buds)
  - Biweekly sampling from October to April since 2019
- Data analysis performed with CCOVI software
  - LT10, 50 and 90 is communicated to growers every 1 to 3 weeks
- Weather monitored on site with data logger



5a: Cultivars and sites



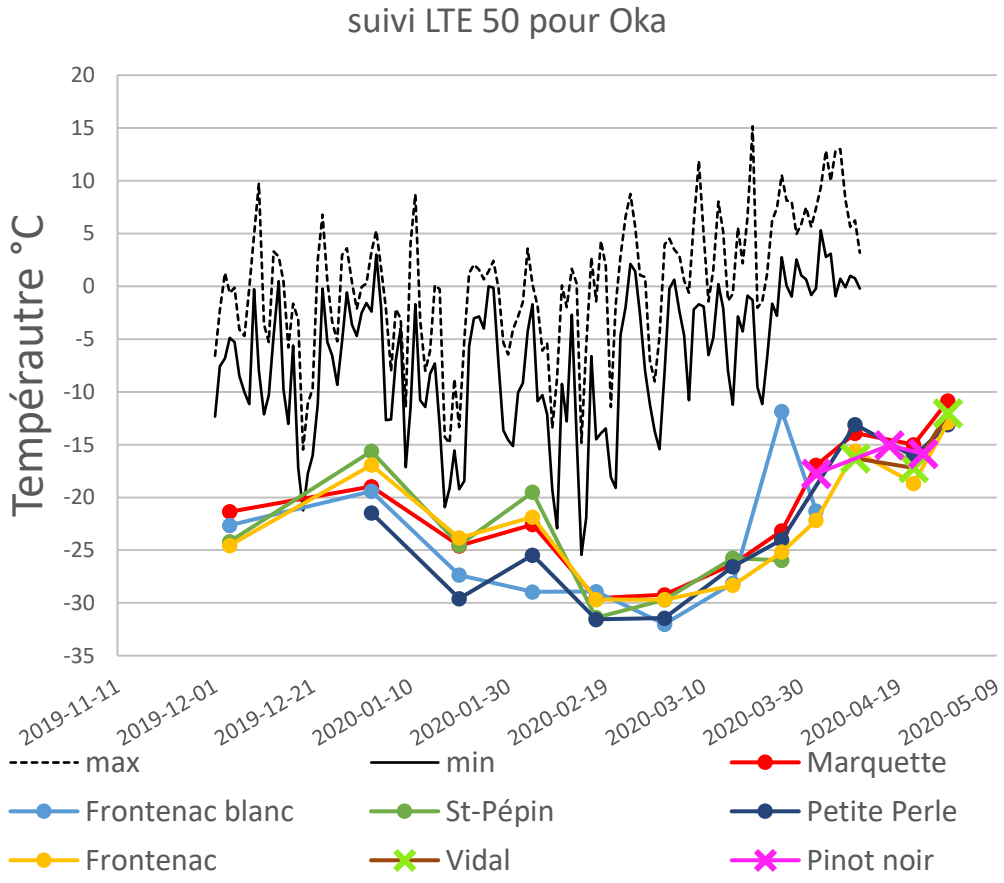
White cultivars

- Frontenac blanc, Frontenac gris, St-Pépin
- Chardonnay, Seyval, Vidal

Red cultivars

- Frontenac, Marquette, Petite pearl
- Gamaret, gamay, pinot noir

5a: Establishment of the program



- Year 1 – 2019/2020
  - Unexpected trends earlier in season, max hardiness only in February
  - Some days below -20°C and -25°C on the colder sites
  - Important reacclimation trend during deacclimation

