A Nova Scotia Wine Grape Deep Freeze Event: Climate Trends, Considerations and Pruning

Kentville Research and Development Centre (KRDC)
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Two notable and lethal winter low temperature events have occurred in Nova Scotia over the past three years. On February 15, 2020, and January 22, 2022, temperatures across much of Nova Scotia dropped below -20 °C and in some areas, below -25 °C. Location, topography, the direction of a slight breeze, tidal influence and other factors determined the minimum temperature reached at each site. In some cases, vineyards separated by only a few hundred metres saw nighttime lows differ by several degrees. Such variability is typical of a thermal inversion event, a condition where cool, dense air is allowed to settle near the ground and warmer air is found above. Instrument readings for the February 15, 2020 event showed that temperatures at 9 m (≈ 30') above the ground were roughly 5 °C warmer than temperatures at 1 m (≈ 3') above the ground in the KRDC vineyard.

Deep Freeze Fallout

- Bud mortality (**Figure 1**) was observed in many vineyards in the wake of both the February 15, 2020 and the January 22, 2022 events. Some sites were minimally impacted, while in others, losses approached 100%.
- Secondary and tertiary buds are typically more hardy (and smaller), but less fruitful than primary buds.
- Time will tell how the 2022 deep freeze event will affect the overall Nova Scotia crop load this year, but yields were notably down in the wake of the 2020 event.

Figure 1. A Chardonnay bud in the wake of the February 15, 2020 event shows a damaged, but still viable, secondary bud (left) and a non-viable primary bud (right).

The level of mortality varied depending on the minimum temperature reached and the grape variety, in addition to unknown factors requiring more research. Preliminary studies at the KRDC have found, somewhat surprisingly, that the crop load (at least in hybrids*) does not appear to have a strong influence on bud hardiness; however, harvest timing was found to have a moderate effect on both a hybrid and a vinifera. Data obtained from the Nova Scotia bud hardiness survey have shown that bud hardiness levels for a given variety can vary by a few degrees between sites. As the authors of the biweekly bud hardiness report, explaining this

* Vinifera were not yet tested locally, and literature on the topic is mixed.

site variability remains a topic of great interest. Research that investigates the impact of nutrient status could yield insights into how to grow hardier grapevines in Nova Scotia.

Winter Minimum Temperatures in a Changing Climate

Regardless of the length of the growing season or the amount of heat the vineyard receives, it only requires one night of lethal cold temperatures to wipe out a grape crop in a given year. The historical weather data (1913–2022) for Kentville, NS, show the following trends over this defined time period:

- The growing season has increased by roughly 40 days, and the number of base 10 °C growing degree days (GDD) from April 1 to October 31 has increased by 27%.
- The yearly average temperature has increased by by 1.9 °C (**Figure 2A**).
- The coldest temperature experienced each year has increased by an average of 6 °C, from -25.9 °C in 1913 to -19.9 °C in 2022 (**Figure 2B**).
- A -22 °C event would likely cause moderate damage to many vinifera sites, while a -25 °C event would devastate most vinifera sites and cause moderate damage to less hardy hybrid sites.
- The probability of either a -22 °C or -25 °C event occurring in a given year has decreased (**Figure 2C**).

In summary, our winters are growing disproportionately warmer relative to the overall warming trend; however, this also means our protective snow cover is becoming less reliable. Despite the overall warming trend, the year-to-year weather variability remains high, and a cool season or a damaging winter freeze, though less likely, remain possible in any given year. Furthermore, a warming climate has emboldened growers to increasingly push the envelope with what can be grown in Nova Scotia. Less winter-hardy wine grape varieties are increasingly being grown successfully in Nova Scotia, but with an elevated level of risk; 100 years ago, most vinifera varieties, and less hardy hybrids, would have experienced winter damage nearly every year **(Figure 2C)**.