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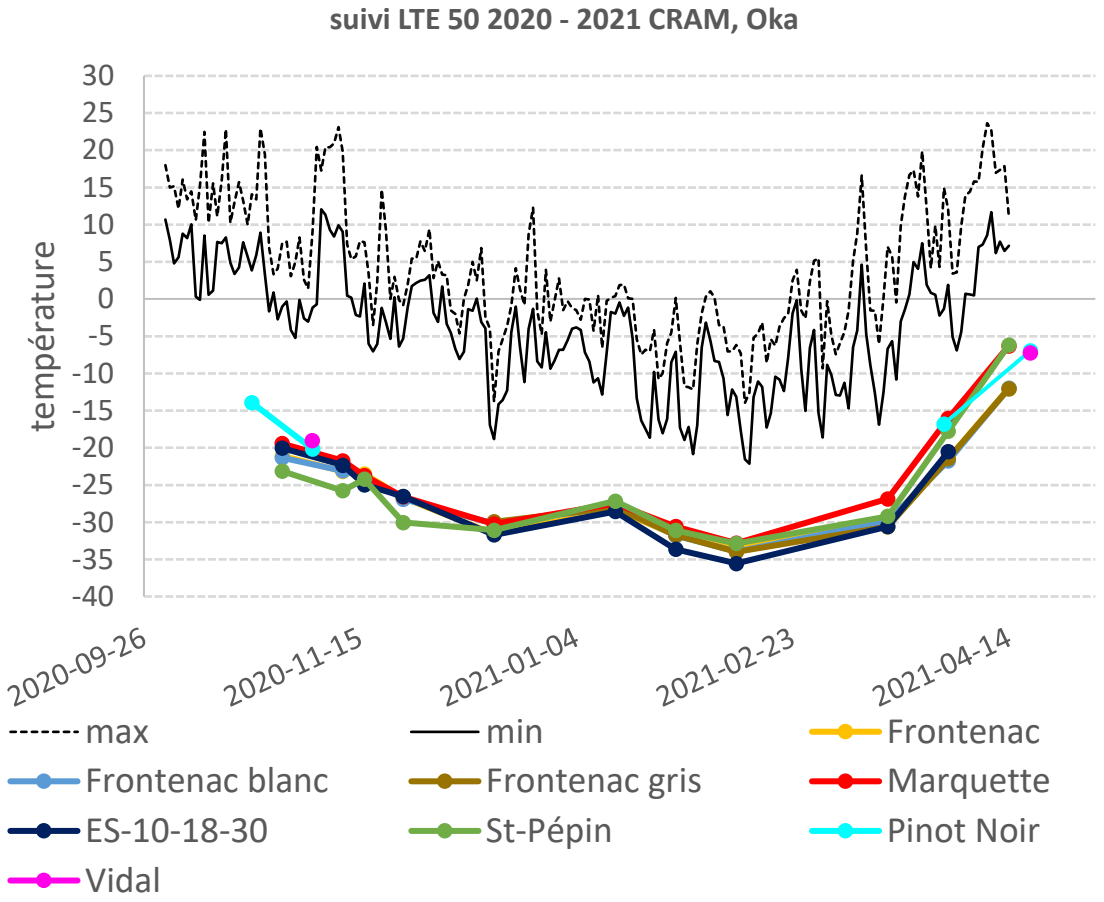
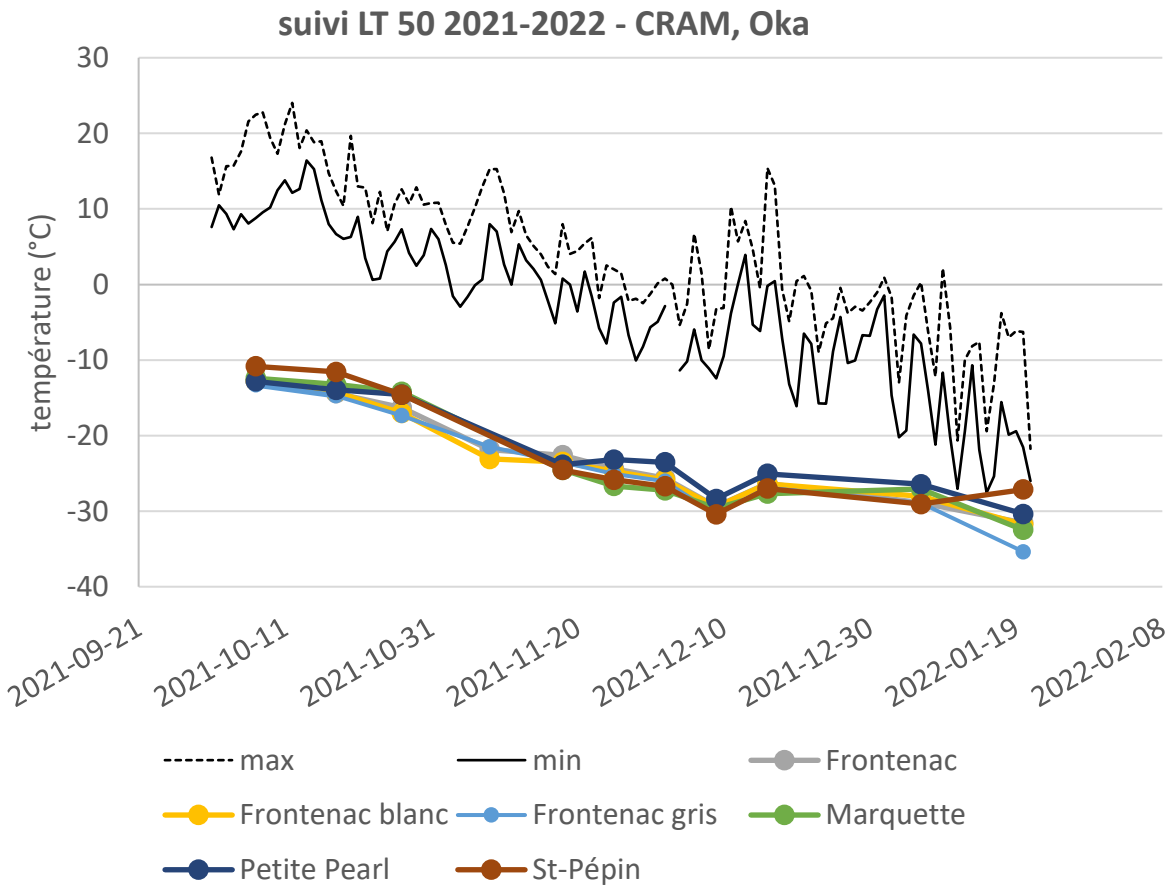