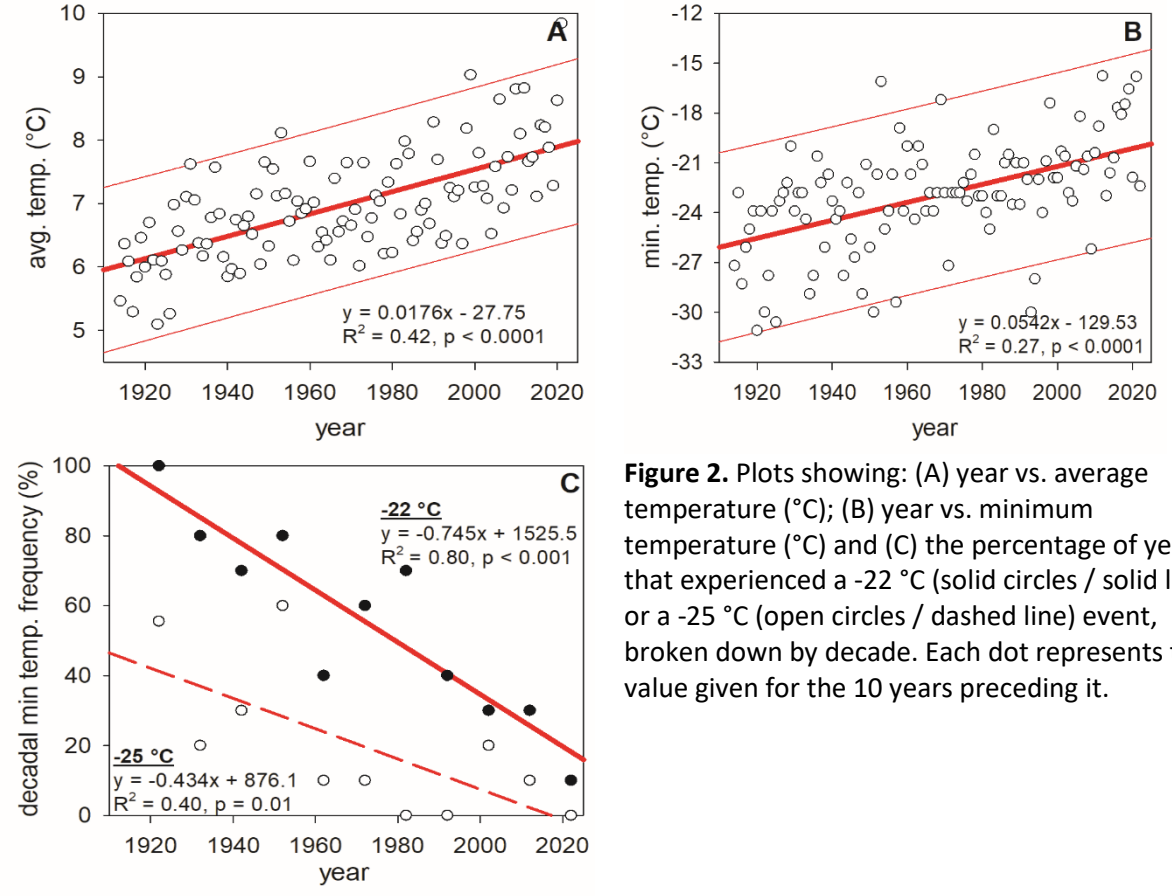

Figure 2. Plots showing: (A) year vs. average temperature (°C); (B) year vs. minimum temperature (°C) and (C) the percentage of years that experienced a -22 °C (solid circles / solid line) or a -25 °C (open circles / dashed line) event, broken down by decade. Each dot represents the value given for the 10 years preceding it.

Pruning After a Deep Freeze Event

It is important to understand the level of bud mortality before beginning to prune grapevines. Waiting until the coldest temperatures have passed reserves the option to lay down additional nodes, if necessary. In the wake of the February 15, 2020 event, which saw temperatures drop below -25 °C in the KRDC vineyard, a post-deep freeze pruning trial was conducted on both Chardonnay and Vidal vines. The primary and secondary bud mortality rates of the Chardonnay both exceeded 98%, while the hardier Vidal buds were slightly less damaged, with primary and secondary bud mortality levels of 76% and 66%, respectively. Four different pruning strategies were implemented: 1. 10-bud spur (minimal pruning), 2. 3-bud spur, 3. double cordon (i.e., 4 cordons, double the usual number), and 4. pruned back to the head (maximum pruning). Six panels (i.e., 24 vines) of each variety / pruning treatment were trialled using a randomized design. The effects of the treatment strategies can be found in **Table 1**.

- Spur pruning yielded a heavier crop for both varieties, but none of the pruning strategies produced a crop worth harvesting among the more heavily damaged Chardonnay.
- Spur pruning ("10-bud" + "3-bud") produced fewer shoots emanating from the head / fewer cordon options in the subsequent year (i.e., 2021).
- "Double cordon" and "head" treatments resulted in more vigour at the head.
- Overall vine vegetation, measured as dormant pruning mass (excludes cordons + spurs), was lower with the "head" treatment.
- Yields bounced back nicely in year 2, with no strong differences between pruning treatments.

Table 1. Post-deep freeze pruning trial vine performance

	2020 (year of freeze)					2021
Treatment	**yield (kg / vine)**	**shoot no. (head)**	**weak shoot no. (head)†**	**largest cane diameter (mm)‡**	**dormant pruning mass (kg)**	**yield (kg / vine)**
Chardonnay						
10-bud spur	0.23	3.5	0.74	12.4	0.82	4.2
3-bud spur	0.11	3.5	0.96	13.2	0.85	4.3
double cordon	0.06	6.0	1.35	15.1	0.80	4.2
head	0.03	7.3	1.54	14.1	0.60	4.1
Vidal						
10-bud spur	2.89	3.1	0.57	12.7	0.75	9.2
3-bud spur	2.86	3.6	0.96	12.5	0.75	7.9
double cordon	2.05	5.4	0.95	14.5	0.75	8.5
head	1.30	6.1	0.92	15.2	0.67	7.7

Other considerations in this trial included the ease of converting the vines from spur pruning back to cane pruning. In the year after the deep freeze event, the vines that were spur pruned required a number of large cuts, and it was difficult to remove the three-year-old cordon / spur material from the trellis system compared to the "double cordon" and "head" treatments. While numbers are too low to draw implications, six vines died during the course of this two-year study: four "10-bud", one "double" and one "head" treatment.

Acknowledgements

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† "weak shoot" definition: a shoot that did not reach the top catch wires and was therefore unsuitable for use as a cordon.

‡ This is the diameter of the *largest* cane emanating from the head and is *not* the average shoot diameter.