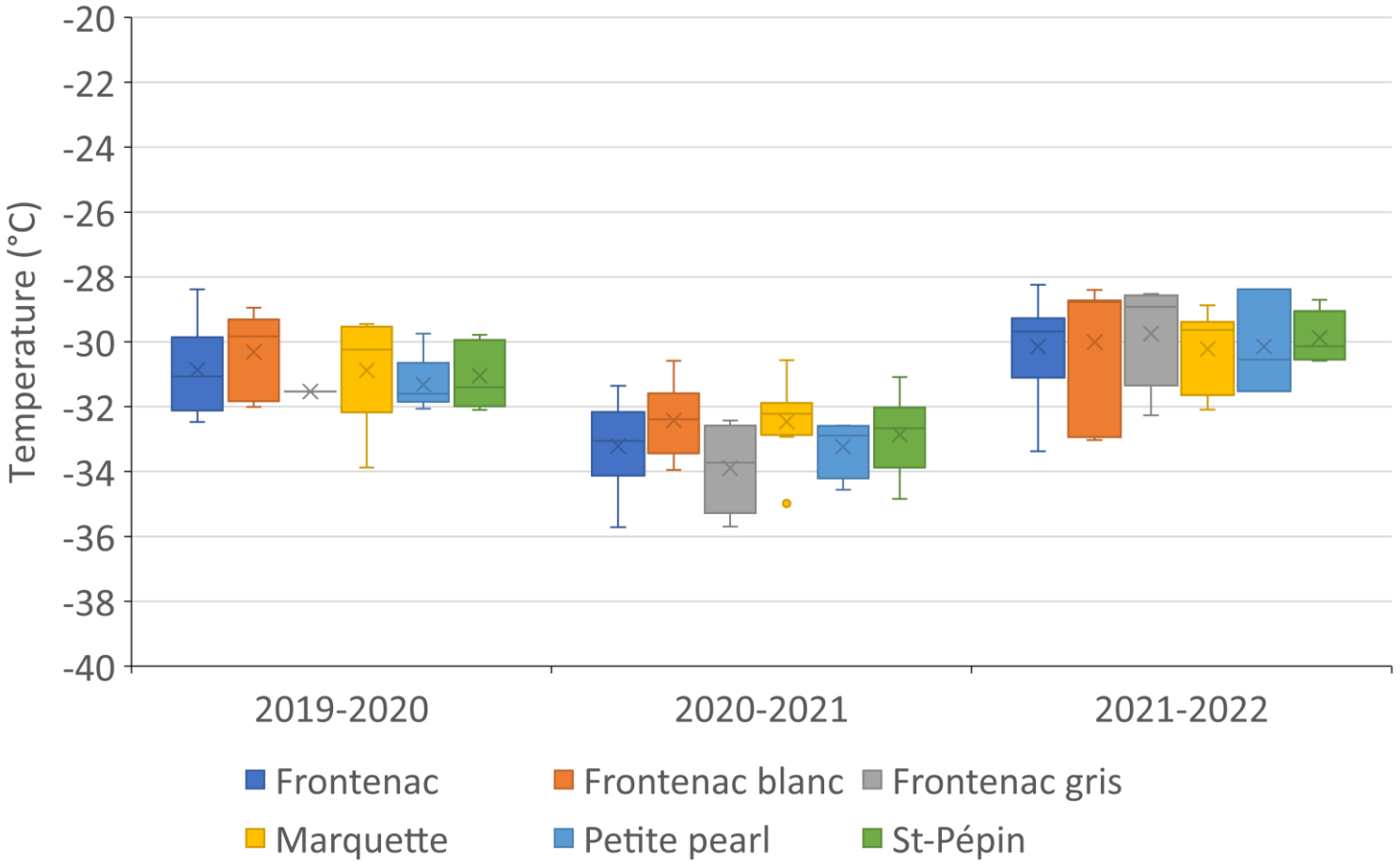
- Year 1 – 2019/2020
  - Unexpected trends earlier in season, max hardiness only in February
- Year 2 – 2020/2021
  - Important annual differences
  - Following expected trend – U-shape
  - Starting to see differences between cultivars and sites

5a: Establishment of the program



- Year 3: 2021/2022
  - New freezer – more data
  - Very different from preceeding years
  - Colder temperatures in January – close to LT50
  - Allows us to compare our DTA output to bud survival in the field

5a: Max hardiness over the years



- Lowest LT50 pooling all sites
  - More sites for Frontenac, less for Frontenac gris, St-Pépin and Petite pearl
  - Observed either in January or February
  - Maximum hardiness potential is not achieved every year
- Important annual and site differences
- Hard to determine the hardiest cultivar
  - More extensive data analysis required

5a: Preliminary outcomes and conclusions

- Outcomes
  - We have built a bud hardiness monitoring system for the Quebec industry
  - Published 24 newsletters so far over three years
  - Working on a website to share data rapidly like VineAlert
- Preliminary observations and conclusions
  - Site and cultivar differences are important and we need to keep monitoring if we want a robust model
  - Maximum hardiness of the hybrids is attained and being documented
  - Hardiness of *Vitis vinifera* similar to hybrid until geotextiles are installed
- Future direction
  - Better caracterization of the hardiness-temperature relationship between hybrids
  - Relating rates of acclimation and deacclimation to dormancy phases and timing of bud break

Overview of activity 5b

Use of winter protection systems to reduce winter injuries of cold sensitive cultivars

Knowledge acquisition on winter protection systems with geotextile (or other material) in order to optimize grapevine winter protection and consequently to increase yield and fruit quality;

Determination of optimal use (timing of installation and removal) of geotextile as winter protection that will be presented to the growers

5b: Geotextile technology

- Geotextile
  - reflect sunlight and help retain ground temperature under them.
  - Covered by snow, they limit temperature fluctuations throughout the winter.
- Technical challenges
- Questions:
  - **Does the type of geotextile makes a difference?**
  - **Does the timing of geotextile installation and removal influence vine physiology?**
- Other projects concurently on pruning and installation height

5b: Materials and methods

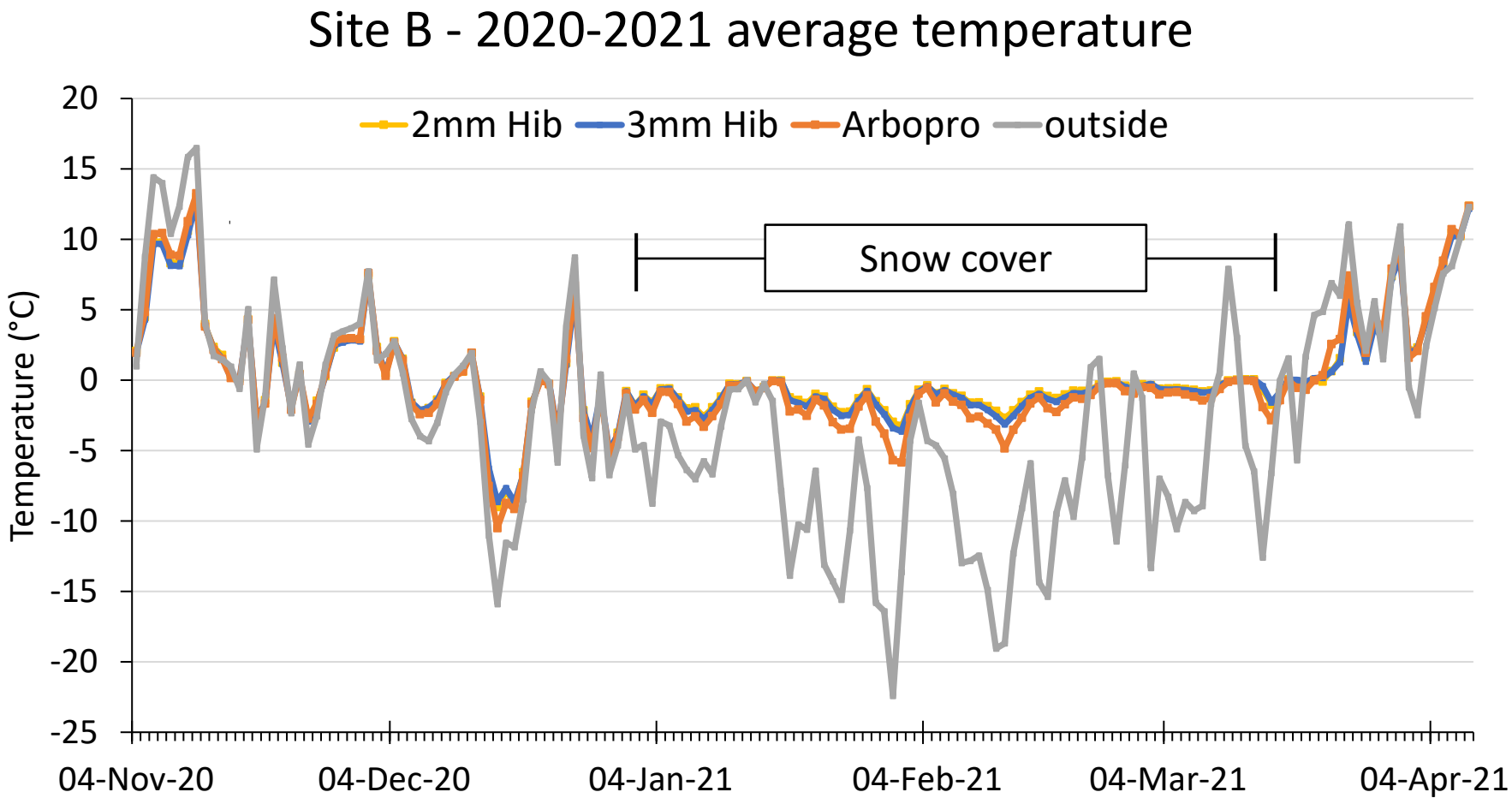
- Testing combinations of type of geotextile and timings of installation/removal
  - Texel arbopro, Hibertex 2mm, Hibertex 3mm
  - Installation/removal: early/early, early/late, late/early, late/late
  - Chardonnay, Vidal, Pinot noir
- Randomized complete block design replicated in multiple vineyards
  - 5-vine replicates, 4 rep per site, 3-year replication
- Data collected
  - Weather on site and under geotextile
  - Snow cover
  - Timing phenological stages, lignification
  - Yield, yield components, berry chemistry

Site	Cultivar	Years	Treatment (cultivar)
Site A	Chard, PN, Vidal	2018, 2019, 2020	time*type, type (PN)
Site B	PN, Vidal	2019, 2020, 2021	time (Vidal), type (PN)
Site C	Vidal	2019, 2020, 2021	time
Site D	Vidal	2020, 2021, 2022	time*type
Site E	Chardonnay	2020, 2021, 2022	time*type

	YEAR 1				YEAR 2				YEAR 3			
	early install	late install	early removal	late removal	early install	late install	early removal	late removal	early install	late install	early removal	late removal
Site A	Nov 14 2018	Nov 28 2018	Apr 16 2019	May 04 2019	Nov 21 2019		Apr 02 2020		Nov 06 2020	Nov 20 2020	Apr 05 2021	Apr 27 2021
Site B	Nov 04 2020	Nov 18 2020	Apr 08 2021	Apr 26 2021	Nov 08 2021	Nov 19 2021						
Site C	Nov 20 2019		Apr 16 2020		Nov 04 2020	Nov 18 2020	Apr 08 2021	Apr 26 2021	Nov 02 2021	Nov 19 2021		
Site D	Nov 02 2020	Nov 16 2020			Nov 05 2021	Nov 17 2021						
Site E	Nov 05 2020	Nov 19 2020	Apr 06 2021	Apr 23 2021	Nov 04 2021	Nov 16 2021						

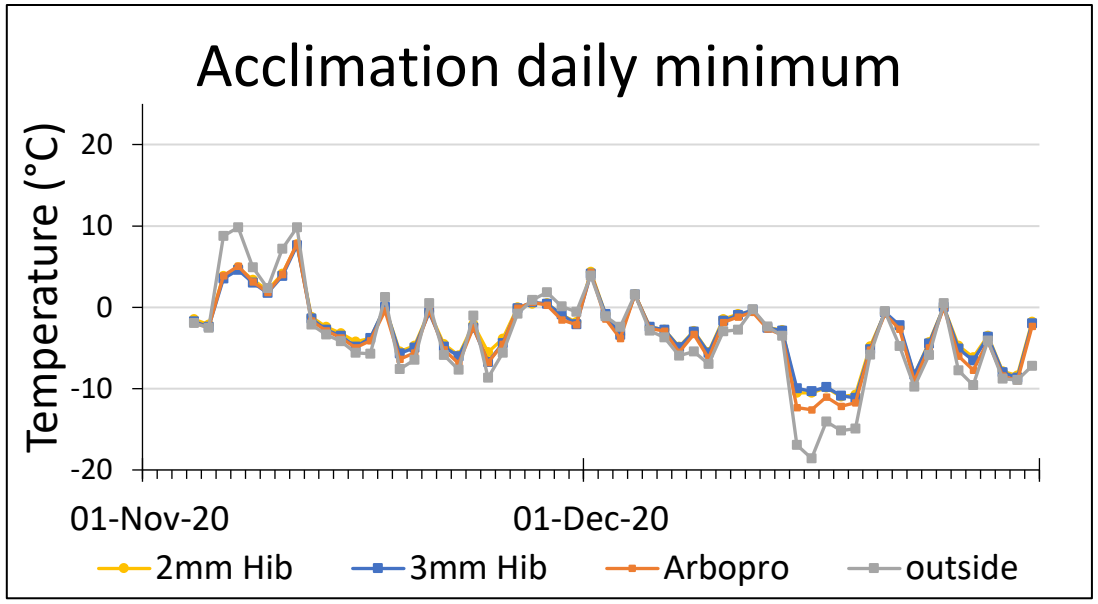
5b: Type of geotextile

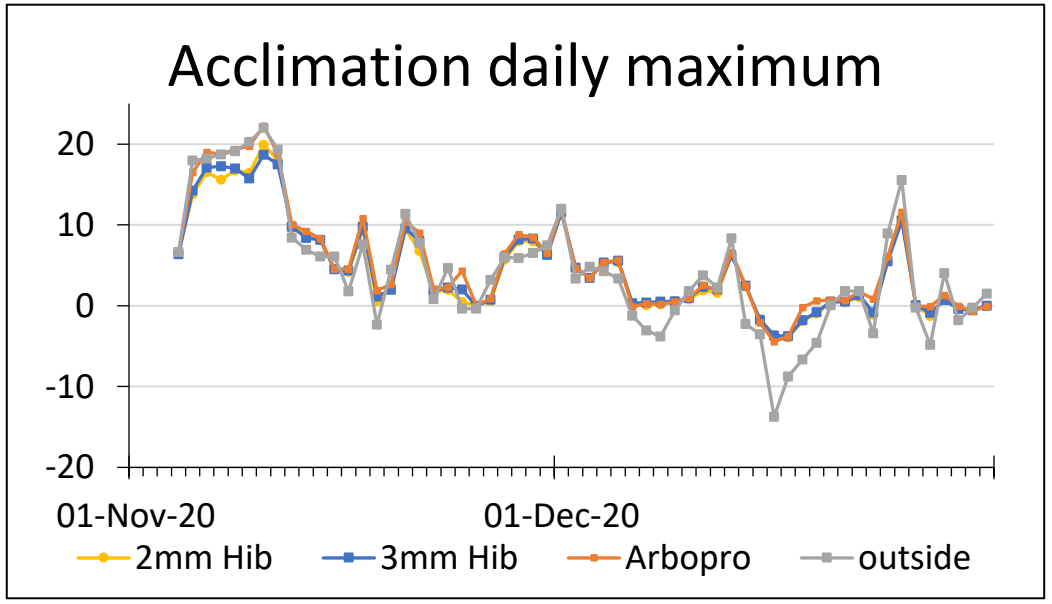
- Snow cover is the biggest factor in maintaining the temperature under the geotextile
- Reduces temperature fluctuation
- Some small anecdotal differences between types of geotextile
  - Not consistent between blocks



5b: Timing of installation

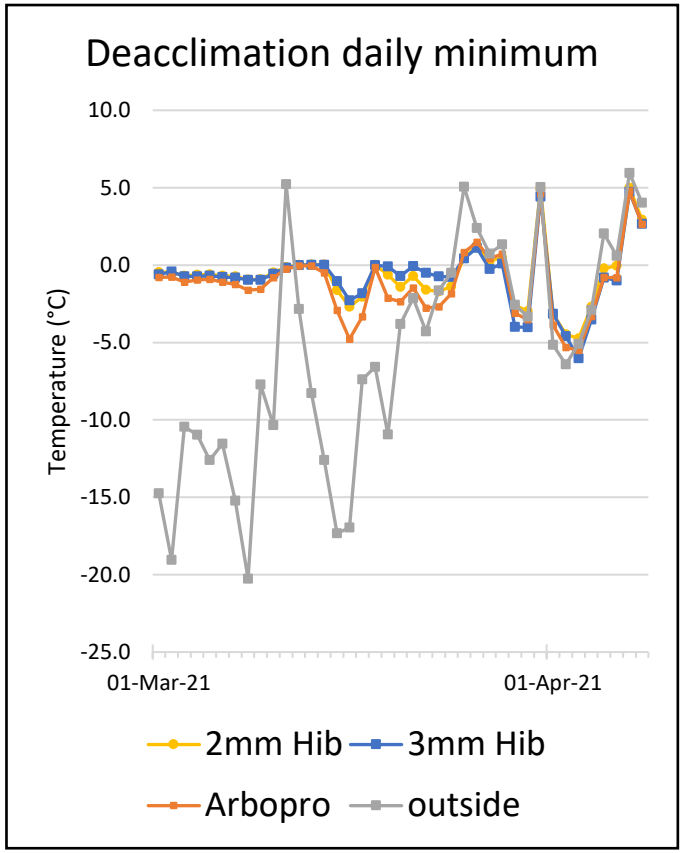
- Minimum temperatures follow the outside trends
- Maximum temperatures do not seem to be impacted by a greenhouse effect
- Early or late installation should not lead to more susceptibility to cold, and we expect little influence on bud survival and yield

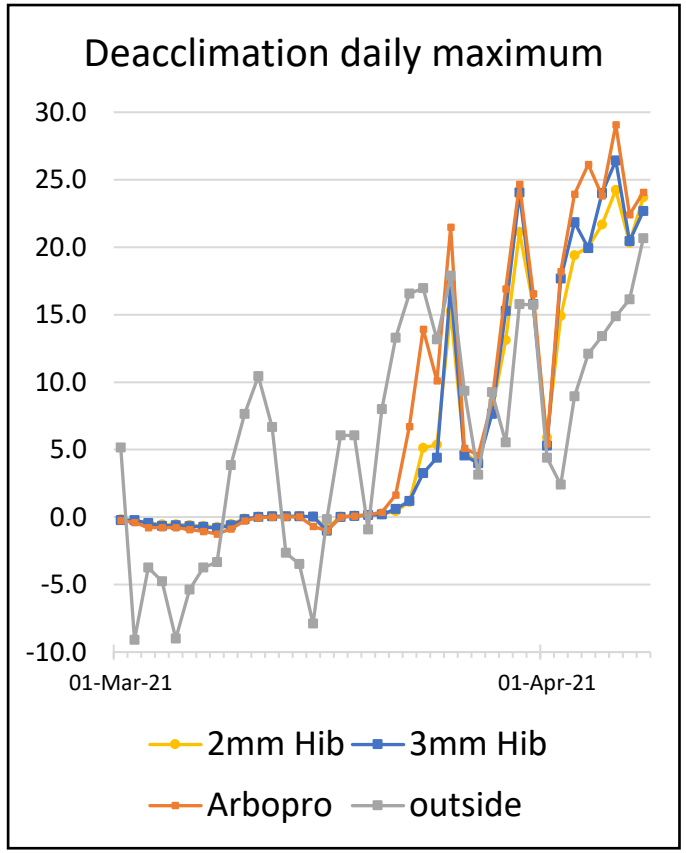




5b: Timing of removal

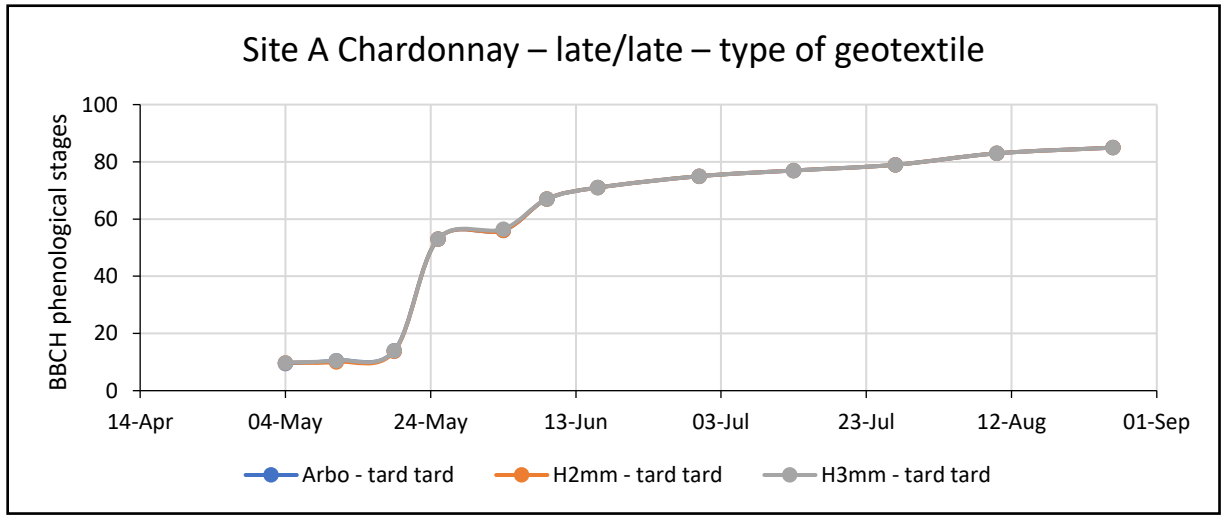
- Resist the daily temperature fluctuation as long as there is a snow cover
- When snow is off
  - Minimum similar to outdoors
  - But potential greenhouse effect that raises maximum temperatures during the day
- Implication for deacclimation rate and potentially timing of bud break

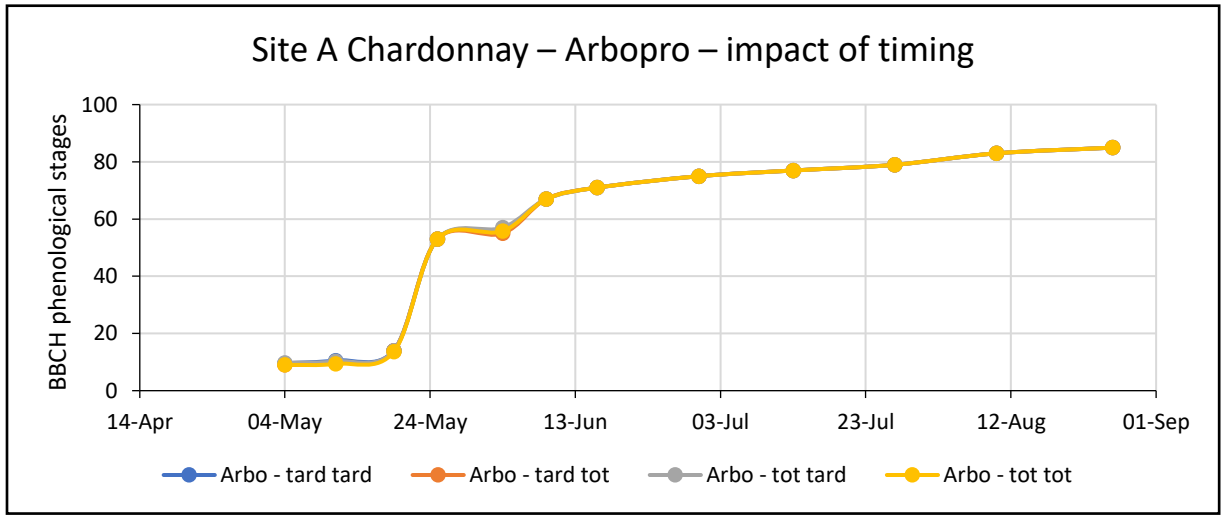




5b: but does it matter?

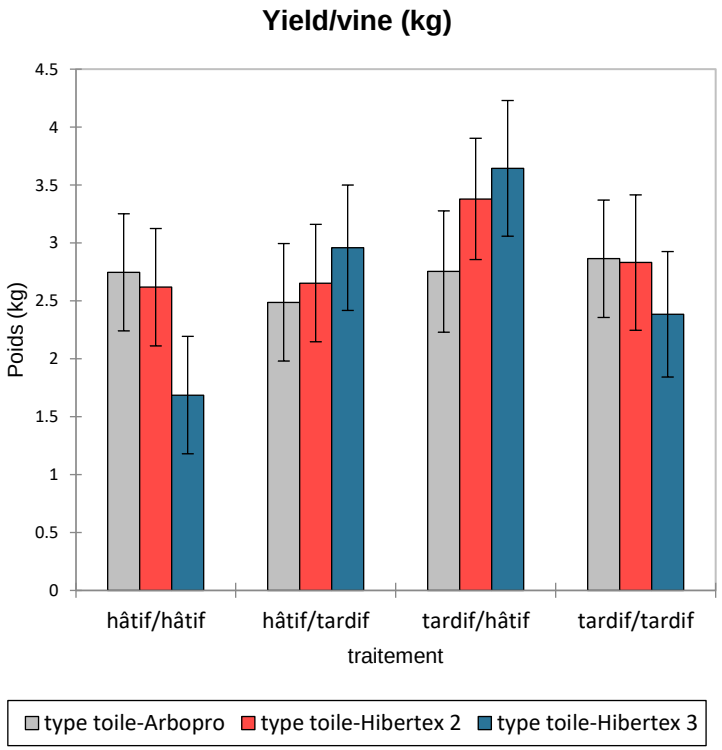
- Phenological stages are not earlier even if temperature is higher under the geotextile
  - Need more years of data collection, could be vintage dependent…
  - Need to compare to cold hardiness data and bud survival

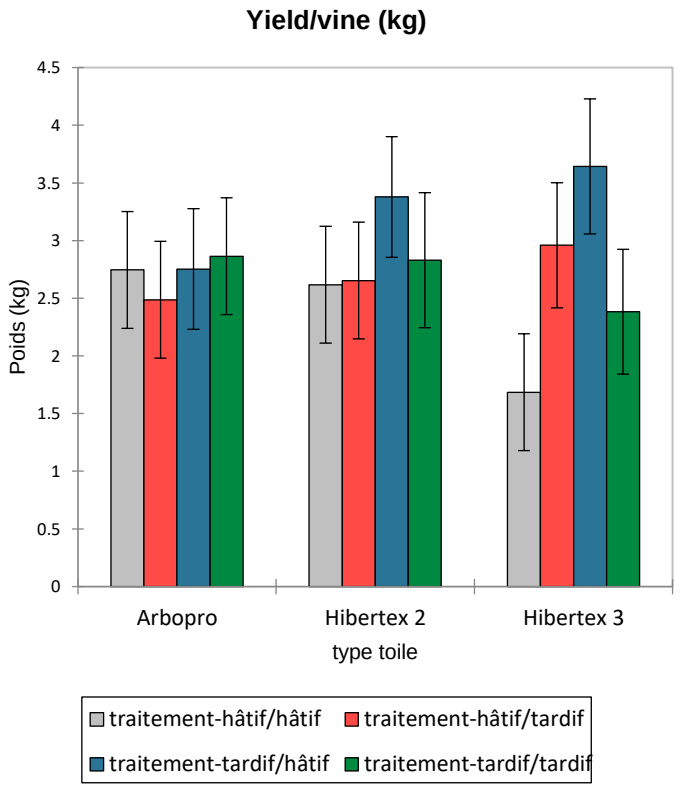




5b: but does it matter?

- None of the treatments had reproducible impact on yield or yield components
  - Need more years of data collection, could be vintage dependent…
  - …but unlikely with the little differences we see in temperature and phenological stage
- Two-way ANOVA doesn't identify any interaction between the type of geotextile and the timing for **yield**, **number of cluster**, **cluster weight**





5b: preliminary conclusions

- Types of geotextiles
  - No differences in temperature under geotextile as per preliminary statistical analysis
  - Because no differences between the types of geotextile, no impact on survival, yield or fruit quality
- Timing of installation and removal
  - Temperature under geotextile during acclimation are similar to outside
  - High temperatures under geotextile during deacclimation could impact hardiness and timing of budbreak in theory
  - Little overall impact on physiology, yield and yield components
- So far, it appears that any of the three geotextile is good, and timing of installation is flexible
  - Working on better understanding deacclimation dynamics

Acknowledgment

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- Special thanks to Alexander Campbell for all the pictures in this presentation
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